

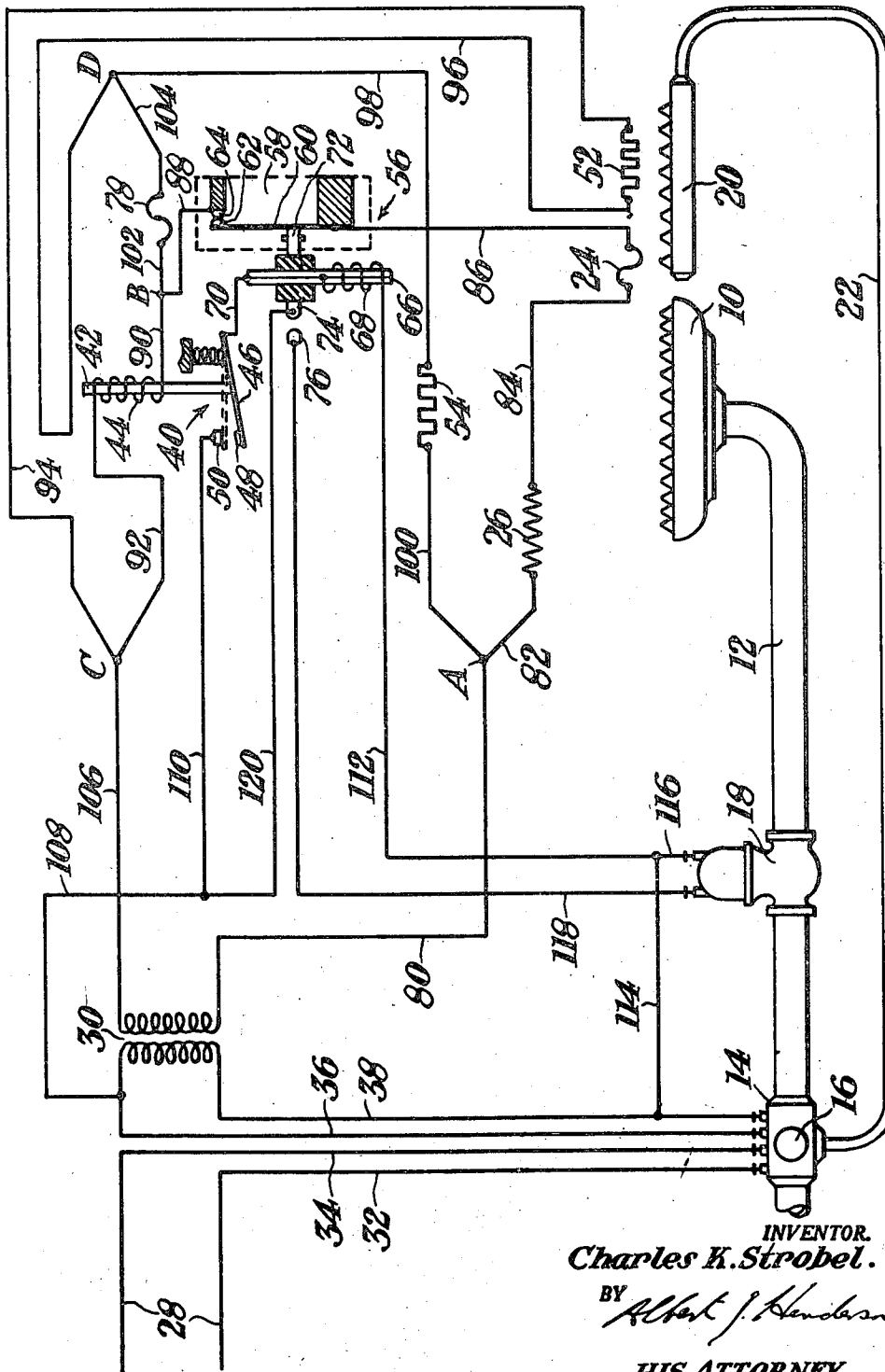
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SAFETY CONTROL AND IGNITION SYSTEM FOR FUEL BURNERS

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SAFETY CONTROL AND IGNITION SYSTEM
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This invention relates to safety and ignition apparatus for fuel burners and, more particularly, to electrically operated apparatus therefor.

In my copending application Serial No. 594,664, filed May 19, 1945, now matured as Patent No. 2,430,373, granted November 4, 1947, there is disclosed a safety and ignition apparatus for automatically controlling a fuel burner with safety and with a minimum delay in starting the burner in operation or recycling the same after an undesired stoppage. The system there disclosed utilizes a relatively inexpensive thermal timer for disconnecting the igniter from a conventional bridge circuit such as specified in Patent No. 2,380,125, dated July 10, 1945. The present invention seeks to improve the apparatus disclosed in application Serial No. 594,664 by having for an object the avoidance of the necessity of admitting fuel substantially simultaneously to the main and pilot burners in starting or recycling.

Another object of the present invention is to render it necessary that the pilot burner produce a flame before any flow of fuel to the main burner is possible.

Another object of the invention is to incorporate a purge period during the recycling operation of sufficient duration to permit the escape of unburned fuel remaining from the previous operation.

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 and ignition system for gaseous fuel burners, said view embodying a wiring diagram.

Referring more particularly to the drawing, a gaseous fuel burner 10 is supplied with fuel by a main fuel pipe 12. The fuel supply in pipe 12 is controlled by a main valve 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 burner 10 is an electromagnetic or solenoid gas valve 18 of any known type which is arranged to be opened by energization of the usual solenoid coil thereof and closed by gravity, springs or the like upon effective de-energization of said coil.

A pilot burner 20 is provided for igniting the main burner 10 and is supplied with fuel from a conduit 22 connected to the main valve 14 to receive fuel from the pipe 12 when the main valve 14 is opened. The pilot burner 20 is not under the control of the solenoid valve 18 as is the

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main burner 10 and it will be apparent that the provision of means to be described hereinafter render it necessary that the pilot burner 20 produce a flame before any flow of fuel to the main burner 10 can occur. Automatic lighting means in the form of an electric resistance igniter 24 is provided in proximity to the pilot burner 20 and a series resistor 26 is associated therewith.

Electric current for the operation of the apparatus is supplied by the line wires 28 connected to the primary of a transformer 30 which may receive commercial current at the primary at a voltage variation from 105 to 125 volts. In this embodiment, the main valve 14 has a main switch (not shown) combined therewith which is of the double-pole type having two terminals connected in series circuit with the line wires 28 by wires 32 and 34. The other two terminals of the main switch are connected by wires 36 and 38 in series circuit with the primary of the transformer 30. The arrangement provides for opening movement of the main valve 14 and simultaneous closing of the main switch as well as opening of the switch upon closing of the main valve 14.

A control relay 40 is included in the system and has a magnetizable core 42 in the form of a floating plunger which moves into attracted position relative to an operating coil 44 in response to current above a predetermined minimum value being supplied to the coil 44 and which drops 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 44 cannot retain the core 42.

Movement of the core 42 into and out of attracted relation with the coil 44 serves to operate a hinged contact arm 46 as indicated in broken lines in the drawing. In the attracted position of the core 42, that is, when energizing current above the predetermined minimum value is being supplied to the coil 44, engagement is made by a contact 48 carried by the contact arm 46 with a fixed contact 50. In the released position of the core 42, that is, when current of less than the predetermined minimum value is being supplied to the coil 44, contact arm 46 will be moved by dropping of the core 42 to the position shown in full lines in the drawing causing separation of the contacts 48 and 50.

A ballast resistor 52 having normally a relatively low resistance and a positive temperature coefficient of resistance is positioned to be ex-

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posed to the flame of the pilot burner 20 for causing, in cooperation with other devices to be described, operation of the control relay 40 to move the contact arm 46 from one position to the other. It will be understood that although the ballast resistor 52 is thermally responsive to the passage of current therethrough, it is primarily the heating thereof by the flame of the pilot burner 20 which causes the variation in resistance relied upon in this embodiment of the invention. The ballast resistor 52 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 54 is provided for cooperation with the ballast resistor 52 to control operation of the control relay 40 and serves to render the adjustment of the circuit constants less critical. In order to accelerate the operation of the control relay 40 upon a change in the value of the current supplied thereto, the control resistor 54 is thermally responsive and has normally a relatively low resistance and a constant temperature coefficient of resistance as in the case of the ballast resistor 52. The resistor 54 is also in the form of a coil of wire having required characteristics but is not exposed to the heat of any flame. This resistor 54 is adapted to become heated upon passage of electric current therethrough and will change its resistance appreciably in accordance with the changes in temperature caused by changes in the value of the current.

Means are provided for deenergizing the igniter 24 after a predetermined period during which the pilot burner 20 has time to produce a flame and the ballast resistor 52 to become heated thereby. Thermally operable switching means 56 are provided for this purpose as well as for another purpose to be described hereinafter. Thus, provided in the circuit of the igniter 24 is a snap-action switch 58 having a switch blade 60 of spring material carrying a contact 62 for cooperation with a fixed contact 64. The switch blade 60 has a normal bias for disengaging the contacts 62, 64. The snap-action switch 58 forms a first switching means operable for causing a variation in the total resistance value of the circuit in which it is connected sufficient to cause operation of the relay 40 as will be apparent hereinafter. This switch 58 may be of the well-known microswitch type and further description thereof is considered unnecessary.

A timing device is provided for causing operation of the switch 58 between open and closed positions of the contacts 62, 64. The timing device is of the thermally operable type and comprises a bimetal arm 66 forming the timing element and having means cooperable therewith for initiating the timing period. Thus, a heater coil 68 is provided for the bimetal arm 66 and may be wrapped around or otherwise associated therewith in heat transferring relation. For the purpose of clarity in illustration, one end of the heater coil 68 is shown as electrically connected to the bimetal arm 66 and a wire 70 is shown as extending from this bimetal arm 66 for connection to one end of the contact arm 46. It will be understood, however, that one end of the heater coil 68 could be directly connected to the contact arm 46, if desired, without establishing a circuit through the bimetal arm 66.

An operating stem 72 projects from the bimetal arm 66 into operative engagement with the switch blade 60 for operating the same to close the contacts 62, 64. As indicated in the drawing, the

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stem 72 is suitably insulated from the bimetal arm 66. Similarly insulated on the opposite side of the bimetal arm 66 is a movable contact 74 for cooperation with a fixed contact 76. The arrangement is such that when the bimetal arm 66 is heated it will warp to the left as shown in the drawing and cause disengagement between contacts 62, 64 and thereafter cause engagement between contacts 74, 76.

It will be understood, therefore, that a predetermined time delay period occurs between the energizing of the heating coil 68 and the disengagement of contacts 62, 64. Moreover, a further additional time delay period occurs between the opening of the contacts 62, 64 and the closing of the contacts 74, 76. There is thus a period of short duration in the reverse movement of the bimetal arm 66, that is, from the hot to the cold position thereof, wherein neither of the contacts 74, 76 nor the contacts 62, 64 are closed. As will be apparent hereinafter, this is termed the purge period in the operation of the device.

The elements of the circuit are completed by the provision of the usual cutout 78 in the circuit of the relay coil 44 and which is preferably of the thermal type having time delayed operation to open the circuit upon passage of overcurrent therethrough as might occur due to failure of the ballast resistor 52. The connection of the various elements in an energizing circuit from the source 28 will be described in connection with the operation of the apparatus, which now proceeds, it being noted that upon initial closing of the main switch of valve 14 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. At this time fuel flows to the pilot burner 20 by way of the conduit 22 and the simultaneous closing of the main switch as described completes the following electric circuit: From the lower terminal of the secondary of the transformer 30, by wire 80 to junction A of the bridge circuit. The first arm of this bridge comprises wire 82, series resistor 26, wire 84, igniter 24, wire 86, switch blade 60, contacts 62, 64 and wire 88 to junction B of the bridge. The second arm of the bridge includes wire 90, relay coil 44 and wire 92 to junction C of the bridge. The third arm includes wire 94, ballast resistor 52 and wire 96 to junction D of the bridge. The fourth arm includes wire 98, control resistor 54 and wire 100 to junction A. The cut-out 78 is connected as the detector arm of the bridge in this initial or starting circuit by a wire 102 connecting one terminal thereof to junction B and by connecting the other terminal thereof by wire 104 to junction D. A wire 106 connects junction C to the upper terminal of the secondary of the transformer 30 and completes the bridge circuit.

Since the contacts 62, 64 of the switching means 56 are initially closed, the igniter 24 is energized in the described bridge circuit. Moreover, if the cut-out 78 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 30. The first parallel mesh consists of the igniter 24 in parallel with the control resistor 54 and the second parallel mesh consists of the relay coil 44 in parallel with the ballast resistor 52. The existence of the first parallel mesh results in a reduction of the im-

pedance in series with the second parallel mesh and therefore an increase in current through the relay coil 44. Such current is of sufficient value to cause pick-up of the core 42 of the relay 40 and consequent movement of the contact arm 46 to close contacts 48, 50. A series circuit through the contacts 48, 50 is then established as follows: upper terminal of primary of transformer 30, wire 108, wire 110, contacts 50, 48, contact arm 46, wire 70, bimetal arm 66, heater coil 68, wire 112, wire 114 and wire 38 to the lower terminal of the primary of transformer 30. The heater coil 68 of the switching means 56 is thus energized through the described series circuit from the primary of the transformer 30 and the bimetal arm 66 becomes heated. During this operation the fuel flowing from the pilot burner 20 is ignited by the igniter 24 and the ballast resistor 52 becomes heated by the pilot burner flame.

The bimetal arm 66 now warps and moves to the left as viewed in the drawing and causes opening of the snap-action switch 58 by permitting movement of switch blade 60 under its bias to open the contacts 62, 64. Such opening movement of the contacts 62, 64 occurs after a predetermined time delay period set by the time required for effective heating of the bimetal arm 66. The igniter 24 is thereupon deenergized together with the series resistor 26. The bridge circuit is thus converted into a circuit including the secondary of the transformer 30 and control resistor 54 in series with a parallel mesh having in one branch the ballast resistor 52 and in another branch the relay coil 44 and cut-out 78.

The resistance value of this parallel mesh circuit is adjusted, as described in the application and patent previously referred to herein, so that the current value to the relay coil 44 will fall below the holding value unless the ballast resistor 52 has been sufficiently heated by the flame at the pilot burner 20 to increase in resistance value and cause the required current value to be applied to the relay coil 44. If such heating has occurred, the current value to the relay coil 44 is reduced only to the holding value and the apparatus is then ready to be placed in running condition with the contact arm 46 in position to maintain the contacts 48, 50 closed.

After the bimetal arm 66 has caused opening of the contacts 62, 64, further warping occurs as described until the contacts 74, 76 are in closed position. Upon this occurrence, a circuit for the solenoid coil of valve 18 is completed as follows: upper terminal of primary of transformer 30, wire 108, wire 120, contacts 74, 76, wire 118, coil of solenoid valve 18, wire 116, wire 114, and wire 38 to the lower terminal of the primary of transformer 30. Such circuit is in parallel with the circuit of the heater coil 68 and relay contacts 48, 50, and serves to energize the solenoid valve coil whereupon this valve 18 moves to open position and fuel is admitted to the main burner 10. Such fuel issuing from the main burner 10 is ignited by the flame from the pilot burner 20 and the apparatus is thus set in steady running condition.

In the event that flame failure occurs, such as by extinguishment of the pilot burner 20, then the ballast resistor 52 will cool and decrease in resistance value until the current distribution is such as to cause the relay coil 44 to release the contact arm 46 of the relay 40 and open the contacts 48, 50. Such operation will cause deenergization of the heater coil 68 and consequent

cooling of the bimetal arm 66. A reverse movement of the bimetal arm 66 to the right, as viewed in the drawing, then occurs causing the contacts 74, 76 to move to open position. Such contact operation serves to deenergize the coil of the solenoid valve 18, whereupon this valve moves to closed position. The fuel supply to the main burner 10 is thus shut off.

However, the purge period previously referred to occurs upon the foregoing operation of contacts 74, 76 due to a lag in the operation of the bimetal arm 66 before closing the contacts 62, 64 to again energize the igniter 24. During this purge period any unburned fuel remaining from the previous operation has time to escape from the vicinity of the burners 10 and 20. However, as soon as the bimetal arm 66 moves far enough to overcome the bias of switch blade 60 and operate the snap-action switch 58 to close the contacts 62, 64, then the igniter 24 is reenergized and the system undergoes a recycling operation as described for the normal starting period.

It will be observed that both in the starting and recycling operations the fuel to the pilot burner 20 is first turned on and no flow of fuel to main burner 10 can occur at these times. In the event that the bimetal arm 66 is heated by the heating coil 68 and opens the contacts 62, 64, but the pilot burner 20 has not been ignited and the ballast resistor 52 remains unheated, then the contacts 48, 50 of the relay 40 will be opened due to the lack of current of holding value in coil 44 as previously described. The heating of the bimetal arm 66 will thus be discontinued and there will be no possibility of closing the contacts 74, 76 to complete the circuit through the coil of the solenoid valve 18 and permit flow of fuel to the main burner 10. It is evident that in the arrangement herein shown and described it is necessary that the fuel flowing from the pilot burner 20 be ignited before there can be any flow of fuel from the main burner 10.

It will be apparent that the snap-action switch 58 which is operated by the bimetal arm 66 introduces a desirable characteristic into the apparatus. During a recycling operation the heater coil 68 is deenergized during the cooling period and immediately reenergized as soon as the contacts 62, 64 become closed to reestablish the bridge circuit and cause pick-up of the contact arm 46. It may thus be seen that if the customary slow make-and-break contacts were used for the cold position, the time during which the cold contacts would remain closed would be relatively short unless temperature lagging means were added to the device. However, since the snap-action switch 58 requires a large force to operate it to closed position than to release it for movement to open position then an effective temperature lag is obtained by using this type of switch 58 in conjunction with the bimetal arm 66. It is apparent that the temperature of the bimetal arm 66 during the recycling operation would have to be lower to close the switch 58 than to permit it to open again.

The provision of the control relay 40 permits the use of control valves of different types and capacities without limitation to those which will operate in small variations in current value. The desirable features of an inexpensive time delay and an improvement of the system voltage range are retained in this embodiment as in the case of the application hereinbefore referred to. It will be apparent that many modifications and changes can be made in the arrangement and

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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 main and pilot burners, comprising the combination with an electrical bridge circuit including a control relay having contact means operable between positions in response to variations in the energy value supplied to said relay, switching means operable for causing a variation in the total resistance value of said circuit sufficient to cause operation of said contact means to one of said positions, and a thermal resistor responsive to the presence of a flame at the pilot burner for varying in resistance value sufficient to compensate for said variation and prevent said contact operation, of a timing device controlled by operation of said contact means and adapted for causing operation of said switching means upon expiration of a predetermined period following operation of said contact means to another said position and during which said thermal resistor has time to become responsive to said flame, electrically operable means for controlling the supply of fuel to the main burner, and second switching means operable by said timing device for completing a circuit for said electrically operable means while said thermal resistor remains responsive to said flame.

2. Safety control apparatus for fuel burners having main and pilot burners, comprising the combination with an electrical bridge circuit including a control relay having contact means operable between positions in response to variations in the energy value supplied to said relay, switching means operable for causing a variation in the total resistance value of said circuit sufficient to cause operation of said contact means to one of said positions, and a thermal resistor responsive to the presence of a flame at the pilot burner for varying in resistance value sufficient to compensate for said variation and prevent said contact operation, of a timing element for causing operation of said switching means upon expiration of a predetermined period during which said thermal resistor has time to become responsive to said flame, means cooperable with said timing element and controlled by operation of said contact means for initiating said period upon said contact means being operated to another said position, electrically operable means for controlling the supply of fuel to the main burner, and second switching means operable by said timing element for completing a circuit for said electrically operable means while said thermal resistor remains responsive to said flame.

3. Safety control apparatus for fuel burners having main and pilot burners, comprising the combination with an electrical bridge circuit including a control relay having contact means operable from closed to open position in response to a variation in the energy value supplied to said relay, switching means operable from closed to open position for causing a variation in the total circuit resistance sufficient to cause said operation of said contact means, and a thermal resistor responsive to the presence of a flame at the pilot burner for varying in resistance value sufficient to compensate for said variation and prevent said contact operation, of a thermal timing element operatively associated with said switching means for causing said operation thereof upon expiration of a predetermined

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period during which said thermal resistor has time to become responsive to said flame, heating means cooperable with said timing element and connected to said contact means for initiating said period in the closed position of said contact means, electrically operable means for controlling the supply of fuel to the main burner, and second switching means operatively associated with said timing element for completing a circuit for said electrically operable means while said contact means remain in said closed position.

4. Safety control apparatus for fuel burners having main and pilot burners, comprising the combination with an electrical bridge circuit including a control relay having contact means operable from closed to open position in response to a variation in the energy value supplied to said relay, switching means operable from closed to open position for causing a variation in the total circuit resistance sufficient to cause said operation of said contact means, and a thermal resistor responsive to the presence of a flame at the pilot burner for varying in resistance value sufficient to compensate for said variation and prevent said contact operation, of a thermal timing element operatively associated with said switching means for causing said operation thereof upon expiration of a predetermined period during which said thermal resistor has time to become responsive to said flame, a heater coil for said timing element connected in circuit with said contact means for initiating said period in the closed position of said contact means, electrically operable means for controlling the supply of fuel to the main burner, and second switching means operatively associated with said timing element for completing a circuit in parallel with the last said circuit for energizing said electrically operable means while said contact means remain in said closed position.

5. Safety control apparatus for fuel burners having a source of electric energy and main and pilot burners, comprising in combination, 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 a flame at the pilot burner, 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, a control relay having a coil in the arm of said second pair adjacent said one resistor and having contact means operable from closed to open position in response to a variation in the energy value supplied to said coil, switching means in the other arm of said second pair and being operable from closed to open position for causing a variation in the total circuit resistance sufficient to cause said operation of said contact means unless said one resistor is heated by said flame, a thermal timing device controlled by operation of said contact means and adapted for causing said operation of said switching means upon expiration of a predetermined period following operation of said contact means to said closed position and during which said one resistor has time to become heated by said flame, electrically operable means for controlling the supply of fuel to the main burner, and second switching means operable by said timing device for completing a circuit for said electrically operable means while said one resistor remains heated by said flame.

6. Safety control apparatus for fuel burners having a source of electric energy and main and

pilot burners, comprising in combination, 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 a flame at the pilot burner, 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, a control relay having a coil in one arm of said second pair adjacent said one resistor and having contact means operable from closed to open position in response to a variation in the energy value supplied to said coil, an electric resistance igniter for the pilot burner in the other arm of said second pair, switching means in the last said arm and operable from closed to open position for electrically disconnecting said igniter, a thermal timing element operatively associated with said switching means for causing said operation thereof upon expiration of a predetermined period during which said one resistor has time to become heated, said resistors being cooperable to cause said variation in energy value when said one resistor remains unheated by said flame, a heater coil for said timing element connected in circuit with said contact means for initiating said period in the closed position of said contact means, electrically operable means movable between fuel flow permitting and preventing positions for controlling the main burner fuel supply, second switching means operatively associated with said timing element for operation thereby from open to closed position upon expiration of said period, said second switching means in closed position being adapted for completing a circuit in parallel with the last said circuit for energizing said electrically operable means while said contact means remain in said closed position.

7. Safety control apparatus for fuel burners 40

having main and pilot burners, comprising the combination with an electrical bridge circuit including a control relay having contact means operable between positions in response to variations in the energy value supplied thereto, an electric resistance igniter for the pilot burner, switching means operable for electrically disconnecting said igniter during normal running operation of the main burner and thereby being effective for causing a variation in the total resistance value of said circuit sufficient to cause operation of said contact means to one of said positions, and a thermal resistor responsive to the presence of a flame at the pilot burner for varying in resistance value sufficient to compensate for said variation and prevent said contact operation, of a timing device controlled by operation of said contact means and adapted for causing operation of said switching means upon expiration of a predetermined period following operation of said contact means to another said position and during which said thermal resistor has time to become responsive to said flame, electrically operable means for controlling the supply of fuel to the main burner, and second switching means operable by said timing device following expiration of said period for completing a circuit for said electrically operable means while said thermal resistor remains responsive to said flame and for opening said last circuit in the event of extinguishment of said flame, said timing device being operable in said event for causing another operation of the first said switching means for reconnecting said igniter after a predetermined period sufficient for the escape of unburned fuel remaining after the previous running operation.

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No references cited.