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BURNER CONTROL SYSTEM

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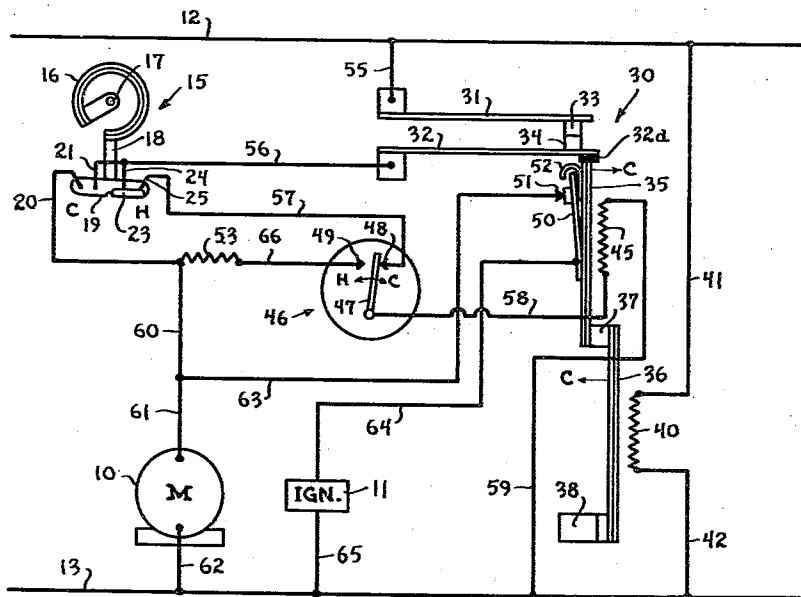


Fig. 1

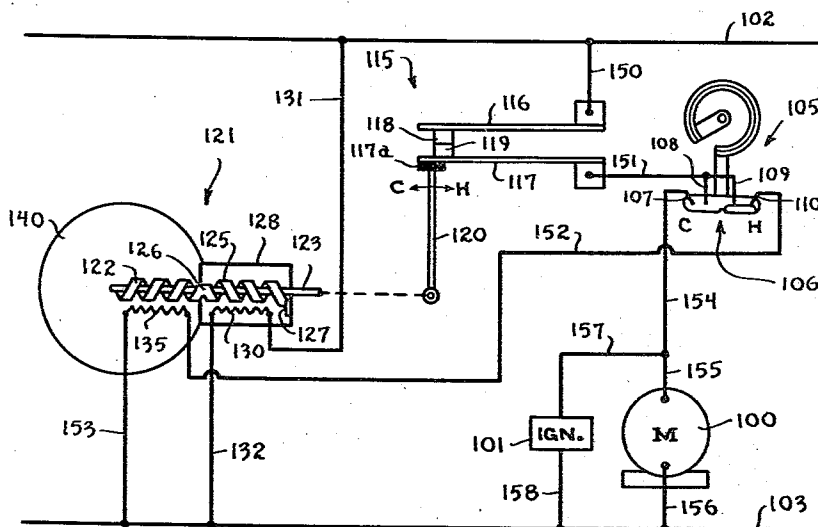


Fig. 2

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BURNER CONTROL SYSTEM

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12 Claims. (Cl. 236—68)

The present invention relates to burner controllers and more particularly to circuits including safety switches for an oil burner.

In systems of the class to which the instant control circuits apply, wherein a timer is adapted to trip a safety switch, dangerous conditions often occur when the timer fails. Timers which must be positively moved as a result of the application of heat by a heater prove extremely hazardous for practical use because the heaters may burn out. Many systems have been proposed which operate upon the principle of heat dissipation to move a timer. That is, the moving element is normally heated and, upon a call for heat by the space thermostat, the heater will be deenergized to allow said element to cool to thereby start the burner. In such systems the device is protected against burning out of the heater. However, if a power failure should occur, due to a burned out fuse, or a failure at the source of power, the device will go out on safety. Inasmuch as such power failures are quite frequent, it is desirable to use a safety switch which will not be placed out of operation because of such failure.

An object of this invention is to provide a simplified and efficient burner controller which obtains a maximum of safety.

Another object of the present invention is to provide a simplified burner control system which obviates the above recited difficulties.

A further object is to provide an improved safety switch which times the trial ignition period for an oil burner.

Another object is to provide a combustion responsive device in combination with a timer which will render a burner motor inoperative if the combustion responsive device fails to respond properly to the presence or absence of combustion.

A further object is to provide a timer which times the trial ignition period by utilizing a heat dissipating actuating element.

Another object is to provide a combustion controller which times the trial ignition period by the cooling of a control element which is heated when the burner is not in operation, cooled when the burner is placed into operation, heated if combustion is properly established, or cooled to break the burner motor circuit if combustion is not properly established.

Still another object, in connection with the last preceding object, is to provide such a controller which will break the burner motor circuit if a heater for the timer burns out, but will not

break the burner motor circuit in the event that a failure in the source of electric power should occur.

Other objects will be obvious or pointed out in the accompanying detailed description and in the appended claims.

For a complete understanding of my invention reference is made to the following specification and to the accompanying drawing, in which,

Figure 1 is a diagrammatic view of a preferred embodiment of my invention, and

Figure 2 is a diagrammatic view of a modification.

Referring more in detail to the drawing a motor 10 is shown which is adapted to operate an oil burner, a gas valve, or the like. An ignition means 11 is adapted to ignite the fuel which is delivered by the motor when in operation. Electrical energy is supplied from line wires 12 and 13 to the motor and to the ignition means.

The circuit to the motor 10 and the ignition means 11 is controlled by a thermostat 15. This thermostat is suitable for location in a space in which the temperature is to be controlled. The thermostat 15 comprises a bimetal 16 which is suitably secured to some suitable mounting means (not shown) by pin 17. The bimetal 16 has an arm 18 to which a snap acting switch, such as a mercury switch 19 is secured. The mercury switch is rendered snap acting by a suitable indentation in the center of the bottom thereof and has contacts 20 and 21 which are bridged by the mercury 23 when the bimetallic element 16 is cooled. Another pair of electrodes 24 and 25 are bridged by the mercury 23 when the bimetallic element 16 is hot.

A safety switch mechanism 30 is provided to break the circuit to the motor 10 and to the ignition means 11 in the event that an abnormal condition occurs, for example, failure of combustion or failure of the burner to start upon a call for heat by the thermostat 15. The safety switch 30 comprises a relatively stiff contact blade 31 and a relatively flexible contact blade 32 which is normally biased away from the blade 31 so that contacts 33 and 34 mounted on the blades will be held apart if blade 32 is released. A suitable heat motor is provided to maintain the contacts 33 and 34 in engagement for normal operation of the heating system. In the present instance this heat motor comprises a bimetal 35 which engages an insulating block 32a carried upon the contact blade 32. The bimetal 35 is mounted upon a compensating bimetal 36 by a bracket 37. The lower end of the bimetal 36 is

suitably secured to a mounting bracket 38 which may be suitably secured to a switch case (not shown). The bimetals 35 and 36 are so arranged that they will warp in opposite directions upon the application of heat to both of the bimetals. By so arranging the bimetals any deflection of the upper part of the bimetal 35 due to changes in ambient temperature will be compensated for by the bimetal 36.

The bimetal 36 has a heater 40 located adjacent thereto which is connected across the line wires 12 and 13 by electrical conductors 41 and 42. The bimetal 36 is selected so as to flex toward the right as shown in Figure 1 upon the application of heat thereto by the heater 40. In the event of a failure in the source of electric power which supplies energy to the line wires 12 and 13, the bimetallic element 36 will warp toward the left. The bimetal 35 is provided with a heater 45 which is arranged adjacent thereto and is adapted to supply heat to the bimetal 35 under control of the thermostat 15 and a combustion responsive device generally indicated at 46. The bimetal 35, in cooperation with the bimetal 36 and the heaters 40 and 45, is adapted to act as an ignition timing means.

The combustion responsive device 46 may be a conventional device which has a bimetallic element which extends into the stack of a furnace, or a device which is arranged so that a temperature responsive element will respond directly to the radiant heat of a flame present in the furnace upon the occurrence of combustion. For illustration purposes the combustion device 46 which is shown comprises a switch arm 47, a cold contact 48, and a hot contact 49. The cold contact 48 will be engaged by the contact arm 47 when there is no flame present in the combustion chamber and the contact 49 will be engaged by the contact arm 47 when combustion is present in the combustion chamber.

An ignition controller is carried by the bimetal 35. This controller comprises a press back contact blade 50 which is adapted to engage a contact 51 when the bimetal 35 is heated up to a predetermined value. A hook 52 is adapted to engage the upper end of the contact blade 50 to open the contact 51 when the bimetal 35 cools off. A resistance member 53 is placed in circuit by the combustion responsive device 46 to control the circuit to the heater 45 to cause the bimetal 35 to cool off a sufficient amount to open the contact 51 in a manner to be hereinafter more fully described.

Operation

With the device in the position shown the thermostat 15 is in the satisfied, or hot, position and the electrodes 24 and 25 are bridged by the mercury 23. A circuit is then established for the heater 45 for the bimetal 35 as follows: From the line wire 12 to the conductor 55, switch blade 31, contact 33, contact 34, switch blade 32, conductor 56, electrode 24, mercury 23, electrode 25, conductor 57, contact 48, contact arm 47, conductor 58, heater 45, and conductor 59 to the other line wire 13. Energization of the heater 45 will maintain the bimetal 35 in the position shown beneath the insulating piece 32a on the contact blade 32 and the contacts 50 and 51 closed.

Assuming now that the thermostat 15 cools off to rotate the mercury switch 19 toward the right and cause the mercury 23 to pass rapidly across the indentation in the bottom of the switch, to

open the contacts 24 and 25 and close the contacts 20 and 21. A circuit for the burner motor may then be traced as follows: From the line wire 12 through conductor 55, switch blade 31, contacts 33 and 34, switch blade 32, conductor 56, electrodes 20 and 21 through the mercury 23, conductor 60, conductor 61, the burner motor 10, and conductor 62 to the other line wire 13. Also a circuit for the ignition means 11 may be traced from the conductor 60 through the conductor 63, contact 51, contact blade 50, conductor 64, ignition means 11, and the conductor 65 to the other line wire 13.

When the circuit for the burner motor and ignition is established the circuit for the heater 45 through the hot contacts 24 and 25 on the thermostat 15 will be broken. Hence, the heater 45 will not supply heat to the bimetal 35 to maintain the bimetal in engagement with the insulating piece 32a carried by the contact arm 32. However, if the switch arm 47 of the combustion responsive device 46 moves into engagement with the hot contact 49 in response to the establishment of the combustion, before the bimetal 35 has cooled sufficiently to trip the contacts 33 and 34 to open position, then a circuit for the heater 45 may be traced as follows: From the line wire 12 through conductor 55, switch arm 31, contacts 33 and 34, switch arm 32, conductor 56, electrode 21, mercury 23, electrode 20, resistance 53, conductor 66, contact 49, contact arm 47, conductor 58, heater 45, and conductor 59 to the other line wire 13. If switch arm 47 should stick to cold contact 48 the above circuit will not be closed and bimetal 35 will open the switch 33, 34. It will be noted that the resistance 53 is now in series with the heater 45. This will result in the emanation of less heat from the heater 45 and hence the bimetal 35 will cool off an amount determined by resistance 53. It is desired that this cooling will not move the bimetal 35 out of engagement with the insulating block 32a but will be just sufficient to separate the contact 51 from the contact blade 50 to break the ignition circuit which was energized in the ignition circuit previously pointed out. This is the normal running condition of the system.

In the event that there is a flame failure or that combustion does not take place upon a call for heat by the thermostat 15, the contact blade 47 will not engage the contact 49 and there will be no circuit to the heater 45 for the bimetal 35. When this condition occurs the bimetal 35 will cool off and the upper end thereof will warp toward the right until it moves from beneath the insulating piece 32a thus permitting the contacts 33 and 34 to separate and shut down the system.

After the system has been shut down due to some undesirable condition the safety switch 30 must be manually reset. Any of several conventional reclosing means could be utilized and therefore none have been shown in the drawing.

In the event that the heater 45 should burn out it will be apparent that the bimetal 35 would move from beneath the insulating piece 32a to permit the safety switch to open. In the event the heater 40 for the compensating bimetal 36 should burn out the bimetal 35 would be moved in the opposite direction from beneath the insulating piece 32a by the warping of the bimetal 36 to permit opening of the safety switch. Hence it is seen that protection is given for the burning out of either of the heaters for the safety switch.

After a normal burner operation the thermo-

stat 15 will become satisfied and move into the position shown in Figure 1 to set up the original heating circuit for the bimetal 35 through the cold contact 48 of the combustion responsive switch. If the contact 47 should stick to the hot contact 49 and not engage the contact 48 the heater 45 will not be energized and the bimetal 35 will cool down to move out from beneath the insulating piece 32a to permit the contacts 33 and 34 of the safety switch to open. Hence it is seen that a system is provided wherein if the stack switch should stick in either the cold or the hot position the safety switch will break the electrical circuit so that the motor can not again be started up until manual attention has been given to the system.

Referring now to Figure 2, burner motor 100 and ignition means 101 are supplied with electrical energy from line wires 102 and 103. A thermostat 105 carries a snap acting mercury switch 106 which has contacts 107 and 108 which are closed when the thermostat is in the cold position and contacts 109 and 110 which are closed by the mercury when the thermostat is in the hot position. A safety switch 115 has a contact arm 116 which is relatively rigid, a flexible contact arm 117 which is biased so as to open the contacts 118 and 119 and an arm 120 which is moved by a combustion responsive device 121 and is adapted to engage an insulating piece 117a carried on the contact arm 117 to maintain the safety switch closed under normal operating conditions.

The combustion responsive device 121 serves as a timing means and comprises a bimetallic helix 122 which is wound so as to cause the contact arm 120 to rotate toward the left when the helix 122 cools off and to rotate the arm 120 toward the right when the bimetallic helix 122 is heated. A rod 123 is secured to the left end of the helix 122 and to the arm 120. A second helix 125 is secured to the helix 122 at the point 126. The helix 125 is wound oppositely to the helix 122 so that the two helices will rotate in opposite directions when heated. The helix 125 is mounted at 127 to a casing 128. Therefore, because the two helices rotate equally and oppositely, one end of the helix 125 being secured to the casing and the opposite end of the helix 122 being connected to the rod 123, the rod 123 will not be rotated due to changes in ambient temperatures which affect both of the helices in the same degree. A heater 130 normally supplies heat to the compensating helix 125 because it is connected across the line wires 102 and 103 by conductors 131 and 132. A heater 135 supplies heat to the helix 122 when the thermostat 105 is in the hot position as shown in the drawing. When the thermostat 105 is in the cold position no heat will be supplied to the helix 122 by the heater 135 and heat must be supplied by combustion to prevent the safety switch 115 from being opened. Means 140 are shown for supplying heat to the helix 122. This means may be the stack from the furnace or a window which is located adjacent the combustion chamber of a furnace or any other conventional means for causing a bimetal to respond to the presence of flame in a combustion chamber. It is anticipated that by exposing the helix 122 to a lesser degree of flame, as for example through a window directed at the flame itself, rather than locating the bimetallic helix in the stack, will affect an economy in electricity supplied to the heater 135 in that the heat supplied to the helix 122 by the heater 135 in some installations may need to be substantially the same as the heat supplied by

combustion. It is also fully anticipated that, by properly selecting the casing 128 for the helix 125, a differential temperature may be maintained between the two helices whereby a small heater 135 would be sufficient to prevent opening of the safety switch even though the combustion responsive element were subjected to a wide variation of temperature.

Operation of Figure 2

With the parts in the position shown the thermostat 105 is satisfied and a circuit for the heater 135 may be traced as follows: From the line wire 102 through conductor 150, switch arm 116, contacts 118 and 119, contact arm 117, conductor 151, electrodes 109 and 110, conductor 152, heater 135 and conductor 153 to the other line wire 103. At this time heat will be supplied to the helix 122 so that the arm 120 will be maintained in engagement with the insulating piece 117a to prevent opening of the contacts 118 and 119 of the safety switch 115.

Assuming now that the thermostat 105 cools so as to cause the contacts 109 and 110 to open and the contacts 107 and 108 to close with a rapid action due to the fact that the mercury within the switch must pass over an indentation in the bottom of the mercury switch. A circuit may now be traced for the motor and ignition means as follows: From line wire 102, conductor 150, switch arm 116, contacts 118 and 119, contact arm 117, conductor 151, electrodes 108 and 107, conductors 154, 155, motor 100, and conductor 156 to the other line wire 103. A circuit for the ignition may be traced from the conductor 154, through conductor 157, ignition means 101, and conductor 158 to the line wire 103.

Because the electrodes 109 and 110 are unbridged when the thermostat 105 is in the cold position there will be no energy supplied to the heater 135. In the event that flame does not occur in the combustion chamber the helix 122 will cool off to cause the arm 120 to move out from beneath the insulating piece 117a and permit the contacts 118 and 119 of safety switch 115 to open. However, if flame occurs before this section takes place then the heat of the flame will affect the helix 122 in a manner to cause the arm 120 to remain in engagement with the insulating piece 117a to keep the contacts 118 and 119 closed. Hence, it is seen that means are provided whereby a safety switch is combined with a combustion responsive switch to effect control in response to the presence of combustion in a combustion chamber upon a call for heat.

In the event of flame failure when the thermostat 105 has the motor and ignition means in operation, the combustion responsive helix 122 will cool off to move the arm 120 out of engagement with the insulating piece 117a to permit the contacts 118 and 119 to open thereby shutting down the system. Any suitable means can be used for manually resetting the system once it has been opened and therefore no means have been shown.

If either one of the heaters 130 or 135 should burn out of the contacts 118 and 119 will be permitted to open because the arm 120 can move from beneath the insulating piece 117a in either direction.

In the event of power failure in either of the systems shown in Figure 1 or Figure 2 there will be no drop out of the safety switches. When the power fails in the system shown in Figure 1 both

of the heaters 40 and 45 will be deenergized and, inasmuch as the bimetals 35 and 36 affected by the heaters warp in opposite directions they will both cool off and as they are arranged to compensate each other the upper end of blade 35 will not move and the safety switch will not be opened. In the system shown in Figure 2 the same situation will obtain inasmuch as the bimetallic helixes 122 and 125 are oppositely wound and compensate each other for the same change in temperature affecting both bimetals.

While I have shown two preferred embodiments which my invention may take, it is obvious that many modifications will occur to those skilled in the art. Many modifications utilizing timing by cooling in a combustion responsive control device while still preventing drop out on power failure will become apparent to those skilled in the art. Hence I do not wish to be limited by those forms shown and described but by the spirit and scope of the appended claims and the status of the prior art.

I claim as my invention:

1. In a burner control system comprising an electrically operable fuel controller and a controlling circuit therefor including a normally closed safety switch, in combination, timing means including a first element movable in a first direction upon heating and in a second direction upon cooling to mechanically open said safety switch when cool and to hold said safety switch closed when hot, a continuously heated second compensating element operatively connected to said first element to compensate it for changes in ambient temperature, and means for causing heating of said first element when said controlling circuit is open but not when said circuit is closed, said first element being heated as a result of successful combustion.

2. In a timing device for a combustion control system, in combination, normally closed switch means in circuit with a fuel controller, timing means including a first element movable in a first direction upon heating and in a second direction upon cooling to open said circuit when moved beyond a predetermined range of movement, a continuously heated second compensating element associated with said first element and movable in said second direction upon heating and in said first direction upon cooling, said second element being adapted to compensate said first element for ambient temperature variations under normal operating conditions of said combustion controller system, means for heating said first element under normal operating conditions of said combustion controller system to prevent opening of said switch means, and means associated with said timing means for causing said switch means to open when an abnormal condition exists.

3. In a fuel burner control system, in combination, an electrically operable fuel controller, a circuit therefor, circuit control means to open and close said circuit, a normally closed safety switch associated with said circuit in a manner to interrupt said circuit, timing means including an element movable in a first direction upon heating and in a second direction upon cooling, said element being associated with said safety switch in a manner to open said safety switch upon movement of said element beyond a predetermined range of movement, heating means to supply heat to said element, combustion responsive means movable between hot and cold positions for controlling the supply of heat to

said element at all times in a manner to prevent opening of said safety switch under normal operating conditions of said system, an electrically operable fuel ignition circuit controlled by said element, and means for affecting the heat capacity of said heating means to effect control of said ignition circuit when said combustion responsive means moves between hot and cold positions.

4. In a fuel burner control system, in combination, fuel burner means, an electrically operable fuel controller including a circuit therefor, a normally closed safety switch operable to interrupt said circuit, timing means including an element comprising means responsive to heat from the fuel burner and being movable in a first direction upon heating and in a second direction upon cooling, said element being operable to open said safety switch upon movement of said element beyond a predetermined range of movement, heating means to supply heat to said element, and condition responsive means movable between a plurality of positions, one of said positions completing a circuit to said fuel controller and breaking a circuit to said heating means to thereby render said element dependent for heat upon said fuel burner, and another of said positions completing a circuit to said heating means and breaking said circuit to said fuel controller.

5. In a fuel burner control system, in combination, an electrically operable fuel controller for fuel burner means and including a circuit therefor, a normally closed safety switch operable to interrupt said circuit whenever the safety switch opens, timing means including an element comprising means responsive to heat from the fuel burner and being movable in a first direction upon heating and in a second direction upon cooling, said element being operable to open said safety switch upon movement of said element beyond a predetermined range of movement, heating means to supply heat to said element, condition responsive means movable between a plurality of positions, one of said positions completing a circuit to said fuel controller for initiating burner operation and breaking a circuit to said heating means to thereby render said element dependent for heat upon said fuel burner, and another of said positions completing a circuit to said heating means and breaking said circuit to said fuel controller to terminate burner operation, compensating means associated with said element movable in said second direction upon heating and said first direction upon cooling to thereby compensate said element for variations in ambient temperature, and electric heating means associated with said compensating means to prevent opening of said safety switch upon power failure.

6. In a fuel burner control system, in combination, a normally closed safety switch, thermal timing means operable upon cooling to open said safety switch, said timing means being so located with respect to said fuel burner so as to be affected by the heat produced thereby when the burner is operating, and control means to supply heat to said timing means only when said burner is not operating.

7. In a fuel burner control system, in combination, a normally closed safety switch, thermal timing means operable upon cooling to open said safety switch, said timing means being so located with respect to said fuel burner as to be affected by the heat produced thereby when the burner is operating, control means to supply heat to said

timing means and when said burner is not operating, and compensating means associated with said timing means for preventing said safety switch from opening due to power failure.

8. In a burner control system comprising an electrically operable fuel controller and a controlling circuit therefor including a normally closed safety switch, in combination, a thermal element associated with said safety switch, a heater for heating said thermal element to maintain said safety switch closed, said safety switch being opened when said thermal element is cooled, a combustion responsive device movable between hot and cold contact positions in response to combustion, and a thermostat movable between hot and cold contact positions in response to ambient temperature, the hot contact of said thermostat and the cold contact of said combustion responsive device being adapted to cooperate to control said heater when said fuel controller is not in operation, the cold contact of said thermostat and the hot contact of said combustion responsive device being adapted to cooperate to control said heater when said fuel controller is in operation.

9. In a burner control system comprising an electrically operable fuel controller and a controlling circuit therefor including a normally closed safety switch, in combination, a thermal element associated with said safety switch, a heater for heating said thermal element to maintain said safety switch closed, said safety switch being opened when said thermal element is cooled, a combustion responsive device movable between hot and cold contact positions in response to combustion, a thermostat movable between hot and cold contact positions in response to ambient temperature, the hot contact of said thermostat and the cold contact of said combustion responsive device being adapted to cooperate to control said heater when said fuel controller is not in operation, the cold contact of said thermostat and the hot contact of said combustion responsive device being adapted to cooperate to control said heater when said fuel controller is in operation, ignition control means associated with said thermal element, and resistance means associated in circuit with said heater and the hot contact of said combustion responsive means for controlling said ignition control means by causing said thermal element to move only a predetermined amount when the resistance means is placed in circuit.

10. In a burner control system comprising an electrically operable fuel controller and a controlling circuit therefor including a normally closed safety switch, a normally heated first distortable bimetal movable in a first direction upon heating and in a second direction upon cooling

operatively connected at its first end with said safety switch to hold the same closed when hot and to open the same when cool, a second distortable bimetal fixed at its first end and secured at its second end to the second end of said first bimetal and movable in directions opposite with respect thereto upon heating and cooling to thereby compensate the same for fluctuations in ambient temperature, an electric heater adjacent said second bimetal for continuously heating the same, an ambient temperature responsive thermostat, means for heating said first bimetal, and switch means operable by said thermostat for controlling the supply of heat to said first bimetal.

11. A fuel burner control system comprising in combination, hot and cold switches, a heat demand responsive device for opening the hot and closing the cold switch on a demand for heat and opening the cold and closing the hot upon becoming satisfied, an electrical fuel feeding device, a circuit therefor including said cold switch, a safety switch in control of said fuel feeding device, a thermal timer which when cold opens said safety switch, means for maintaining a supply of heat to said thermal timer during a demand for heat by said responsive device, said last named means including said cold switch, said supply of heat being dependent upon the establishment of combustion, and a heating circuit for said thermal timer including said hot switch for maintaining said timer in its hot position while said responsive device is satisfied.

12. A burner control circuit in combination comprising, fuel supply means and a circuit including control means therefor, thermally operated timing means including means for supplying heat thereto at a first value when the fuel supply circuit is opened by the control means and to supply the timing means with heat at a second value upon the establishment of combustion, a safety switch in the fuel control circuit which is maintained in a closed position by the said timing means when the timing means is supplied with heat within a predetermined range including said first and second values and which is opened when the timing means is not supplied with heat sufficient to maintain it at a temperature within said range, combustion responsive means for controlling the supply of heat to said timing means to maintain the supply at the said second value when combustion is established, and ignition means controlled by said timing means for operation of the igniter only when the supply of heat to the timing means is maintained at said first value.

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