May 13, 1941. W. L. McGRATH 2,242,183

FUEL BURNER CONTROL SYSTEM

Filed June 21, 1939

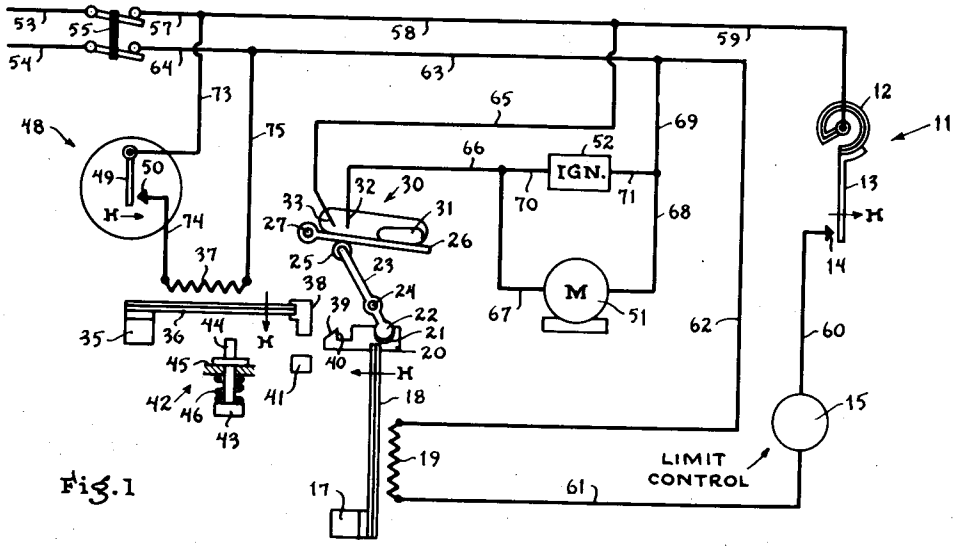

Fig. 1

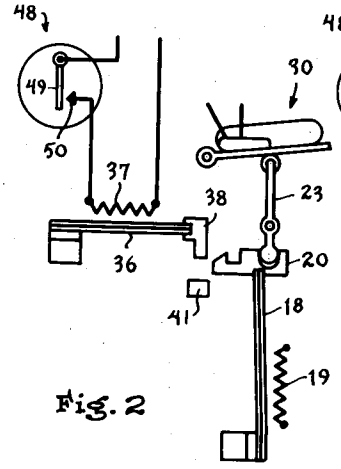

Fig. 2

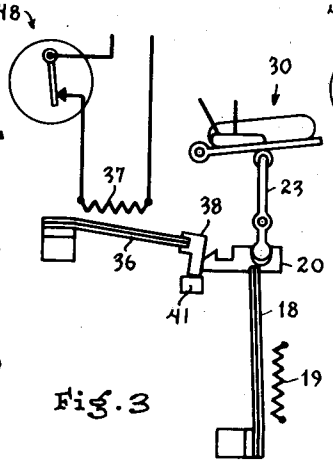

Fig. 3

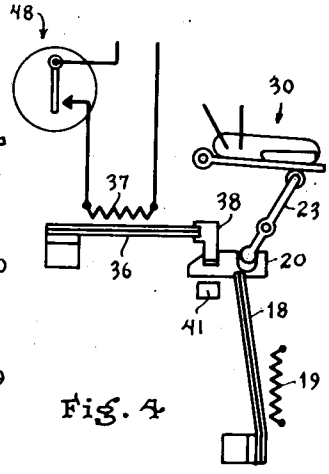

Fig. 4

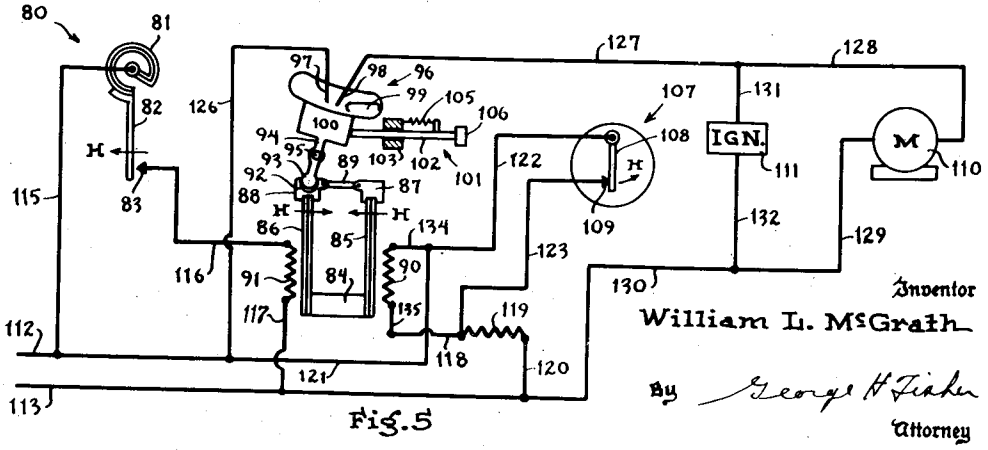

Fig. 5

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FUEL BURNER CONTROL SYSTEM

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16 Claims. (Cl. 158—28)

This invention relates to a simplified system for electrically controlling fuel burners and is directed more particularly to that type of system wherein the fuel feeding device is directly controlled by timers, making it possible to obtain the proper control without the necessity for relays and complicated circuits.

One of the main objects of the invention is to provide a system in which a timer closes a switch in the circuit to the fuel feeding device and then reopens the switch after a predetermined length of time if combustion has not been obtained.

Another object is to provide a combustion responsive device for preventing the timer from reopening the switch if combustion takes place thereby maintaining the circuit to the fuel feeding device closed as long as the timer remains energized.

Still another object is to provide a system in which the timers are thermal elements having electric heaters, one of the elements being energized to close the switch in the circuit to the fuel feeding device and the other being energized in response to combustion to physically prevent the reopening of the switch by the first timer.

Another object is to fix two bimetal timers at one end and connect them at their free ends, the timers being oppositely disposed so that when both are heated no motion will take place but when only one is heated that one will develope sufficient force to bend both of them.

Still another object is to pivotally mount a mercury switch and actuate it by means of a lever so mounted that as the lever rotates in one direction the mercury switch will be first closed and then opened.

These and other objects will readily become apparent to those skilled in the art as the following specification is read in the light of the accompanying drawing in which:

Figure 1 is a diagrammatic representation of one form of my invention, the parts being shown in their deenergized positions;

Figure 2 is a partial view showing the two timers, the combustion responsive switch, and the switch in control of the fuel feeding device in the positions they occupy shortly after the first timer has been energized;

Figure 3 is a view similar to Figure 2 showing the position of the parts after combustion has been obtained;

Figure 4 is a view similar to Figures 2 and 3 showing the position of the parts in the absence of combustion and when the switch has been locked in open position, and

Figure 5 shows a modified form of my invention.

Referring now to Figure 1, the main control for my fuel burner control system may be in the form of a room thermostat indicated generally at 11 which is shown as comprising a bimetal coil 12 which is fixed at one end and which carries at its free end a switch blade 13. On a decrease in temperature to a predetermined value, the bimetal coil 12 will move the switch blade 13 into engagement with the stationary contact 14. The room thermostat 11 is wired in series with the usual limit control 15 which may act to open the circuit on an increase in boiler temperature or pressure above a predetermined value.

Fastened to the bracket 17 is one end of a bimetallic timer 18. The timer 18 is provided with an electric heating element 19 for producing a timed movement thereof. Carried on the upper end of the timer 18 is an actuating block 20 which is provided with a depression 21 in which is seated a rounded end 22 of a lever 23 which is shown as pivoted at 24. The other end of the lever 23 is provided with a roller 25 which engages the under side of a second lever 26 which is shown to be pivoted at 27. Lever 26 carries thereon a mercury switch generally indicated at 30. This switch may be of the usual glass tube type which contains a globule of mercury 31 which acts to bridge and unbridge the electrodes 32 and 33.

Secured to the bracket 35 is a second bimetallic timer 36 with which is associated an electrical heater 37. A latch member 38 is carried on the free end of the bimetallic timer 36. The latch 38 is adapted to cooperate with the cam surface 39 and depression 40 on the actuating block 20 under certain circumstances which are described in detail hereinafter. On being heated by the heater 37, the bimetallic timer 36 warps in a downwardly direction and its motion is limited by means of a stop 41. Reset member 42 comprises a knob 43 and stem 44 which is slidably received in an opening in a stationary member 45. A coil spring 46 biases the reset member to the position shown in Figure 1. If the bimetallic timer 36 is in its deflected position, it may be manually moved by pressing on the knob 43 of the reset member. This action becomes necessary in releasing the latch as will be explained more fully hereinafter.

A combustion responsive device is indicated generally at 48 and comprises a switch arm 49

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and stationary contact 50. This device is shown diagrammatically but it will be appreciated that the switch arm 49 is actuated by means of an element which is responsive to combustion in the furnace controlled by the present system. As is well known in the art, the element is connected to the switch arm by means of a slip friction device so that the switch is actuated not in response to any definite temperature but rather in response to a change in temperature produced by the appearance or disappearance of a flame in the furnace. This switch is so arranged that when combustion is obtained the switch arm 49 will engage the stationary contact 50.

This system is provided with the usual fuel feeding device in the form of an electric burner motor 51. An ignition means 52 is also provided for igniting the fuel delivered by the motor 51. Electric power is supplied to the system from supply lines 53 and 54 over a double-pole single-throw manually operated switch indicated at 55.

In considering the operation of this system, let it be assumed that the room thermostat 11 has been satisfied for a sufficient length of time to permit the combustion device 48 to have separated the switch arm 49 from the contact 50 and for the bimetallic timers 18 and 36 to have returned to their cold positions. Under these conditions the burner motor 51 will be deenergized and the temperature in the room will decrease. After the room temperature has decreased to a predetermined value, the bimetallic element 12 will move the switch arm 13 into engagement with the stationary contact 14 which will establish the following circuit: supply line 53, manual switch 55, conductors 57, 58, and 59, bimetallic element 12, switch arm 13, contact 14, conductor 60, limit control 15, conductor 61, electric heater 19, conductors 62, 63, and 64, and manual switch 55 back to the other supply line 54. The above circuit energizes the heater 19 and causes the bimetallic timer 18 to heat up and flex to the left. This causes a rotation of the lever 23 toward a vertical position resulting in a raising of the lever 26 which causes the mercury 31 to bridge electrodes 32 and 33. Figure 2 shows the parts in this position. When the mercury bridges the electrodes 32 and 33 it closes the following circuit: from conductor 58 to conductor 65, electrode 33, mercury 31, electrode 32, conductors 66 and 67, burner motor 51, and conductors 68 and 69 back to the conductor 63. This circuit energizes the burner motor 51 and it will be noted that the ignition means 52 is connected in parallel with motor 51 by means of conductors 70 and 71. In other words, this system is a constant ignition system wherein the ignition means is energized during the entire time that the burner motor is running. This system could easily be changed into an intermittent ignition system by putting a switch in conductor 70 which can be opened by the combustion responsive device 48, or if desired, this switch could be opened by the timer 36 as it warps downwardly and strikes stop 41.

Energization of the burner motor and ignition means will normally produce combustion within the furnace which will cause the combustion responsive device 48 to move the switch arm 49 into engagement with the stationary contact 50. This results in closing a circuit from the conductor 57 to conductor 73, switch arm 49, contact 50, conductor 74, electric heater 37, and conductor 75 back to conductor 64. Energization of the heater 37 will cause the bimetallic timer 36 to heat up and warp in a downwardly direction. The timers 18 and 36 are so related that under normal conditions the timer 18 will close the mercury switch 30 to produce combustion resulting in the warping of the timer 36 which will heat up and engage the stop 41 before the timer 18 will have warped sufficiently for the actuating block 20 to engage the latch 38. With the bimetallic timer 36 in its hot position, the latch 38 acts as a stop for the actuating block 20 thereby preventing further warping of the timer 18 as is clearly shown in Figure 3. The arrangement is such that the timer 18 will be stopped in a position where it holds the mercury switch 30 closed and therefore the burner motor and ignition means will remain energized. This is the normal running condition of the system.

As a result of the operation of the burner motor and ignition means, the temperature in the room will begin to rise and after it has reached a predetermined value the bimetallic element 12 will move the switch arm 13 out of engagement with the stationary contact 14. This results in breaking the circuit to the electric heater 19 and the bimetallic element 18 will begin to cool and return to its original position thereby opening the mercury switch 30. This breaks the circuit to the fuel burner motor and as a result the delivery of fuel to the burner will be stopped. In response to the failure of combustion the combustion responsive device 48 will cause the switch arm 49 to separate from contact 50 and the resultant deenergization of the electric heater 37 will cause the bimetallic timer 36 to return to its original position as shown in Figure 1.

If the bimetallic timer 18 closes the mercury switch 30 in response to a demand for heat by the room thermostat 11 and combustion does not take place, the heater 37 will remain deenergized because the combustion responsive device 48 will not close the switch arm 49 against the contact 50. The bimetallic timer 18 will therefore continue to flex toward the left as viewed in Figure 1 and the latch 38 will ride up on the cam surface 39 until it drops into the depression 40 in the actuator block 20. At this time the bimetallic timer 18 will have flexed far enough to rotate the lever 23 to a position where the lever 26 has reopened the mercury switch 30. This condition is illustrated in Figure 4 and at this time it will be seen that the latch 38 locks the bimetallic timer 18 in its warped position and prevents the reclosing of the mercury switch 30.

With the switch 30 locked in open position, the owner will be aware of the fact that there is something wrong with the system and he will open the manual switch 55 to remove the power from the system and remedy the cause of the trouble. He will then press the knob 43 of the reset member which will manually raise the bimetallic timer 36 permitting the bimetallic timer 18 to return to its cold position. After the reset member has been released, the manual switch 55 may be reclosed and the system is then in condition to make another attempt at a normal start.

It will be clear also that if the system is running normally with the parts in the position shown in Figure 3 and a combustion failure should occur, the combustion responsive device 48 will cause the switch arm 49 to separate from the contact 50. This will deenergize the heater 37 and the bimetallic timer 36 will warp upwardly until it releases the actuating block 20 for movement by the bimetallic timer 18. As the heater 19 is still energized the bimetallic

timer 18 will immediately swing the actuating block 20 to the left and cause the latch to lock the parts as shown in Figure 4. This will reopen the mercury switch 30 and the system will be shut down as described above.

If a power failure should occur at any time, both of the heaters 19 and 37 will be deenergized and the timers will return to their cold positions where they can make a normal start when power is resumed.

Figure 5 discloses a slightly modified form of my invention. This system is also provided with a room thermostat disclosed generally at 80 and provided with a bimetallic element 81 and switch arm 82 which cooperates with a stationary contact 83. The bracket 84 carries one end of each of a pair of bimetallic timers 85 and 86. The timer 85 carries a block 87 at its free end and timer 86 carries a block 88 at its free end. These two blocks are pivotally connected by means of the link 89. An electric heater 90 is positioned to heat the timer 85 and electric heater 91 is adapted to heat the timer 86. The block 88 is provided with a depression 92 in which is seated the rounded end 93 of the lever 94 shown as being pivoted at 95. The upper end of the lever 94 carries a mercury switch generally indicated at 96. This switch may be of the usual glass tube type and is shown as curved and having a pair of electrodes 97 and 98. A globule of mercury 99 is located within the tube to alternately bridge and unbridge the two electrodes. The lever 94 is provided with a shoulder 100 with which a latch generally indicated at 101 is adapted to cooperate when the lever is rotated beyond a predetermined position in a counter-clockwise direction. The latch 101 comprises a stem 102 which slides within a stationary support 103. The latch is biased toward the left as seen in Figure 5 by means of a light spring 105. The stem is provided with a knob 106 whereby the latch member may be manually withdrawn when it is desired to reset the switch 96. This system is provided with a combustion responsive device 107 which is exactly like the device 48 described in connection with the first modification except that the switch arm 108 is adapted to be moved away from the stationary contact 109 in response to combustion. This system is also provided with a fuel feeding device in the form of a burner motor 110 and an ignition means 111. Electric power is supplied to the system by means of supply lines 112 and 113.

Assuming that the temperature in the room has been at or above the desired value for some time, the parts will be in the position shown in Figure 5. At this time the mercury switch 96 will be in open position and the burner motor 110 and ignition device 111 will be deenergized. As a result the temperature will decrease in the room until the bimetallic element 81 causes the switch arm 82 to engage the stationary contact 83. This will establish the following circuit: line wire 112, conductor 115, bimetallic element 81, switch arm 82, stationary contact 83, conductor 116, heater 91, and conductor 117 back to line wire 113. This circuit results in the energization of electric heater 91 which will heat the bimetallic timer 86 and cause it to warp toward the right. It will be noted at this time that the electric heating element 90 is shunted by the following circuit: line wire 112, conductors 121, 122, switch arm 108, contact 109, conductor 123, protective resistance 119, and conductor 120 back to line wire 113. Electric heater 90 is therefore deenergized.

As the bimetallic timer 86 heats up it will warp toward the right bending the bimetallic timer 85 in the same direction. This will cause the lever 94 to rotate in a direction to cause the mercury 99 to bridge the electrodes 97 and 98. This results in the energization of the burner motor 110 and ignition means 111 by means of the following circuit: from line wire 112, conductor 126, electrode 97, mercury 99, electrode 98, conductors 127 and 128, burner motor 110, and conductors 129 and 130 back to line wire 113. The ignition means is connected in parallel with the burner motor 110 by means of conductors 131 and 132.

Energization of the burner motor 110 and ignition means 111 will normally produce combustion with the result that the combustion responsive device 107 will cause the switch arm 108 to separate from contact 109 and break the shunt circuit around the electric heater 90. The heater 90 will now be energized by the following circuit: line wire 112, conductors 121 and 134, electric heater 90, conductors 135 and 118, protective resistance 119, and conductor 120 back to line wire 113. The resultant energization of the heater 90 causes the bimetallic timer 85 to heat up and tend to warp toward the left in opposition to the warping movement of the bimetallic timer 86. The timers 85 and 86 are so related that at this time the timer 85 will exert just sufficient force on the timer 86 to hold it in a position to maintain the mercury switch 96 in closed position thereby maintaining the burner motor 110 and ignition means 111 energized. This is the normal running condition of the system.

When the room thermostat 80 is satisfied, the switch arm 82 will be moved out of engagement with the contact 83. This will deenergize the heater 91 and cause the bimetallic timer 86 to flex toward the left and move the mercury switch 96 to open position. The burner motor 110 and ignition means 111 will then be deenergized and the resultant failure of combustion will cause the combustion responsive device 107 to move the switch arm 108 into engagement with contact 109 and reestablish the shunt circuit around the heater 90.

If the room thermostat calls for heat and energizes the heater 91, the bimetallic timer 86 will close the mercury switch 96 energizing the burner motor 110 and ignition means 111. If combustion is not established at this time, the switch arm 108 will remain in contact with the stationary contact 109 thus preventing the energization of the electric heater 90. The bimetallic timer 85 will therefore not oppose the warping of the bimetallic timer 86 toward the right and this movement continues until the mercury switch 96 is reopened thereby deenergizing the burner motor 110 and ignition means 111. At this time the latch 102 will be pulled beneath the shoulder 100 on the lever 94 by means of the spring 105, thereby locking the switch 96 in open position. This apprises the owner of the fact that there is something wrong with the system and he opens the manual switch in the power supply, such as the switch 55 shown in Figure 1, and corrects the trouble. After this he releases the latch 101 by means of the knob 106 and the parts return to the cold position. The system is now in a condition to make another attempt at a normal start when the manual power delivery switch is closed.

It will also be understood that if a flame failure occurs while the system is running normally the

combustion responsive device 107 will move the switch arm 108 into engagement with contact 109 which completes the shunt circuit around heater 90. The resultant deenergization of this heater permits the bimetallic timer 85 to be moved toward the right under the influence of the bimetallic timer 86 and its heater 91 and the mercury switch 96 will be reopened and latched in open position as in the case when combustion is not obtained on starting.

On a failure of power the heaters 90 and 91 will be deenergized and the parts will return to their cold position where they will be ready to attempt a normal start.

This system may also be made an intermittent ignition system by having the combustion responsive device 107 open an ignition switch in conductor 131 or 132 as the combustion responsive device heats up.

It is thus seen that I have provided in the above described systems a simplified control in which no magnetic relays or complicated circuits are necessary and yet one which provides the proper safety features in the event of ignition failure or flame failure.

As various changes and modifications in these systems may occur to those who are skilled in the art, it is to be understood that I am to be limited only by the scope of the appended claims and not by the specific embodiment disclosed.

I claim as my invention:

1. A control system comprising in combination, first and second timers, a fuel feeding device, a first means for causing actuation of said first timer to render said fuel feeding device operative, and second means responsive to combustion produced by said fuel feeding device for causing actuation of said second timer, said first timer rendering said fuel feeding device inoperative again after a predetermined length of time unless said second means shall have caused actuation of said second timer first to cause it to mechanically oppose further movement of said first timer to prevent such action.

2. A control system comprising in combination, first and second timers, a fuel feeding device, a first means for energizing said first timer to render said fuel feeding device operative, second means responsive to combustion produced by said fuel feeding device for energiizng said second timer, said first timer rendering said fuel feeding device inoperative again after a predetermined length of time unless said second means shall have energized said second timer first to cause it to mechanically oppose further movement of said first timer to prevent such action, and means for locking said first timer to prevent its automatic return in the event that it renders said fuel feeding device inoperative before said second timer is energized.

3. A control system comprising in combination, first and second timers, a fuel feeding device, a first means for energizing said first timer to render said fuel feeding device operative, second means responsive to combustion produced by said fuel feeding device for energizing said second timer, said first timer rendering said fuel feeding device inoperative again after a predetermined length of time unless said second means shall have energized said second timer first to cause it to mechanically oppose further movement of said first timer to prevent such action, means for locking said first timer to prevent its automatic return in the event that it renders said fuel feeding device inoperaive before said second timer is energized, and manual means for releasing said locking means to permit said first timer to return automatically to its original position.

4. A control system comprising in combination a first bimetallic element fixed at one end, a second bimetallic element fixed at one end, means connecting the free ends of said elements, a fuel feeding device, a switch in control thereof, a heater for said first element, means for energizing said heater to cause said first element to warp and close said switch and then reopen it a predetermined time later, a second heater for said second element, and means responsive to combustion produced by said fuel feeding device for energizing said second heater to cause said second element to resist the warping movement of said first element and thereby prevent said first element from reopening said switch.

5. A control system comprising in combination a first bimetallic element fixed at one end, a second bimetallic element fixed at one end, means connecting the free ends of said elements, a fuel feeding device, a switch in control thereof, a heater for said first element, means for energizing said heater to cause said first element to warp and close said switch and then reopen it a predetermined time later, a second heater for said second element, means responsive to combustion produced by said fuel feeding device for energizing said second heater to cause said second element to resist the warping movement of said first element and thereby prevent said first element from reopening said switch, and means to lock said switch in open position after it has been reopened due to failure to obtain combustion.

6. A fuel burner control system comprising, a timer, an electrical fuel feeding device, a switch in control of said device, means for energizing said timer continuously to close said switch for a predetermined period of time and then open it again, means physically opposing said timer as a result of the establishment of combustion, for preventing said timer from opening said switch, and means for locking said switch in open position in the event that combustion does not occur before said timer reopens said switch.

7. A fuel burner control system comprising, a timer, an electrical fuel feeding device, a switch in control of said device, means for energizing said timer continuously to close said switch for a predetermined period of time and then open it again, and means responsive to combustion for physically opposing further movement of said timer thereby preventing it from reopening said switch.

8. A fuel burner control system comprising, a timer, an electrical fuel feeding device, a switch in control of said device, means for energizing said timer to close said switch for a predetermined period of time and then open it, thermally responsive means, a heater therefor, and means responsive to combustion for energizing said heater whereby said thermally responsive means physically opposes said timer to prevent it from reopening said switch.

9. A fuel burner control system comprising, a timer, an electrical fuel feeding device, a switch in control of said device, means for energizing said timer to close said switch for a predetermined period of time and then open it, thermally responsive means, a heater therefor, means responsive to combustion for energizing said heater whereby said thermally responsive means physically op-

poses said timer to prevent it from reopening said switch, and a latch carried by said thermally responsive means, said timer operatively engaging said latch whereby said switch is locked in open position in the event that combustion does not take place.

10. A fuel burner control system comprising, a timer, an electrical fuel feeding device, a switch in control of said device, means for energizing said timer to close said switch for a predetermined period of time and then open it, thermally responsive means, a heater therefor, means responsive to combustion for energizing said heater whereby said thermally responsive means physically opposes said timer to prevent it from reopening said switch, a latch carried by said thermally responsive means, said timer operatively engaging said latch whereby said switch is locked in open position in the event that combustion does not take place, and means for manually moving said thermally responsive means to release said latch and permit said timer to return to its original position.

11. A fuel burner control system comprising, a timer, an electrical fuel feeding device, a switch in control of said device, means for energizing said timer to close said switch for a predetermined period of time and then open it, thermally responsive means, a heater therefor, means responsive to combustion for energizing said heater whereby said thermally responsive means physically opposes said timer to prevent it from reopening said switch, and means for latching said switch in open position in the event that combustion does not take place.

12. A control system comprising in combination, an electrical fuel feeding device, a control switch therefor, a bimetal timer associated with said switch, electric heating means for said timer, a main switch for energizing said heating means to cause said timer to first close said control switch and then open it again after a predetermined time, a second bimetal timer, an electric heating means therefor, and means responsive to combustion for energizing said last named heating means to cause said second timer to warp and prevent said first timer from reopening said switch.

13. A control system comprising in combination, an electrical fuel feeding device, a control switch therefor, a bimetal timer associated with said switch, electric heating means for said timer, a main switch for energizing said heating means to cause said timer to first close said control switch and then open it again after a predetermined time, a second bimetal timer, an electric heating means therefor, means responsive to combustion for energizing said last named heating means to cause said second timer to warp and prevent said first timer from reopening said switch, and latch means, said latch means acting on failure to obtain combustion to lock said switch in open position.

14. A control system of the class described comprising in combination, an electrical fuel feeding device, an electric circuit therefor, a pivoted mercury switch in control of said circuit, a pivoted lever for tipping said mercury switch, a timer operatively associated with said lever, means for energizing said timer to rotate said lever and tip said mercury switch to closed position and then after a predetermined time to open position again, a resilient member carrying a latch, said latch cooperating with said timer after it has reopened said switch to lock said switch in open position, said resilient member comprising a bimetallic element, a heater for said bimetallic element, and means responsive to combustion for energizing said heater to cause said element to warp and prevent said timer from reopening said switch.

15. A fuel burner control system comprising, a timer, an electrical fuel feeding device, a switch in control of said device, means for continuously energizing said timer to cause it to move in a direction to close said switch for a predetermined period of time and then open it again, and means responsive to combustion for physically preventing said timer from moving sufficiently to open said switch, a subsequent failure of combustion rendering said last mentioned means incapable of preventing said timer from continuing its movement to open said switch.

16. A control system comprising in combination, first and second timers which move to one position when energized and return to their original position when deenergized, an electrical fuel feeding device, means responsive to a demand for fuel for energizing said first timer and maintaining it energized so long as said demand exists, said timer upon energization first rendering said fuel feeding device operative and, after a predetermined period of time, rendering it inoperative again as said timer moves into its energized position, and means responsive to the combustion of the fuel for energizing said second timer and causing it to prevent the first timer from moving into its energized position if it has not already done so.

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