Nov. 4, 1947. C. K. STROBEL 2,430,373

SAFETY AND IGNITION CONTROL SYSTEMS FOR FUEL BURNERS

Filed May 19, 1945

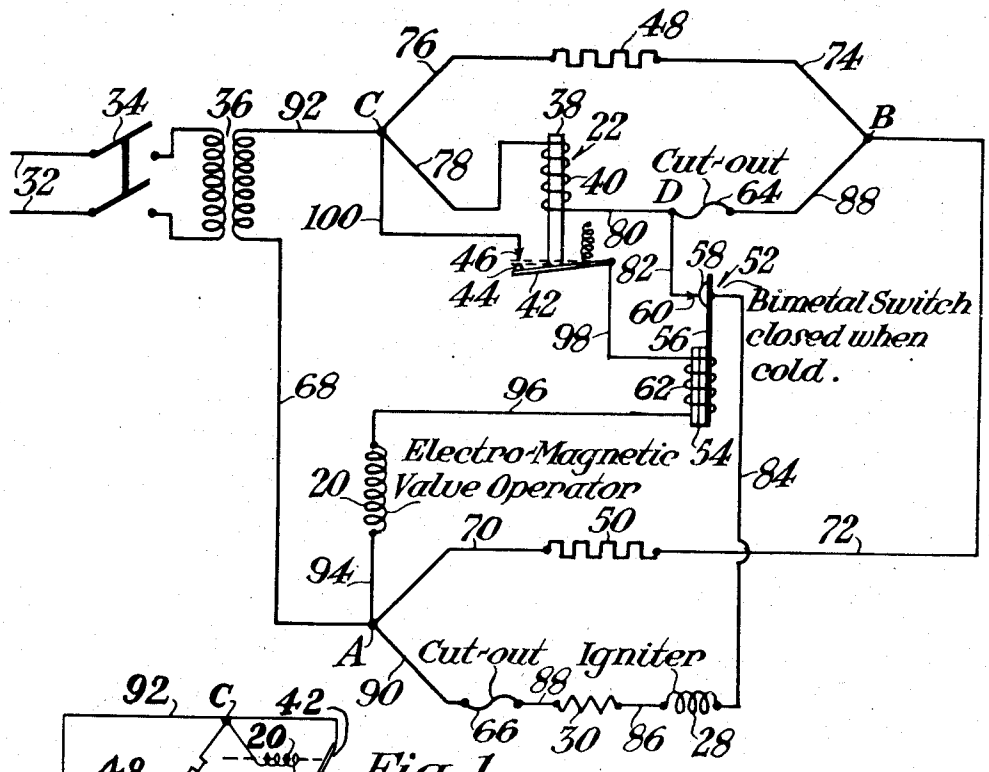


Fig. 1.

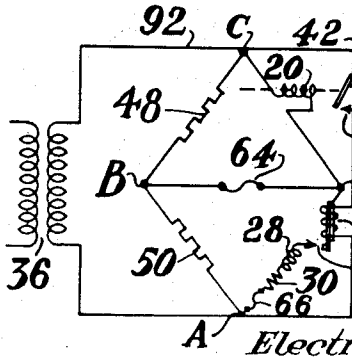


Fig. 3.

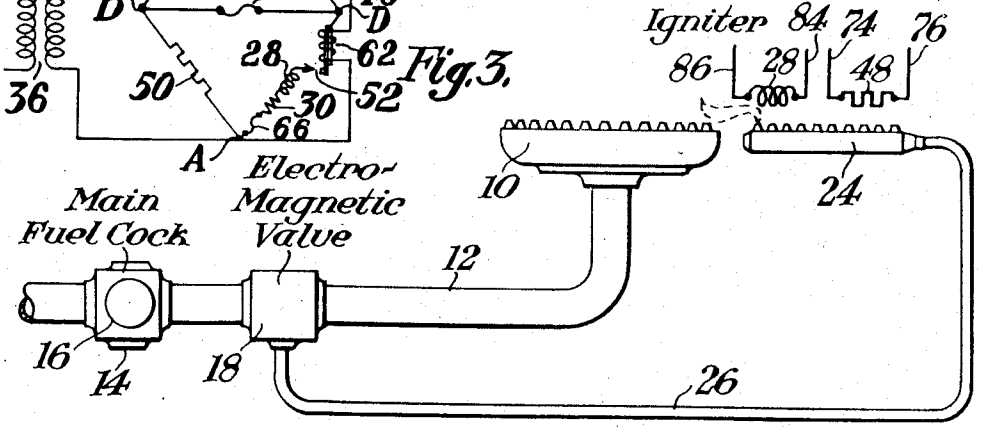


Fig. 2.

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2,430,373

SAFETY AND IGNITION CONTROL SYSTEM FOR FUEL BURNERS

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Application May 19, 1945, Serial No. 594,664

6 Claims. (Cl. 158—117.1)

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

During operation of fuel burners either in domestic cooking or furnace usage it is possible that sudden drops in line voltage applied to the safety system will cause the safety control to operate and shut off the flow of fuel. Such voltage reduction may be caused by the heavy starting currents of other household electrical equipment and, in non-recycling systems will cause the burner to remain shut-off until manually restarted.

An object of this invention is to incorporate the recycling principle in a safety system having a minimum delay period upon starting either initially or upon recycling.

Another object of the invention is to reduce the noise during the starting and running periods of the system to a minimum.

Another object of the invention is to permit use of a pilot burner equipped with an igniter while ensuring complete shut-off of fuel to both the main and pilot burners upon failure of the igniter.

Another object of the invention is to facilitate the substitution in the system of fuel control devices of various fuel capacities and electrical characteristics without requiring corresponding alterations in the circuit constants or the existing circuit elements.

Another object of the invention is to render the system economical in manufacture by utilizing simple and inexpensive elements.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawing, wherein:

Fig. 1 is a wiring diagram incorporating various elements of the safety control and ignition apparatus,

Fig. 2 is a schematic view of the fuel burner for which the electrical control shown in Fig. 1 is adapted for use, and

Fig. 3 is a wiring diagram of a modified form.

Referring more particularly to the drawing, a gaseous fuel burner 10 is shown in Fig. 2 as being supplied with fuel by a main fuel pipe 12. The fuel supply is controlled by a main fuel cock 14 which, in this instance, is arranged for manual operation by a suitable knob or handle 16 but which may be arranged for thermostatic operation if desired. Interposed in the fuel supply pipe 12 between the main valve 14 and the main burner 10 is an electromagnetic or solenoid gas valve 18 of any known type which is arranged to be opened

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by energization of a coil 20 of the solenoid and closed by gravity or spring means upon deenergization of the coil.

As will be apparent hereinafter, the coil 20 of the solenoid valve 18 need not necessarily be completely deenergized in order to effect closure thereof but may be arranged for movement to open position, in which fuel is supplied to the burner 10, when energy of sufficient value is supplied to the solenoid and being movable to a closed position, in which such fuel supply is prevented, when energy of insufficient value is supplied to the solenoid. However, in the preferred embodiment of this invention the opening of the solenoid valve 18 to admit fuel to the main burner 10 is contingent upon current of a predetermined value being supplied to a control relay 22, shown in Fig. 1, and the solenoid valve 18 is either energized or deenergized by operation of the relay 22 dependent upon this current value.

A pilot burner 24 is provided for igniting the main burner 10 and is supplied with fuel from a conduit 26 connected to the solenoid valve 18 to receive the fuel from the pipe 12 when the solenoid valve 18 is in open position. It is apparent, therefore, that the main burner 10 and pilot burner 24 receive fuel simultaneously when the solenoid valve 18 is opened and that, regardless of the open position of the main fuel cock 14, neither burner can receive fuel until such opening of the solenoid valve 18 occurs. It is further apparent that the pilot burner 24 could be dispensed with if desired. Automatic lighting means in the form of an electric resistance igniter 28 is provided in proximity to the pilot burner 24 and a series resistor 30 is associated therewith.

Referring now more particularly to the wiring diagram of Fig. 1, electric current for the operation of the apparatus is supplied by the line wires 32 connected through a double-pole switch 34 to the primary of a transformer 36. If desired, the double-pole switch 34 can be arranged for joint operation with the main fuel cock 14 so that when the handle 16 thereof is turned to open the cock 14, then the main switch 34 will be closed. The transformer 36 is adapted to receive commercial current at the primary at a voltage variation from 105 to 125 volts.

The control relay 22 includes a magnetizable core 38 in the form of a floating plunger which moves into attracted position relative to an operating coil 40 in response to current above a predetermined minimum value being supplied to the coil and is dropped by gravity, spring or other means when the current is reduced below such

minimum value. It will be understood that the pick-up value of the relay current may be greater than the holding value and that the latter is at least the predetermined minimum value below which the coil 40 cannot retain the core 38.

Movement of the core 38 into and out of attracted relation with the coil 40 serves to operate a hinged contact arm 42 as indicated in broken line in Fig. 1. In the attracted position of the core 38, that is, when energizing current above the predetermined minimum value is being supplied to the coil 40, engagement is made by a contact 44 carried by the contact arm 42 with a fixed contact 46. In the released position of the core 38, that is, when current of less than the predetermined minimum value is being supplied to the coil 40, the contact arm 42 will be moved to the position shown in full line in the drawing causing separation of the contacts 44—46.

A ballast resistor 48 having normally a relatively low resistance and a positive temperature coefficient of resistance is positioned to be exposed to the flame of the pilot burner 24 for causing, either directly or in cooperation with other devices to be described, operation of the control relay 22 to move the contact arm 42 from one position to the other. It will be understood that although the ballast resistor 48 is thermally responsive to the passage of current therethrough, it is primarily the heating thereof by the pilot burner flame which causes the variation in resistance relied upon in this embodiment. The ballast resistor 48 may be in the form of a coil of wire having the required characteristics but it will be apparent that other forms of thermally responsive or flame sensitive devices may be employed.

A second or control resistor 50 is provided for cooperation with the ballast resistor 48 to control operation of the control relay 22 and serves to render the adjustment of the circuit constants less critical. In order to accelerate the operation of the control relay 22 upon a change in the value of the current supplied thereto, the control resistor 50 is thermally responsive and has normally a relatively low resistance and a positive temperature coefficient of resistance as in the case of the ballast resistor 48. The resistor 50 is also in the form of a coil of wire having the required characteristics but is not exposed to the heat of any flame. This resistor 50 is adapted to become heated upon passage of electric current therethrough and will change its resistance appreciably in accordance with changes of temperature caused by changes in the value of the current.

Means are provided for deenergizing the igniter 28 after a predetermined period in which the pilot burner has time to produce a flame and the ballast resistor 48 to become heated thereby. Thermally operable switching means 52 are provided in the igniter circuit for this purpose. As shown in Fig. 1, such switching means may comprise a bimetal element 54 carrying a contact arm 56 having a contact 58 engageable with a fixed contact 60. When the bimetal element 54 is unheated the contacts 58—60 are closed. Means controlled by the relay contacts 44—46 are provided for heating the bimetal element 54 sufficiently to cause opening of the contacts 58—60. Such heating means may be in the form of a heater coil 62 wrapped around the bimetal 54 or otherwise disposed in heat transferring relation thereto but always suitably insulated therefrom.

A first cut-out 64 is included in the circuit of

the relay coil 40 and is preferably of the thermal type having time-delayed operation for a purpose which will be apparent hereinafter. Such devices are constructed with predetermined time current characteristics and usually contain a heater element in addition to and affecting a fusible member which opens the circuit by passage of overcurrent. A second cut-out 66 is included in the igniter circuit and is also preferably of the thermal type having time-delayed operation. The electrical connection of these and the other elements in an energizing circuit from the secondary of the transformer 36 will be described in connection with the operation of the apparatus which now proceeds, it being noted that upon initial closure of the main switch 34 the electrically operated elements are connected in a bridge type of circuit for the duration of the starting period.

The thermostatic or manual opening of the main valve 14 by handle 16 permits fuel to flow in the main fuel pipe 12 as far as the solenoid valve 18 which is initially closed. The main switch 34 is then manually closed or, if it is combined with the main fuel cock 14, then it is operated to closed position by handle 16 when the main fuel cock 14 is opened. The electrical circuit is then established as follows: from the secondary of the transformer 36 by wire 68 to junction A of the bridge. One arm of the bridge from junction A includes wire 70, control resistor 50, and wire 72 to junction B. The second arm of the bridge includes wire 74, ballast resistor 48 and wire 76 to junction C. The third arm includes wire 78, coil 40 of relay 22, and wire 80 to junction D. The fourth arm includes wire 82, contacts 58—60 of switch 52, wire 84, igniter 28, wire 86, series resistor 30 wire 88, cut-out 66 and wire 90 to junction A.

The cut-out 64 is connected as the detector arm of the bridge in this initial or starting period circuit by a wire 88 connecting one terminal thereof to junction B and by connecting the opposite terminal thereof directly to the junction D. A wire 92 connects junction C to the secondary of transformer 36 and completes the energizing circuit. As previously stated, the contacts 44—46 of control relay 22 are opened when coil 40 is receiving insufficient current to pick up or hold the core 38 or when the coil 40 is deenergized. The contacts 44—46 are connected in a series circuit from the transformer secondary including the heater coil 62 and the coil 20 of the solenoid valve 18 and such circuit has parallel connection with the bridge. Such connection is made by a wire 94 connecting one terminal of the coil 20 to junction A of the bridge, a wire 96 connecting the opposite terminal of the coil 20 to one terminal of the coil 62, a wire 98 connecting the opposite terminal of the coil 62 to the armature 42 carrying contact 44 and by a wire 100 connecting contact 46 to junction C of the bridge.

Since the contacts 58—60 of the switching means 52 are initially closed, the igniter 28 is now energized in the described bridge circuit. Moreover, if the cut-out 64 is considered of negligible impedance or a short-circuit during the starting period, then the circuit consists of two parallel meshes connected in series with the secondary of the transformer 36. The first parallel mesh consists of the igniter 28 in parallel with the control resistor 50 and the second parallel mesh consists of the relay coil 40 in parallel with the ballast resistor 48. The existence of the first par-

allel mesh results in a reduction of the impedance in series with the second parallel mesh and therefore an increase in current through the relay coil 40. Such current is of sufficient value to cause pick-up of the core 38 of the relay 22 causing movement of armature 42 for closing contacts 44—46. The heater coil 62 of the switching means 52 and the coil 20 of the solenoid valve 18 are thus energized in a series circuit through the contacts 44, 46 which is established as follows: upper terminal of the secondary of transformer 36, wire 92, junction C, wire 100, contacts 46, 44, wire 98, heater coil 62, wire 96, valve coil 20, wire 94, junction A, and wire 68 to the lower terminal of the secondary of transformer 36. The opening of the solenoid valve 18 causes fuel to flow to the main burner 10 and the pilot burner 24 and such fuel is ignited by the igniter 28 at the pilot burner 24 causing ignition of the main burner 10.

At the end of a predetermined period, which may be eighteen seconds, the heater coil 62 causes the thermally operable switching means 52 to open its contacts 58—60 by operation of the bimetal element 54. The igniter 28 is deenergized by opening of the contacts 58—60 and the series resistor 30 and cut-out 66 are also deenergized. The bridge circuit is thus converted into a circuit including the secondary of transformer 36 and control resistor 50 in series with a parallel mesh having in one branch the ballast resistor 48 and in another branch the relay coil 40 and cut-out 64. The resistance value of this circuit is adjusted so that the current value to the relay coil 40 will fall below the holding value unless the ballast resistor 48 has been sufficiently heated by the pilot burner flame to increase in resistance value and cause the required current value to be supplied to the relay coil 40. If such heating has occurred the current value to the relay coil 40 drops only to holding value and the apparatus is placed in running condition with the solenoid valve maintained in open position permitting fuel to flow to both the main and pilot burners.

It should be observed that the heating of the ballast resistor 48 and the control resistor 50, the former due to the flame of the pilot burner 24 and the passage of current therethrough and the latter due to the passage of current therethrough only, serves to improve the balance of the bridge during the starting period to such an extent that current through the cut-out 64 is soon reduced to a value insufficient to cause operation thereof regardless of whether the main switch 34 is manipulated in on-off-on cycles at this period. The cut-out 64 will only operate on passage of overcurrent and thus protects the circuit against failure of the ballast resistor 48 during the normal running operation. The second cut-out 66 will operate to open the circuit of the igniter 28 should the contacts 58—60 of the thermal switching means 52 become welded together and unable to open.

In the event that ignition of the pilot burner 24 is not effected and the current to the relay coil 40 is rendered insufficient to hold the core 38 as described, then the contacts 44—46 will consequently be opened. The heater coil 62 and the coil 20 of the solenoid valve 18 become deenergized. The deenergizing of the solenoid valve causes it to close to shut off all fuel in the pipe 12 to burners 10 and 24. The contacts 58—60 of the thermal switching means 52 will be closed after the predetermined period which the bimetal element 54 requires to become cool and the sequence of operations will then begin over again. Thus, the thermally operable switching means 52 performs the dual function of causing forced pick-up of the relay armature 42 for quick starting and of introducing the proper delay for purging the vicinity of the burners of unburned fuel prior to another starting operation.

In the event that the igniter 28 becomes burnt out or otherwise fractured, the means of forced pick-up of the relay 22 is removed and the system cannot be started. However, the use of a short-circuiting switch across the igniter 28 would permit the system to be used by igniting the pilot burner with a match, but the recycling feature would not be retained.

Since the temperature condition of the ballast resistor 48 influences the holding value of the current to the relay coil 40 it is apparent that if the system is in the steady state operation and flame failure occurs, then the ballast resistor 48 will cool and the relay coil will receive insufficient current to retain the core 38. The armature will resume its initial position and contacts 44—46 will be opened. The coil 20 of the solenoid valve 18 is thus deenergized and flow of fuel to both the main and pilot burners will be prevented. In addition, the heater coil 62 of the thermal switching means 52 is deenergized and the bimetal element 54 starts to cool. The period during which the bimetal 54 takes to cool is adjusted to be as long or longer than the cooling period of the ballast resistor 48. Thus, at the end of the cooling period of the bimetal element 54 the contacts 58—60 are closed and the system begins its operating sequence over again.

If, in the steady state operation, there is a sudden voltage surge which causes the control relay 22 to drop the core 38 and open the contacts 44—46, the sequence of events is as described in the case of flame failure. The contacts 58—60 of the thermal switch 52 will be closed in the course of recycling and the sysitem will restart as soon as the voltage comes within the operating range.

In normal operation from a cold start, ignition of the main burner 10 occurs within a few seconds. If a number of on-off-on operations are performed or the system when in steady operation is turned off and on again, then there will be a delay in the ignition of the main burner 10 in accord with the recycling principle described.

It will be apparent from the foregoing description that the provision of a relay 22 permits the use of control valves of different types and capacities without limitation to those which will operate on small variations in current values. However, the scope of this invention is not deemed to be limited to the provision of such a relay as the solenoid valve 18 itself could be provided with a pair of contacts operated by the movement thereof. Thus, in the modification shown in Fig. 3 the relay 22 is dispensed with and the circuit of the heater coil 62 consists only of the contacts 44—46 in series with the heater coil 62. The coil 20 of the solenoid valve in this embodiment takes the place of the coil 40 of the control relay 22 between junctions C and D of the described bridge circuit. All such modifications and changes can be made in the arrangement and combination of parts and in the details of construction herein disclosed within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. Safety control apparatus for fuel burners having a source of electrical energy, comprising

in combination, electrically operable means connected to said source for controlling the supply of fuel to the burner, said controlling means including a device movable to a position in which fuel is supplied to the burner when energy of sufficient value is supplied to said device and being movable to another position in which said fuel supply is prevented when energy of insufficient value is supplied thereto, a thermal resistor having a preselected temperature coefficient of resistance located to be heated by a flame at the burner and electrically connected to said device, resistance means in circuit with said device and thermal resistor, said resistance means being adapted for cooperation with said thermal resistor to cause energy of said insufficient value to be supplied to said device when said resistor is unheated by said flame, means for delaying said cooperation for a predetermined period during which said thermal resistor has time to become heated, and means responsive to movement of said device between said positions for controlling said delaying means.

2. Safety control apparatus for fuel burners having a source of electrical energy, comprising in combination, electrically operable means connected to said source for controlling the supply of fuel to the burner, said controlling means including a device movable to a position in which fuel is supplied to the burner when energy of sufficient value is supplied to said device and being movable to another position in which said fuel supply is prevented when energy of insufficient value is supplied thereto, a thermal resistor having a preselected temperature coefficient of resistance located to be heated by a flame at the burner and electrically connected to said device, resistance means in circuit with said controlling means and thermal resistor, said resistance means being adapted for cooperation with said thermal resistor to cause energy of said insufficient value to be supplied to said device when said resistor is unheated by said flame, thermally operable switching means for delaying said energization for a predetermined period during which said thermal resistor has time to become heated, and a heater responsive to movement of said device between said positions for controlling said switching means.

3. Safety control apparatus for fuel burners having a source of electrical energy, comprising a pair of electrical bridge arms each including a resistor, one of said resistors having a preselected temperature coefficient of resistance and being located to be heated by the burner flame, a second pair of bridge arms in parallel circuit with the first said pair, the opposite junctions of said first and second pairs being connected to the source of energy, means for controlling the supply of fuel to the burner including an electrically operable device in the arm of said second pair adjacent said one resistor, said device being movable between fuel supply permitting and preventing positions upon sufficient variation in the energy value supplied thereto, thermally operable switching means in the other arm of said second pair and operable when heated for electrically disconnecting said other arm, a heater for said switching means adapted to cause said operation thereof after a predetermined period during which said one resistor has time to become heated by the burner flame, said resistors being cooperable after said period to cause said energy variation if said one resistor is unheated by the burner flame, an energizing circuit for said heater

connected to said opposite junctions, and switching means responsive to movement of said electrically operable device between said positions for closing and opening said heater circuit.

4. Safety control and ignition apparatus for fuel burners having a source of electrical energy, comprising a pair of electrical bridge arms each including a resistor, of said resistors having a preselected temperature coefficient of resistance and being located to be heated by the burner flame, a second pair of bridge arms in parallel circuit with the first said pair, the opposite junctions of said first and second pairs being connected to the source of energy, means for controlling the supply of fuel to the burner including an electrically operable device in the arm of said second pair adjacent said one resistor, said device being movable between fuel supply permitting and preventing positions upon sufficient variation in the energy value supplied thereto, an electric igniter for the burner in the other arm of said second pair, thermally operable switching means in said other arm and operable when heated for electrically disconnecting said igniter, a heater for said switching means adapted to cause said operation thereof after a predetermined period during which said one resistor has time to become heated by the burner flame, said resistors being cooperable after said period to cause said energy variation if said one resistor is unheated by the burner flame, an energizing circuit for said heater connected to said opposite junctions, and switching means responsive to movement of said electrically operable device between said positions for closing and opening said heater circuit.

5. Safety control apparatus for fuel burners having a source of electrical energy, comprising a pair of electrical bridge arms each including a resistor, one of said resistors having a preselected temperature coefficient of resistance and being located to be heated by the burner flame, a second pair of bridge arms in parallel circuit with the first said pair, the opposite junctions of said first and second pairs being connected to the source of energy, a control relay having means in the arm of said second pair adjacent said one resistor responsive to sufficient variation in the energy value supplied to said means for causing operation of said relay, thermally operable switching means in the other arm of said second pair and operable when heated for electrically disconnecting said other arm, a heater for said switching means adapted to cause said operation thereof after a predetermined period during which said one resistor has time to become heated by the burner flame, said resistors being cooperable after said period to cause said energy variation if said one resistor is unheated by said flame, electrically operable means movable between fuel flow permitting and preventing positions for controlling the supply of fuel to the burner, an energizing circuit for said heater and said electrically operable means connecting said opposite junctions to the source, and switch contacts responsive to operation of said relay for opening and closing said circuit to cause movement of said electrically operable means.

6. Safety control and ignition apparatus for fuel burners having a source of electrical energy, said apparatus having a starting period circuit comprising an electrical bridge having arms in a sequence with opposite junctions of the first and fourth arms and the second and third arms connected to the source, a first thermal resistor in said first arm having a preselected temperature

coefficient of resistance and being heated by the passage of energy therethrough, a second thermal resistor in said second arm having a preselected temperature coefficient of resistance and being located to be heated by the burner flame, a control relay having means in said third arm responsive to sufficient variation in the energy value supplied to said means for causing operation of said relay, an electric igniter for the burner in said fourth arm, a cut-out connected across opposite junctions of said first and second arms and said third and fourth arms, thermally operable switching means in said fourth arm and operable when heated for electrically disconnecting said igniter and thereby converting said bridge into a circuit including the source and said first resistor in series with a parallel mesh having in one branch said first resistor and in another branch said relay operating means and said cut-out, a heater for said switching means adapted to cause said operation thereof after a predetermined period during which said second resistor has time to

become heated, said resistors cooperating after said period to cause said energy variation if the second thermal resistor is unheated by said flame, electrically operable means movable between fuel flow permitting and preventing positions for controlling the supply of fuel to the burner, said electrically operable means and said heater being connected in series circuit and in parallel with said first resistor and said mesh, and switch contacts responsive to operation of said relay for opening and closing said parallel circuit to cause movement of said electrically operable means.

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