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BURNER SAFETY CONTROL SYSTEM

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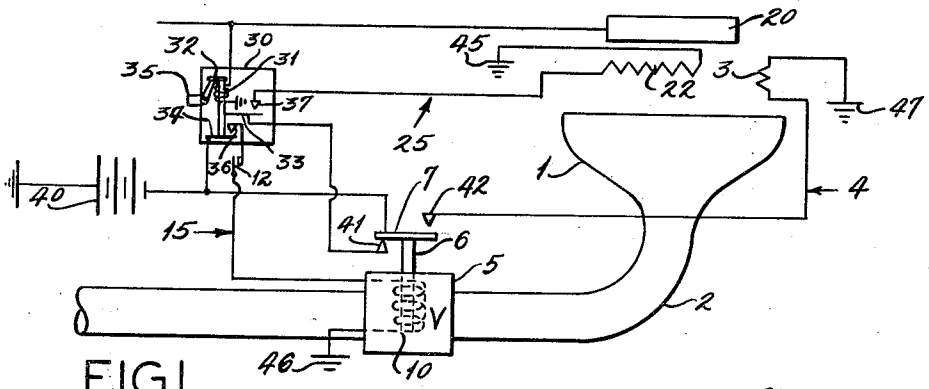

FIG. 1.

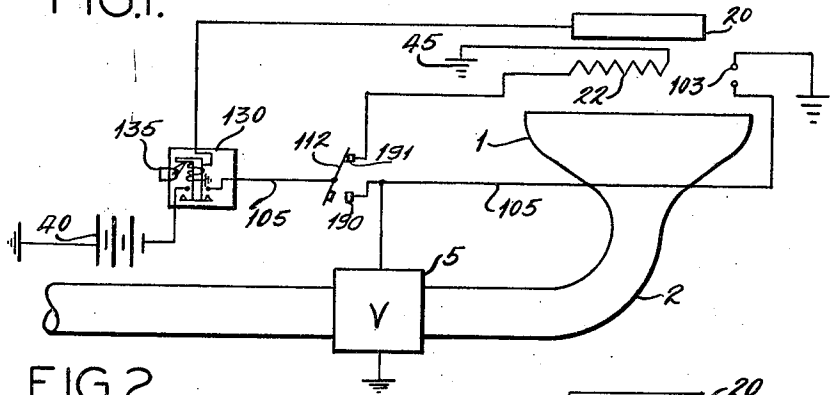

FIG. 2.

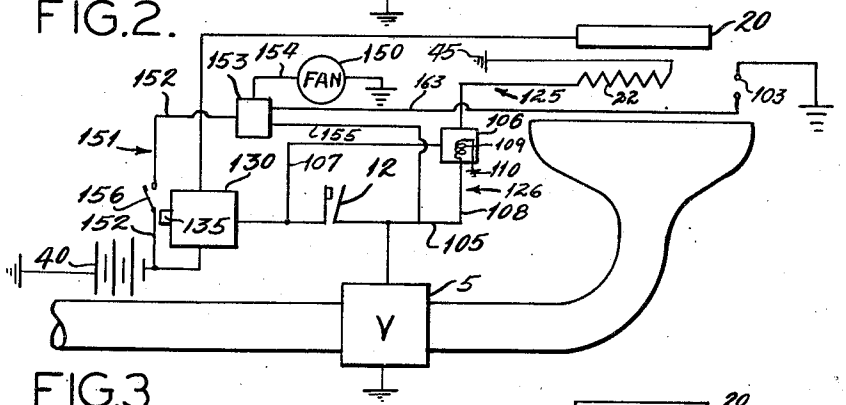

FIG. 3.

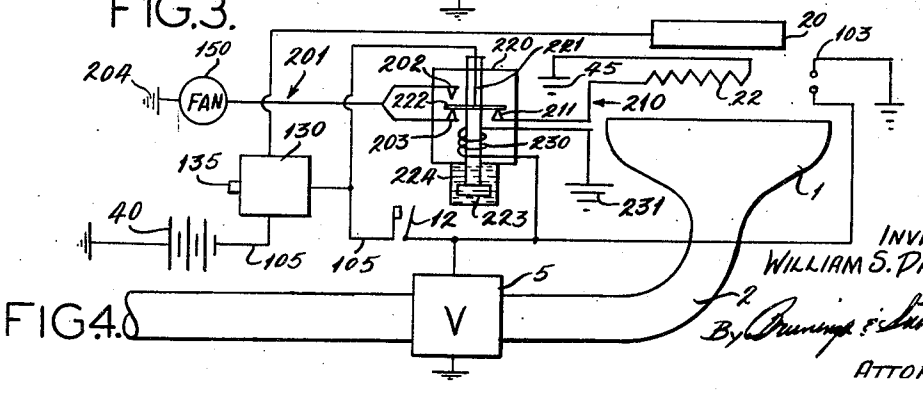

FIG. 4.

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BURNER SAFETY CONTROL SYSTEM

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2 Claims. (Cl. 158—130)

This invention relates to burner controls. The illustrative embodiments of this invention shown in the drawings show the application of this invention to gas heaters. In gas heaters of the type having a pilot flame it has been generally assumed heretofore that if the pilot flame is burning in the combustion chamber of the gas heater this fact proves the main burner. That this assumption is a false one is demonstrated by the fact that, particularly in open flame types of gas heater in which the hot gases from the flame are blown directly into an area to be heated, the main burner sometimes fails to ignite even though the pilot flame is lighted. Heretofore, in reliance upon the false assumption referred to, safety devices controlling the flow of gas to the main burner have been associated with the pilot light rather than with the main burner. In disproving the assumption, and remedying the faults attendant thereon, a control system has been invented which has general application, beyond the gas heater art, in installations in which a burner is to be regularly extinguished and re-ignited.

One of the objects of this invention is to provide a control system whereby the safety control of fuel to a burner is associated with the main burner rather than with a pilot light. Other objects will become apparent to those skilled in the art in the light of the following description and the accompanying drawings.

In accordance with this invention, generally stated, a burner control is provided which automatically shuts off the supply of fuel to the burner if the burner fails to ignite within a reasonable, predetermined time after the fuel is initially supplied thereto. Electric ignition means may be used for the burner. The control may include means for shutting off a draft across the burner during the ignition period.

In the drawings:

Figure 1 is a diagrammatic view of one illustrative embodiment of this invention.

Figure 2 is a diagrammatic view of another illustrative embodiment of this invention.

Figure 3 is a diagrammatic view of still another illustrative embodiment of this invention, and

Figure 4 is a diagrammatic view of still another illustrative embodiment of this invention.

Referring now to Figure 1 for an illustrative embodiment of this invention in which the invention is applied to a gas heater, 1 represents a main burner connected to a main gas supply line 2. An electric ignitor 3 which, in the embodiment shown, is of the hot wire type, is positioned to ignite gas issuing from the main burner 1. A valve 5 which may be of the diaphragm type, is positioned in the main gas supply line 2 to open the line for and close the line against flow of gas to the main burner 1. The valve 5 is provided with a stem 6, carrying a contact plate 7. In the embodiment shown, the valve is solenoid operated. The coil of the solenoid is indicated diagrammatically as 10. A thermostat 12 normally controls the opening and closing of the valve 5. A main burner thermocouple 20 is positioned to be heated by

a flame from the main burner 1 but to be unaffected by the ignitor 3. A heater 22 is positioned to heat the main burner thermocouple 20. Main burner thermocouple 20 is connected with a relay 30 which is shown diagrammatically in this figure as consisting of a coil 31 around an armature 32. The armature 32 carries an upper armature contact 33 and a lower armature contact 34 and is raised to circuit closing position by means of a push button 35. Lower armature contact 34 is connected to a source of power 40. Upper armature contact 33 is connected with a contact point 41. In the raised position of the armature 32 the lower armature contact 34 engages a valve contact 36, while upper armature contact 33 engages a heater contact 37. In its valve open, i. e., raised position, valve stem contact plate 7 engages an ignitor contact 42, while in its valve closed position it engages ignitor contact point 41. Ignitor circuit 4 includes the source 40, the contact plate 7, the ignitor contact 42, and the ground 47. Heater circuit 25 includes the source 40, the contact plate 7, the ignitor contact point 41, upper armature contact 33, heater contact 37 and ground 45. Valve circuit 15 includes source 40, lower armature contact 34, valve contact 36, thermostat 12, coil 10 and ground 46.

In the operation of the device shown in Figure 1, assume that the relay 30 is open, i. e., that the armature 32 has dropped to break heater circuit 25 and valve circuit 15, that the main burner thermocouple 20 is cold, and that the theromstat 12 is open. Valve 5 will be closed, since its circuit 15 is broken. Valve stem 6 will be in its lower position with valve stem contact plate 7 in engagement with heater contact point 41. As has been indicated, however, heater circuit 25 is broken between upper armature contact 33 and heater contact 37. If now it is desired to set the system in operation, push button 35 is manually depressed, mechanically to raise armature 32. The raising of armature 32 closes heater circuit 25 within the relay. Heater circuit 25 is now closed from the source 40 through valve stem contact plate 7 and heater contact point 41 through the relay 30 to the heater 22 and ground 45. The heater 22 raises the temperature of the thermocouple 20 to the point at which the thermocouple 20 produces sufficient current to maintain the armature 32 in its raised position. In the embodiment shown the thermocouple 20 never generates sufficient current initially to raise the armature 32. On the other hand the thermocouple 20 may be of a type requiring an amplifying circuit which in turn supplies current to a relay of the character here described. When the temperature of the thermocouple 20 is sufficient to insure the maintenance of the armature 32 in its raised position the push button 35 may be released. If now the thermostat 12 closes, the valve circuit 15 is completed from the source 40 through lower armature contact 34 and valve circuit 36, through thermostat 12 and coil 10 to the ground 46. Valve 5 is opened and valve stem 6 is raised, breaking the heater circuit 25 and completing the ignitor circuit 4 from the source 40 through the valve stem contact plate 7 and ignitor contact 42 to the ground 47. If the ignitor succeeds in igniting the gas issuing from main burner 1 before the main burner thermocouple 20 has cooled below the point at which sufficient current is supplied to the coil 31 of the relay 30 to maintain the armature 32 in its raised position, the heat of the main burner flame will maintain the temperature of the main burner thermocouple 20 above that point. If, on the other hand, the gas from the main burner fails to ignite within the time required for main burner thermocouple 20 to cool below its critical point the armature 32 will drop, breaking the valve circuit 15 and the heater circuit 25, allowing valve 5 to close and valve stem 6 to drop, break-

ing ignitor circuit 4. The system is thus completely shut down. If, at this time, while the thermostat 12 is closed, the push button 35 is depressed, the valve 5 will be opened, the valve stem 6 will be raised, and gas will be admitted to the main burner, while the ignitor circuit 4 is closed. Under these circumstances it will be necessary for the operator to exercise some discretion, since if the ignitor is not operating successfully, the flow of gas will continue as long as the operator keeps the push button 35 depressed. However, if the main burner fails to ignite the system will again be completely shut down when the operator releases the push button 35. If, on the other hand, the ignitor works properly to produce a flame at the main burner 1 the push button 35 need only be held down until the flame from the main burner 1 has heated the main burner thermocouple 20 above its critical temperature.

In the embodiment of this invention shown in Figure 2 the control of the heater 22, of the valve 5, and of the ignitor 103 depends upon a thermostat 112. The valve 5 may be of the same type as that shown in the embodiment of Figure 1, or it may be of the simple magnetic diaphragm type well-known to the art. The main burner thermocouple 20 is connected to a relay 130 having a push button 135 by which it is reset. The power source 40 is also connected to the relay 130. The relay 130 acts only to make and break the connection between the power source 40 and a main power line 105 from which the heater 22, ignitor 103 and valve coil ultimately receive their current.

The thermostat 112, shown diagrammatically in the drawing, is a double contact thermostat, making contact in one position with heater contact 191 and in the other position with valve and ignitor contact 190. A mercury switch of the type in which an envelope containing a pool of mercury is pivoted so that the mercury pool may be made to run to either end of the envelope is especially suitable. The rocking of the envelope can be thermostatically controlled, and contacts, each completing its circuit when the mercury covers it, can be inserted in both ends of the envelope. Suitable bimetallic elements, without the mercury switch will also be readily envisioned by those skilled in the art.

In the operation of the embodiment of this invention shown in Figure 2 assume that the thermostat 112 is in its heater circuit-closing position as shown in the drawing, and that the relay 130 is not set, so that, since no current is supplied from the power source 40 to the main line 105 and since the valve 5 is closed, the main burner thermocouple 20 is cold. If the push button 135 is depressed to set the relay 130 the heater 22 will raise the temperature of the main burner thermocouple 20 to the point at which the relay 130 will be maintained in its set position, and the push button 135 may be released. When the thermostat 112 moves in response to a demand for more heat (ordinarily when the space to be heated has cooled off) to the valve and ignitor circuit-closing position against contact 190, the heater circuit is broken. If at this point the valve 5 opens properly and the ignitor 103 performs to ignite the issuing gas, the main burner thermocouple 20 will remain heated. If, for some reason, ignition of the gas from the main burner is not accomplished the cooling of the thermocouple 20 will cause the relay 130 to break the circuit between the power source 40 and the main line 105 to shut down the entire system. If the ignition is accomplished, when the thermostat 112 moves to its heater circuit-making, valve and ignitor circuit-breaking position, the valve 5 will close, the ignitor 103 be de-energized, and the heater 22 will take over the task of maintaining the main burner thermocouple 20 above its critical temperature. If when the system is shut down the push button 135 is depressed while the thermostat 112 is in its valve and ignition circuit-making position the valve 5 will be opened and the ignitor 103 energized. It can be seen that if it

is desired to eliminate the human factor there involved, the push button 135 can be arranged to act upon a simple switch to bypass the thermostat 112, cutting off the current to the valve and ignitor circuits and supplying current to the heater as long as the push button 135 is depressed. The matter of making the holding in of the push button 135 automatic will be described hereafter. As in the embodiment shown in Figure 1, the relay 130 is constructed to require manual resetting.

In the embodiment of this invention shown in Figure 2 the ignitor 103 has been shown as being of the spark gap type instead of the hot wire type shown in Figure 1. This is merely by way of illustration. In both of the embodiments the ignitor has been shown as continuing to be energized as long as the valve 5 is open. If it is desired to cut off the ignitor after the main burner has been ignited, a simple heat responsive cut-out may be employed.

The illustrative embodiment of this invention shown in Figure 3 includes a fan 150 with its fan circuit 151. The fan circuit 151 includes the power source 40, a line 152 connected to the power source 40 between that source and the relay 130, a timer 153, to which the fan 150 is connected by a line 154, and a line 155 connecting the timer 153 with the main line 105 beyond the thermostat 12 with respect to the relay 130. A switch 156 may be provided in the fan circuit 151 between the power source 40 and the timer 153 in the line 152. The ignitor 103 is also connected to the timer 153, by a line 163.

In this embodiment a heater relay 106 is connected to the heater 22 and is connected through a line 107 to the main power line 105 between the relay 130 and the thermostat 12. It is also connected by a line 108 to the main line 105 on the other side of thermostat 12. In this embodiment the heater circuit 125 includes the source 40, relay 130, line 107, relay 106, heater 22 and ground 45. A heater control circuit 126 includes source 40, relay 130, thermostat 12, a line 108, a coil 109 and a ground 110. The ignitor 103 is connected to the timer 153. The positioning and the function of the valve 5, main burner thermocouple 20, heater 22, and ignitor 103, may be the same as the corresponding elements of the device shown in Figure 1. The relay 106 is so constructed as to close the heater circuit 125 when the thermostat 12 is open and to break that circuit when the thermostat 12 closes. Suitable devices are well-known in the art.

In the operation of this embodiment, assume that the switch 156 is open, that the relay 130 is not set, and that the thermostat 12 is open. If the push button 135 is now depressed the heater circuit 125 is completed through line 107 and relay 106. When the heater 22 has raised the temperature of the main burner thermocouple 20 above its critical temperature the relay 130 will remain set and the push button 135 may be released. The switch 156 may now be closed to start the fan 150. When the thermostat 12 closes, the valve 5 is opened, the ignitor 103 is put into operation, the heater control circuit 126 is completed, the relay 106 drops back to break the heater circuit 125, and the timer 153 is set in operation to break the fan circuit 151 for a predetermined time, approximately that length of time which is required for the thermocouple 20 to cool below its critical temperature if the main burner fails to ignite. At the end of that time the timer 153 restores the fan circuit 151 and also cuts off the ignitor 103 whether or not the main burner has ignited. If the gas issuing from the main burner 1 is ignited before the main burner thermocouple 20 cools below its critical point and the ignitor is cut off, the heat from the flame will maintain the main burner thermocouple 20 above its critical point to maintain the system in operation. When the thermostat 12 opens, the valve 5 shuts, and the heater control circuit 126 is broken to restore the relay 106 to complete the heater circuit 125. While the fan continues to run after the thermostat 12

opens (or the main line 105 is cut off by relay 130), the timer is reset and the ignitor circuit in the timer is restored, though the ignitor is, of course, not energized because its circuit is broken at the open thermostat 12 (or relay 130). So long as the main burner thermocouple 29 remains heated above its critical temperature, the control of the main gas burner rests with the thermostat 12 as it does in the embodiment of this invention shown in Figure 1. If the main burner fails to ignite so that the relay 130 acts to open the rest of the control circuit the fan continues to run, thus scavenging any unburning gas from the combustion chamber (if the draft of the fan is directed into the combustion chamber).

If the push button 135 is depressed when the thermostat 12 is closed, the valve 5 will be opened, the ignitor circuit energized, and the fan temporarily stopped through timer 153. In this, as in the embodiments shown in Figures 1 and 4, a simple switch may be put in the circuit in the same position with respect to the remaining elements as the thermosat. The switch need only be left open until the heater 22 has raised the temperature of the main burner thermocouple to holding temperature after which the operation of the device will be automatic when the switch is closed.

In the embodiment of this invention shown in Figure 4 a fan circuit 201 and a heater circuit 210 different from the fan and heater circuits shown in Figure 3 are provided. In this embodiment the fan circuit 201 includes the source 40, relay 130, a delay switch 220, upper fan contact 202, lower fan contact 203 and ground 204. The heater circuit 210 includes power source 40, relay 130, delay switch 220, heater contact 211 and ground 45. The delay switch 220 is provided with an armature 221 carrying a contact plate 222 and provided with a piston 223 within a fluid-filled dashpot 224. The armature 221 is operated by means of a coil 230 connected to the main line 105 beyond the thermostat 12 with respect to the circuit breaker 130, and grounded at 231.

In the operation of the embodiment of this invention shown in Figure 4, the fan circuit is normally temporarily interrupted whenever the thermostat 12 opens or closes and is completely interrupted when the relay 130 acts to break the main line 105. Assuming that the main burner thermocouple 20 is cold, that the thermostat 12 is open, and that the relay 130 is not set, the armature 221 of the delay switch 220 will be in its lower position as shown in Figure 4 with the contact plate 222 engaging lower fan contact 203 and heater contact 211. If the push button 135 is now depressed the heater circuit 210 will be established from power source 40 through circuit breaker 130 through contact plate 222 and fan contact 211 to ground 45. Again when the main burner thermocouple 20 has been sufficiently heated the push button 135 may be released.

The setting of the relay 130 also completes the fan circuit from power source 40 through relay 130 through contact plate 222 and lower fan contact 203 to ground 204. The fan is therefore running. When the thermostat 12 closes, the valve 5 is opened and current is supplied to the ignitor 103 as in the embodiments shown in Figure 2. At the same time the coil 230 is energized to raise the armature 221, breaking the heater circuit 210 and the fan circuit 201. The dashpot 224 delays the rising of the armature 221 for a period comparable with the cooling period of the main burner thermocouple 20 so that before the contact plate 222 engages the upper fan contact 202 the gas escaping from the main burner 1 will be given full opportunity to be ignited by the ignitor 103 before the draft from the fan resumes. When the thermostat 12 again opens, if the main burner has ignited, the coil 230 is de-energized, allowing the armature 221 to return to its lower position to engage heater contact 211 and lower fan contact 203. It can be seen that the length of time required for the armature 221 to return to its lower position must be less than that required for the thermocouple 20 to cool, but that is ordinarily not a serious problem because the heat from the flame of the main burner generally exceeds that from the heater 22 so that a longer cooling period may be had when the thermostat 12 opens, than when it closes. In this embodiment, if the main burner fails to ignite the cooling of the main burner thermocouple 20 and the consequent breaking of the main line 105 cuts off the power to the fan 150 as well as to the rest of the circuit. However, if the fan is turned on, i. e., if the armature 221 reaches its upper position shortly before the main burner thermocouple 20 has cooled below its critical temperature, much of the unburned gas will have been scavenged from the combustion chamber before the valve 5 is closed and the fan 150 is turned off by the operation of the relay 130. In this embodiment, if the push button 135 is depressed while the thermostat 12 is closed, the fan draft is automatically delayed by the rising of the armature 221. An indication of the proper time for holding the push button 135 may then be had by the starting of the fan.

While in the embodiment shown in Figures 3 and 4 the draft has been regulated by shutting off the fan 150 it can be seen that in a natural draft installation or even in a forced draft installation, the fan circuits described may be used to close or regulate a damper to effect the same result.

In the embodiment shown in Figure 1, the opening and closing of the ignitor and heater circuits has been accomplished by the movement of the valve stem 6 in response to the closing and opening of the thermostatic switch 12. In the embodiment shown in Figure 2, the heater and ignitor circuits have been opened and closed by the movement of the thermostatic switch 112 itself. In the embodiment shown in Figure 3 the timer 153 and the relay 106 operate in response to the closing of the thermostatic switch 12 to break the heater circuit and close the ignitor circuit. In the embodiment shown in Figure 4, the closing of the thermostatic switch 12 completes the ignitor circuit while the heater circuit is opened by a delay switch 220 operating in response to the closing of the thermostatic switch 12.

Reference is made to my co-pending application, Serial No. 213,173, filed February 28, 1951, for illustrations of suitable valves and main burner thermocouples for use with this invention and for a description of the particular utility of control apparatus of the character wherein the main burner itself is proved.

In the illustrative embodiments described it has been necessary, in resetting the relay, to hold the push button in until the main burner thermocouple has been heated beyond its critical temperature. It can be seen that a simple timing device may be provided for automatically retaining the push button for a length of time sufficient for the heater to bring the main burner thermocouple to its circuit-maintaining temperature. Such a timing device could be of the character of those used in the well-known automobile cigarette lighter. Another such timing device can comprise a mercury switch wherein the mercury, when heated by current through a small built-in resistance expands sufficiently to overbalance its enclosing eccentrically pivoted envelope, to break its circuit. Such a switch would be initially thrown "shut," i. e., tipped about the pivot, by the pushing of the push button, and would supply current to the circuit breaker coil from an outside source for the length of time which it took the mercury to expand, a time corresponding to the time required for the heater sufficiently to raise the temperature of the main burner thermocouple 20. Ordinarily the length of time required for the heater to operate is sufficient to insure ignition of the burner if the valve circuit rather than the heater circuit should be closed when the push button is depressed.

It can be seen that, particularly in the devices of the character shown in Figures 3 and 4 the thermostat can be replaced with a manual control where there is suffi-

cient advantage in the automatic interruption of the fan, and in the automatic shutting off of the entire system when there is a failure to ignite.

While the illustrative embodiments shown and described have related to gas burners, it can be seen, and it is considered as entirely within the scope of this invention, that the invention has application to oil burners, pulverized coal burners, and in fact to practically any fuel burner in which intermittent ignition is used. In such other installations, the valve of the illustrative embodiments may be replaced by a pump, a pump and blower combination, a screw feed, or any other fuel supplying means for a burner subject to intermittent ignition. The substitution of these other fuel supplying means for the valve 5 of the illustrative embodiments is well within the skill of the art, as is the substitution of other fuel supplying conduit in place of the gas supply line 2 and of other types of burner in place of the gas burner 1.

Having thus described my invention what is claimed and desired to be secured by Letters Patent is:

1. In combination with a burner having an electrically operated ignitor and an electric circuit therefor, a fuel controller including a solenoid having a coil and a part which moves in response to the energizing of said coil to fuel supplying position and in response to the deenergizing of said coil to fuel cutoff position; a solenoid coil circuit; a heater circuit; a relay having a coil and having contacts in the solenoid coil circuit and in said heater circuit, said contacts being movable between open and closed positions with respect to both said circuits, being maintainable in closed position by the relay coil as long as said relay coil is supplied with a certain amount of current and biased to move to open position when the amount of current supplied said relay coil falls below said certain amount; a thermocouple electrically connected to said coil and constructed to supply said certain amount of current to said coil only when the said thermocouple is above a certain temperature, said thermocouple being positioned to be heated above said certain temperature by the burner when the burner is ignited, said thermocouple being constructed to supply, under any conditions, less current than is required to move the contacts from open to closed position; an electrically operated heater in the heater circuit positioned to heat said thermocouple above said certain temperature, said thermocouple retaining sufficient heat from said heater to maintain the relay contacts in closed position for a time sufficient to permit the ignition of fuel issuing from the burner by the igniter in operation when the solenoid coil circuit is completed; contacts in the heater circuit operatively associated with the movable solenoid part, said last named contacts being in closed position with respect to the heater circuit when the solenoid part is in fuel cutoff position and being in opened position with respect to the heater circuit when the solenoid part is in fuel supplying position; a thermostatic switch in the solenoid coil circuit, operable when the relay contacts are in closed position to open the solenoid coil circuit, causing the movable solenoid part to move to fuel cutoff position to interrupt the flow of fuel to the burner and energize said heater when the temperature of said thermostatic switch is above a given point, and to close the solenoid coil circuit, causing the movable solenoid part to move to fuel supplying position to start the flow of fuel to said burner and deenergize the heater when the temperature of the thermostatic switch is below said given point; and manually manipulated means for moving the relay contact member from open to closed position.

2. In combination with a burner having an electrically operable fuel controller, a fuel controller electric circuit, a thermostatic switch in said fuel controller circuit, an electrically operable ignitor and an ignitor electric circuit, a control device comprising a relay, said relay having a coil and having contacts in said fuel controller circuit, said contacts being relatively movable between open and closed positions, being maintainable in closed position by said coil as long as said coil is supplied with a certain amount of current and biased to move to open position when the amount of current supplied said coil falls below said certain amount; a thermocouple electrically connected to said coil and constructed to supply said certain amount of current to said coil only when said thermocouple is above a certain temperature, said thermocouple being positioned to be heated above said certain temperature by the burner when the burner is ignited, said thermocouple being constructed to supply, under any conditions, less current than is required to move the contacts from open to closed position; an electrically operable heater positioned to heat said thermocouple above said certain temperature; a heater electric circuit; means including contacts in the heater and ignitor circuits, operable in response to the closing of said thermostatic switch, when the relay contacts are in closed position, to open the heater circuit and close the ignitor circuit, the said thermocouple retaining sufficient heat from said heater when said heater circuit is opened to supply the relay coil with its certain amount of current for a time normally sufficient to permit the ignition of the burner by the ignitor; and manually manipulated means for moving the relay contacts from open to closed position.

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