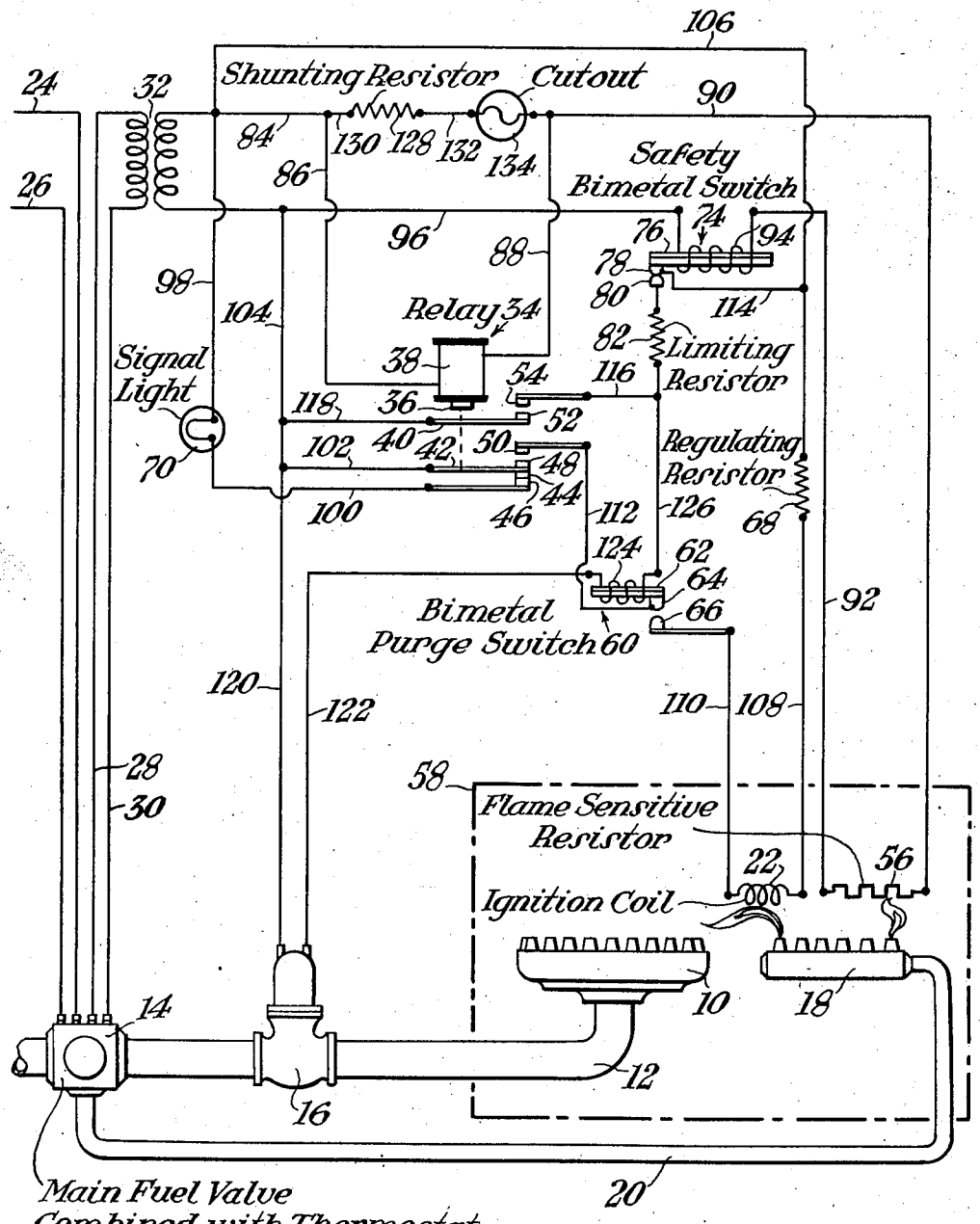
March 26, 1946. S. G. ESKIN ET AL 2,397,311

SAFETY CONTROL SYSTEMS FOR FUEL BURNERS

Filed Dec. 8, 1943



Main Fuel Valve
Combined with Thermostat
with Switch in Handle.

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Patented Mar. 26, 1946 2,397,311

UNITED STATES PATENT OFFICE

2,397,311

SAFETY CONTROL SYSTEM FOR FUEL BURNERS

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Application December 8, 1943, Serial No. 513,388

12 Claims. (Cl. 158—28)

This invention relates to safety control apparatus for fuel burners and, more particularly, to electrically operated controls therefor.

An object of the invention is to utilize electrical igniting means for the burner and automatically deenergize such means upon establishment of normal running conditions of the burner.

Another object of the invention is to reenergize the igniting means after operation of the safety control to provide a recycling system.

Another object of the invenion is to delay reenergization of the igniting means until the vicinity of the burner has been purged of unburned fuel.

A still further object of the invention is to discontinue burner operation in the event of electric power failure or the occurrence of an open circuit in the electrical system.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawing which is a schematic view of a safety control apparatus for a gaseous fuel burner embodying this invention.

Referring more in detail to the drawing, a gaseous fuel burner 10 is supplied with fuel from a main fuel pipe 12. The fuel supply is controlled by a main valve 14 which, in this instance, is adapted for manual operation but which may be arranged for thermostatic operation if desired. Preferably, a double-pole main switch for the electric circuit to be described is included in the main valve 14 and is arranged to establish the electrical circuit of the apparatus whenever the main valve is opened. Interposed in the fuel supply pipe 12 between the main valve 14 and the burner 10 is an electromagnetic gas valve 16 of any suitable type which may be arranged, as in this instance, to be opened by energization of the electromagnet and closed by gravity upon deenergization thereof.

A pilot burner 18 is supplied with fuel from a conduit 20 connected to the main valve 14 to receive fuel from the supply pipe 12 when the main valve is opened. The fuel flowing from the pilot burner is adapted to be ignited by an electric igniting means 22, such as an ignition coil and, in turn, will ignite the fuel issuing from the main burner 10 when in operation. Electrical energy for the operation of the electromagnetic valve 16 and the igniting means 22 is supplied through line wires 24—26 connected to two terminals of the double pole switch combined with the main fuel valve 14. The other two terminals of the double pole switch are connected by wires 28—30 to the primary of a transformer 32.

Operation of the electromagnetic valve 16 and ignition means 22 is controlled by a control relay 34. This relay may include a magnetizable core 36 having the usual energizing coil 38 associated therewith and is shown as adapted to attract a pair of movable armature members 40 and 42 when suitably energized. The armatures 40 and 42 may be mounted for movement toward and away from the core 36 and adapted to return to a normal or unattracted position by gravity, spring or other means (not shown).

In the normal position of the armature 42, that is, when the relay operating means is deenergized, engagement is made by a contact 44 thereon with a fixed contact 46. In addition to the contact 44, the armature 42 carries on the opposite side thereof a contact 48 which is adapted to engage with a fixed contact 50 when the armature 42 moves from normal to attracted position. It will be apparent that upon such movement contacts 44—46 become disengaged. In similar manner, armature 40 carries contact 52 which is adapted for engagement with a fixed contact 54 in the attracted position of this armature. Contact 52 is, however, the only contact carried by armature 40 as distinct from armature 42 which, as described, carries two contacts.

A heat responsive or flame sensitive element 56 is positioned to be exposed to the flame of the pilot burner 18 for causing operation of the relay 34 to move the armatures thereof from one position to the other. The flame sensitive element 56 may take the form of a coil of wire of material having normally a relatively low resistance and a positive temperature coefficient of resistance. Such devices commonly termed "ballast resistors" are thermally responsive to the passage of current therethrough but, in this embodiment, the element 56 is primarily responsive to the heat of the pilot burner flame. Accordingly, it will be understood that it is the variation in resistance in response to the flame of the pilot burner which renders the ballast resistor 56 useful in this invention.

As indicated in the drawing, the main burner 10, pilot burner 18, ignition means 22 and ballast resistor 56, are adapted to be mounted in the chamber 58 of an oven or like device. In such arrangements, in case of flame failure, unburned fuel may be present in the vicinity of the main burner 10 following closure of the electromagnetic valve 16 and such fuel should be permitted to flow away before the ignition means 22 is en-

ergized to ignite the pilot burner fuel. To this end, a purge period is provided in the sequence of operation of the control by a thermally operated switch 60 which maintains the ignition means 22 inoperative for a predetermined period following closure of the electromagnetic valve 16. The timing means for the switch 60 comprises a bimetal element 62 carrying a contact 64 which is adapted to move therewith and engage a fixed contact 66 when the bimetal element 62 is unheated. The arrangement provides that these contacts 64—66 become disengaged whenever the bimetal is sufficiently heated.

Adjustment of the igniter current value in the system may be obtained by the provision of a regulating resistor 68 which is preferably of fixed impedance value. A pilot signal lamp 70 may be included to afford visual indication of normal running operation of the system. In order that the flow of fuel in the main burner 10 will be shut off in case of electric power failure or an open circuit in the electrical system of the apparatus, safety switch means are provided to perform this function. This means may take the form of a second thermally operated switch 74 comprising a bimetal element 76 carrying a contact 78 which is adapted to move therewith and engage a fixed contact 80 when the bimetal element 76 is heated. In this arrangement it is provided that these contacts 78—80 become disengaged whenever the bimetal is unheated. A limiting resistor 82 of fixed impedance value is provided for a purpose which will be apparent hereinafter.

The apparatus so far described is shown in the drawing in the normal running position of the main burner 10, the electromagnetic valve 16 being energized and the ignition means 22 deenergized. At the start of operation to obtain this running position the thermally responsive circuit elements are cold; the control relay 34 occupies the normal position shown; the contacts 64—66 of the purge bimetal switch 60 are closed; while the contacts 78—80 of the safety bimetal switch 74 are open.

Opening of the main valve 14 permits fuel to flow to the pilot burner 18 and also in the main fuel pipe 12 as far as the electromagnetic valve 16 which is normally closed. As the main switch combined with the main fuel valve 14 is also operated to closed position when the main fuel valve is opened, the electrical circuit is established as follows: From the secondary of the transformer 32 to wire 84, wire 86, coil 38 of the relay 34, wire 88, wire 90, ballast resistor 56, wire 92, heater coil 94 of the safety bimetal switch 74, and wire 96 back to the secondary of the transformer 32. This circuit remains energized as long as the apparatus is in operation, provided there are no power supply or electric circuit failures.

A second circuit consists of the secondary of the transformer 32, wire 98, pilot signal light 70, wire 100, fixed relay contact 46, movable relay contact 44, armature 42, wire 102 and wire 104 back to the secondary of the transformer 32. This circuit is established for the short interval between the closing of the main switch of valve 14 (when the system is operating from a cold start) and the operation of the relay to attract armature 42. This interval allows insufficient time for the pilot signal light 70 to light.

Energization of the coil 38 of the control relay 34 in the first circuit described will attract the armatures 40—42 and cause engagement of contacts 52—54 and 48—50, respectively. Thus the circuit of pilot signal light 70 is discontinued by opening of contacts 44—46 and the following additional circuits are established.

One circuit comprises the secondary of the transformer 32, wire 106, regulating resistor 68, wire 108, ignition means 22, wire 110, contacts 66—64 of purge bimetal switch 60, wire 112, relay contacts 50—48, relay armature 42 and wires 102—104 back to the secondary of the transformer 32. The energization of the circuit just described causes the ignition means 22 to be energized to ignite the fuel flowing from the pilot burner 18.

The heater coil 94 of the safety bimetal switch 74 which is included in the first circuit described causes contacts 78—80 of this switch to close shortly after the main switch of valve 14 is closed. Thus, a circuit is established from the secondary of the transformer 32, wire 106, wire 114, safety bimetal switch contacts 78—80, limiting resistor 82, wire 116, relay contacts 54—52, relay armature 40, wire 118 and wire 104 back to the secondary of the transformer 32. It will be apparent that the purpose of the limiting resistor 82 is to prevent a short-circuit on the transformer secondary as contacts 52—54 are closed at the same time as contacts 78—80 are closed. The circuit so established will short-circuit the electromagnetic valve 16 as one terminal thereof is connected by a wire 120 to wire 104 and the other terminal thereof is connected by a wire 122, through a heater coil 124 for the purge bimetal switch 60 and a wire 126 to wire 116.

As the ignition circuit is established through the closed contacts 48—50 of relay 34 and closed contacts 64—66 of the yet unheated purge bimetal switch 60, the fuel flowing from the pilot burner 18 is ignited, causing the ballast resistor 56 to become heated in response thereto. It is intended that when this occurs, the relay 34 will release armatures 40—42 to open contacts 52—54 and 48—50; first, to remove the short-circuit from the electromagnetic valve 16 and; second, to deenergize the igniting means 22 and cause the pilot light 70 to become lighted. It will be apparent, therefore, that the relay 34 is subject to two conditions. The first is that it obtain sufficient electrical energy to pick up the armatures 40—42 when the circuit elements are cold. The second is that it avoid introducing a sufficiently large resistance in series with the ballast resistor 56 which would unduly retard the release of the relay armatures when the ballast resistor becomes heated by the flame of the pilot burner 18.

In order to assure release of the armatures and consequent dropping of the relay contacts under heated conditions of the circuit elements and also to assure attraction of the armatures and incidental closing of the relay contacts under cold circuit conditions, means are provided in this invention to add flexibility to the adjustment of the relay circuit without materially affecting the sensitivity of the relay to changes in resistance of the ballast resistor which are caused by variations in the condition of the pilot burner, such as the lighted and unlighted conditions thereof.

To this end, a shunting resistor 128 is connected across the coil 38 of the relay 34 by wire 130 connected to wire 86, and by wire 132 connected to wire 88. A cut-out 134 may be included in the shunt as by connection between wire 132 and wire 88. The cut-out 134 is preferably of the thermal

type having a time lag operation and will open the circuit in case of failure of the relay circuit as by becoming open circuited. It will be apparent, however, that a cut-out will be unnecessary if the shunting resistor 128 is securely connected directly across the relay coil to render such an open circuit remote. However, if the cut-out 134 is included, the relay coil 38 in its normal condition would require an appreciable current to operate it. Then, in the case of an open circuit in the relay connections or the relay coil itself, the current through the cut-out 134 would be increased sufficiently above normal cut-out current to cause operation thereof.

The shunting resistor 128 serves to reduce the total circuit resistance in series with the ballast resistor 56 and renders the circuit sensitive to the changes in resistance of the ballast resistor responsive to the flame of the pilot burner. Thus, the ballast resistor 56 is enabled to control operation of the relay 34 by varying the total circuit resistance in response to thermal changes caused by operation of the pilot burner, thereby varying the electrical energy value to the relay coil 38. After the pilot burner flame 18 has sufficiently heated the ballast resistor 56 the resistance of this ballast resistor is increased, the voltage to relay coil 38 is decreased to armature release value and the armatures 40 and 42 drop their contacts 52 and 48, respectively.

As outlined in the preceding paragraph, the relay 34 is caused to release the armatures 40 and 42 when the ballast resistor 56 is sufficiently heated. This action is due to the decreased (IR) voltage drop across the resistor 128 when the resistance value of the ballast resistor 56 increases with temperature. As disclosed herein, the voltage source for the control circuits of the burner apparatus is supplied by the secondary winding of the transformer 32; the output of this secondary being connected across its terminals and comprising the described series circuit including heater coil 94, resistor 56 and the shunt circuit including resistor 128 and coil 38. It is apparent that the total current in the series path proportionately divides in the parallel path. The resultant impedance of the resistor 128 and coil 38 in parallel is less than the impedance of coil 38 alone. Moreover, as resistor 56 varies the current value in the circuit, the voltage drop across resistor 128 varies correspondingly and this (IR) voltage drop serves in effect as the voltage source for the coil 38.

The opening of contacts 52—54 and 48—50 occurs simultaneously with closing of contacts 44—46. The opening of contacts 48—50 discontinues the described circuit controlled thereby and causes deenergization of the ignition means 22; closing of contacts 44—46 completes the described circuit controlled thereby and causes the pilot light 70 to be lighted; and opening of contacts 52—54 as will now be described removes the short-circuit and causes the electromagnetic valve 16 to be energized for movement to open position permitting flow of fuel to the main burner 10. This valve energizing action occurs owing to the safety bimetal switch contacts 78—80 being closed and the circuit consequently consisting of the transformer secondary 32, safety bimetal switch contacts 78—80, limiting resistor 82, heater coil 124 of the purge bimetal switch 60, wire 122, electromagnetic valve 16 and wire 120, back to the secondary of the transformer 32. It will be observed that the heated condition of the purge bimetal switch 60 causes its contacts 64—66 to be opened and the normal running condition of the apparatus is established.

In the event that both the main burner and the pilot burner flames are extinguished, the system will recycle. The flame sensitive ballast coil 56 will cool and its resistance will consequently be decreased until there is sufficient current in the circuit of the relay coil 34 to cause the armatures 40—42 to be attracted thus closing contacts 52—54 and 48—50. During this cooling period of the ballast resistor 56 the electromagnetic valve 16 remains energized and consequently unburned fuel will temporarily escape from the main burner 10. However, as soon as the contacts 52—54 close, the electromagnetic valve 16 and heater coil 124 of the purge bimetal switch 60 become short-circuited. This causes the valve to close and the fuel to the main burner 10 to be shut off while the purge bimetal switch 60 begins to cool. It will be observed that the closing of contacts 48—50 does not immediately cause the ignition means 22 to be energized as the circuit is still open owing to the purge bimetal switch contacts 64—66 being open. The cooling period of the bimetal switch 60 is arranged to be definitely longer than the period during which the unburned main burner gas escapes. When the purge bimetal switch 60 cools sufficiently to close its contacts 64—66, the igniting means 22 is energized and the system operates as previously described. Thus, the unburned fuel remaining from a previous operation is permitted time to flow away from the vicinity of the burner before another igniting operation is initiated.

In case of failure of the fuel supply, the system undergoes a recycling operation up to the point where the igniting means 22 is energized. The system remains in this condition with the armatures 40—42 attracted and the electromagnetic valve 16 closed until the fuel supply is reestablished. The system will then continue through the recycling operation previously described.

In the case of electric current failure, the fuel to the main burner 10 will be shut off by operation of the safety bimetal switch 74 and the pilot burner 18 will continue to produce a flame. When the power supply is resumed, the safety bimetal switch 74 will close its contacts 78—80 causing the electromagnetic valve 16 to be reenergized and admit fuel to the main burner 10. If the pilot flame should be extinguished during a power failure, the unburned pilot burner fuel will escape and the system will cool down to starting condition. In the event of an open circuit occurring in the ballast resistor circuit, the safety bimetal switch 74 will open its contacts 78—80 and cause the electromagnetic valve 16 to close and shut off the flow of fuel to the main burner 10.

While a preferred embodiment of the invention has been shown and described, it is apparent that many modifications will occur to those skilled in the art. Hence, the invention is not to be limited to the form shown and described or otherwise than as included in the scope of the claims appended hereto.

We claim:

1. A safety control for fuel burners having main and pilot burners, comprising a main circuit including a source of electrical energy, electrically operable means movable between positions for controlling the supply of fuel to the main burner, an electric igniter adapted for operation to ignite the pilot burner, an electrically responsive device for positioning said movable means and controlling the operation of said igniter, and a second-

ary circuit including said source of electrical energy, said device, and means for varying the total circuit resistance in response to thermal changes caused by operation of the pilot burner thereby varying the energy value to said device to change the position of said movable means.

2. A safety control for fuel burners having main and pilot burners, comprising a main circuit including a source of electrical energy, electrically operable means movable between positions for controlling the supply of fuel to the main burner, an electric igniter adapted for operation to ignite the pilot burner, an electrically responsive device for positioning said movable means and controlling the operation of said igniter, and a secondary circuit including said source of electrical energy, said device, and a ballast resistor for varying the total circuit resistance in response to thermal changes caused by operation of the pilot burner thereby varying the energy value to said device to change the position of said movable means.

3. A safety control for fuel burners having main and pilot burners, comprising a main circuit including a source of electrical energy, electrically operable means movable between positions for controlling the supply of fuel to the main burner, an electric igniter adapted for operation to ignite the pilot burner, an electrically responsive device for positioning said movable means and controlling the operation of said igniter, and a secondary circuit including said source of electrical energy, said device, and a ballast resistor having a positive temperature coefficient of resistance for varying the total circuit resistance in response to thermal changes caused by operation of the pilot burner thereby varying the energy value to said device to change the position of said movable means and terminate operation of said igniter.

4. A safety control for fuel burners having main and pilot burners, comprising a main circuit including a source of electrical energy, electrically operable means movable between positions for controlling the supply of fuel to the main burner, a switch controlling the operation of said movable means, an electric igniter adapted for operation to ignite the pilot burner, a separate switch controlling the operation of said igniter, a secondary circuit including said source of electrical energy electrically responsive means for causing operation of said switches, a fixed resistor shunting said electrically responsive means and reducing the effective impedance value of the latter in said secondary circuit, and a ballast resistor for varying the total circuit resistance in response to thermal changes caused by operation of the pilot burner thereby varying the energy value to said electrically responsive means sufficiently to cause said switch operation.

5. A safety control for fuel burners having main and pilot burners, comprising a main circuit including a source of electrical energy, electrically operable means movable between positions for controlling the supply of fuel to the main burner, an electric igniter adapted for operation to ignite said pilot burner, an electrically responsive device for positioning said movable means and controlling the operation of said igniter, a secondary circuit including said source of electrical energy, said device and means for varying the total circuit resistance in response to thermal changes caused by operation of the pilot burner thereby varying the energy value to said device to change the position of said movable means and terminate operation of said igniter, and timing means controlled by one of said devices for maintaining said igniter inoperative for a predetermined period of time.

6. A safety control for fuel burners having main and pilot burners, comprising a main circuit including a source of electrical energy, electrically operable means movable between positions for controlling the supply of fuel to the main burner, an electric igniter adapted for operation to ignite said pilot burner, an electrically responsive device for positioning said movable means and controlling the operation of said igniter, a secondary circuit including said source of electrical energy, said device, and means for varying the total circuit resistance in response to thermal changes caused by operation of the pilot burner thereby varying the energy value to said device to change the position of said movable means and terminate operation of said igniter, an electric heater controlled by said device, and a thermal switch associated with said heater for maintaining said igniter electrically disconnected from said main circuit for a time period determined by said heater.

7. In a safety control for fuel burners, the combination with a main circuit including a source of electrical energy, electrically operable means movable between positions for controlling the supply of fuel to the burner, an electrically responsive device for controlling the operation of said movable means, a thermally operable device also controlling the operation of said movable means, of a secondary circuit including said source of electrical energy, said electrically responsive device, and means for varying the total circuit resistance in response to thermal changes caused by operation of the burner thereby varying the energy value to said electrically responsive device to change the position of said movable means, and an electric heater for said thermally operable device for causing operation thereof to change the position of said movable means in the event of failure of said secondary circuit.

8. In a safety control for fuel burners, the combination with a main circuit including a source of electrical energy, electrically operable means movable between positions for controlling the supply of fuel to the burner, an electrically responsive device for controlling the operation of said movable means, a thermally operable switch for completing said main circuit and thereby controlling the operation of said movable means, of a secondary circuit including said source of electrical energy, said electrically responsive device, and means for varying the total circuit resistance in response to thermal changes caused by operation of the burner thereby varying the energy value to said electrically responsive device to change the position of said movable means, and an electric heater for said switch adapted to cause operation thereof to discontinue said main circuit and change the position of said movable means in the event of deenergization of said heater by failure of said secondary circuit.

9. A safety control for fuel burners having main and pilot burners and a source of electrical energy, comprising electrically operable means movable between positions for controlling the supply of fuel to the main burner, a circuit including the source and said movable means, a relay having a coil and a switch operable thereby for changing the position of said movable means, said switch operation being dependent upon a variation in energy value supplied to said coil,

a second circuit including the source, said coil, and a ballast resistor exposed to a flame at the pilot burner for causing said variation in energy value by varying the total circuit resistance when heated by said flame, and means for reducing the effective impedance value of said coil in said second circuit sufficiently to render said variation in energy value effective to cause said switch operation.

10. A safety control for fuel burners having main and pilot burners and a source of electrical energy, comprising electrically operable means movable between positions for controlling the supply of fuel to the main burner, a circuit including the source and said movable means, a relay having a coil and a switch operable thereby for changing the position of said movable means, said switch operation being dependent upon a variation in energy value supplied to said coil, a second circuit including the source, said coil, and a ballast resistor exposed to a flame at the pilot burner for causing said variation in energy value by varying the total circuit resistance when heated by said flame, and a fixed resistor establishing a shunt on said coil and reducing the effective impedance value thereof in said second circuit sufficiently to render said variation in energy value effective to cause said switch operation.

11. A safety control for fuel burners having main and pilot burners and a source of electrical energy, comprising electrically operable means movable between positions for controlling the supply of fuel to the main burner, a circuit including the source and said movable means, a relay having a coil and a switch operable thereby upon a reduction in the energy value supplied to said coil, means controlled by said switch for short-circuiting said movable means, a second circuit including the source, said coil, and a ballast resistor exposed to a flame at the pilot burner for causing said reduction by increasing the total circuit resistance when heated by said flame, and a fixed resistor establishing a shunt on said coil and reducing the effective impedance value thereof in said second circuit sufficiently to render said reduction in energy value effective to cause operation of said switch to remove said short-circuit.

12. A safety control for fuel burners having main and pilot burners and a source of electrical energy, comprising electrically operable means movable between positions for controlling the supply of fuel to the main burner, an electric igniter adapted for operation to ignite the pilot burner, a circuit including the source, said movable means and said igniter, a relay having a coil and separate switches operable thereby for changing the position of said movable means and terminating operation of said igniter, said switch operation being dependent upon a variation in energy value supplied to said coil, a second circuit including the source, said coil, and a ballast resistor exposed to a flame at the pilot burner for causing said variation in energy value by varying the total circuit resistance when heated by said flame, means for reducing the effective impedance value of said coil in said second circuit sufficiently to render said variation in energy value effective to cause said switch operation, and means responsive to said switch operation for delaying resumption of said igniter operation when said switch operation is terminated upon cessation of said flame.

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