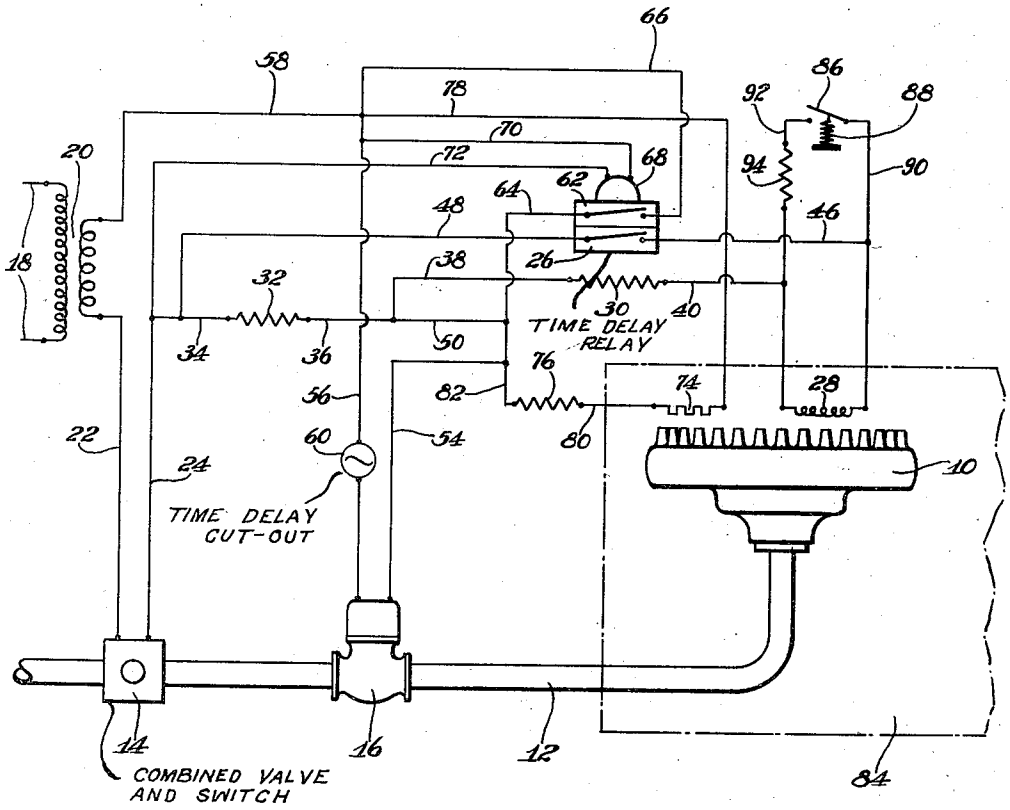
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SAFETY CONTROL APPARATUS FOR FUEL BURNERS

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SAFETY CONTROL APPARATUS FOR FUEL BURNERS

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

Electrically operated fuel control apparatus has been arranged to permit supply of gaseous fuel to a main burner if a heat or flame sensitive portion of the apparatus has previously been heated by a pilot burner. The flame sensitive device may take the form of an electrical resistance element having the characteristic of changing its resistance when heated and thus changing the value of the energizing current supplied to the fuel controlling member of the safety apparatus. The use of the variable resistance characteristic of the flame sensitive device, not only to hold the fuel controlling member open but also to cause its actuation to such position, introduces objectionable features. The establishment of flame sensitive circuit conditions may, however, be used as a device for maintaining flow of fuel to the burner, provided such flow is not initiated thereby.

Apparatus of this type lends itself conveniently to the use of electrical igniting devices for the burner. Where ignition elements of the hot-wire type are employed it is desirable to remove such elements from the circuit, as by deenergization thereof, after the burner is ignited. Such treatment assists in prolonging the life of these elements beyond that expected when continuous energization is employed.

It is an object of this invention to establish a condition in an electrical safety control apparatus for determining whether fuel flow to the burner shall continue when the igniter is removed from the circuit after ignition should have occurred.

Another object of the invention is to ensure positive operation of the fuel flow controlling member while leaving it fully responsive to the condition of the flame sensitive device.

Another object of the invention is to prolong the life of the igniting element.

Another object of the invention is to avoid reliance on the provision of a pilot burner and permit operation of the safety control directly upon the main burner if desired.

Another object of the invention is to permit operation of the apparatus with all the safety features intact, should the igniting element fail and other burner lighting means be employed.

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

Referring more particularly to the drawing, a gaseous fuel burner 10 is supplied with fuel by a main fuel pipe 12. The fuel supply is controlled by a main valve 14 which, in this instance, is arranged for manual operation 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 16 of any known type which may be arranged, as in this instance, to be opened by energization of the solenoid and closed by gravity upon deenerization thereof.

Electric current for the operation of the apparatus is supplied by the line wires 18 connected to the primary of a transformer 20. It is desirable in such apparatus that the electric current be shut off when the main valve 14 is closed to shut off the supply of fuel. Accordingly, a main switch for the electric current from the transformer 20 may be incorporated in the valve 14 with suitable arrangement for causing closure of the main switch when the valve 14 is actuated to open position.

For the purposes of this embodiment of the invention the safety control and ignition system is illustrated and described as operating directly upon the main burner 10. It will be understood, however, that while the apparatus lends itself to such arrangement it is equally applicable to systems employing a pilot burner also. In such cases the pilot burner could receive its supply of fuel from the fuel pipe 12 either ahead of the solenoid valve 16 or from between this valve and the main burner 10. Such choice of pilot connection depends upon whether complete shut-off of fuel is desired in case of electric power failure as will be apparent.

The energizing circuit for the solenoid valve 16 includes the main switch of valve 14 which has one terminal connected by a wire 22 to one terminal of the secondary of the transformer 20. The other terminal of the main switch is connected by a wire 24 to one end of a parallel mesh included in the circuit.

The parallel mesh comprises an initially closed switch 26, an ignition coil 28 and a series resistance element 30 in one branch thereof. The other branch of the parallel mesh comprises a resistance element 32, which may be designated as a control resistance for the solenoid valve 16 for reasons which will appear hereinafter. The connections for these elements may be traced from the wire 24 at one end of the mesh by way

of wire 34 to the valve control resistance 32 and thence by way of wire 36 to a junction with the wire 38 at the other end of the parallel mesh. The wire 38 connects at one end with the series resistance element 30, the other end of which is connected by a wire 40 to one end of the ignition coil 28. The other end of the ignition coil 28 is connected by a wire 46 to one terminal of the normally closed switch 26. A wire 48 connects the other terminal of the switch 26 to the wire 34 at the junction thereof with the starting point of the parallel mesh.

Continuing with the energizing circuit of the solenoid valve 16, there extends from the junction of the wires 36 and 38 at one end of the parallel mesh previously described, a wire 50 which connects by way of a wire 54 with one terminal of the solenoid valve 16. The other terminal of the solenoid valve 16 is connected by way of a wire 56 to a wire 58 which is connected with the secondary of the transformer 20. A cut-out, preferably of the slow-acting bimetallic snap switch type, designated by the numeral 60 may be incorporated in the wire 56 from the solenoid valve 16 for a purpose which will appear hereinafter.

As desirable in apparatus of the kind described, means are provided to permit the ignition coil 28 to reach igniting temperature before the solenoid valve 16 opens and permits fuel to flow to the main burner 10. Accordingly, means are provided for shunting the solenoid valve 16 for a specified period of time after closing of the main switch of valve 14. This shunt may be established by a second normally closed switch 62 connected in parallel circuit with the valve 16. The connection for this parallel circuit may be made by a wire 64 connected at one end to the wire 50 and at the other end to one terminal of the switch 62, the other terminal of the switch being connected by a wire 66 to the wire 58. As will be apparent from the schematic view, both the switches 26 and 62 form part of a control relay, the actuating coil 68 of which is connected at one end by a wire 70 to the wire 56 and at the other end by a wire 72 to the wire 24. The switches 26 and 62 are similar in that both open after a specified time delay, but the switch 26 has a longer time delay period following closing of the main switch of valve 14. These switches are preferably of the mercury tube type, such as disclosed in Patents Nos. 1,778,439 and 2,224,873 among others, and to which patents reference may be had for a fuller description. In the present embodiment of this invention, the switch 62 may have a time delay of five seconds before opening and an instantaneous closing, and the switch 26 may open after a time delay period of thirteen seconds from opening of the switch 62 or a total time delay period of eighteen seconds. It is not essential that the switch 26 having the longer time delay period also have an instantaneous closing upon operation of the main switch of valve 14, it being only necessary that it assume a closed position before opening of the switch 62. Thus, where such a short time delay as five seconds is established for the switch 62, then the switch 26 would almost necessarily have an instantaneous closing action also.

In addition to the shunt for the solenoid valve 16 established by the normally closed switch 62, an additional shunt is provided for this valve. Thus, when the switch 26 having the longer time delay period opens and causes deenergization of the ignition coil 28, the maintenance of the solenoid valve in open position is made dependent upon whether the resistance of the additional shunt mentioned is of such a value at this time as to maintain the current through the solenoid valve above its release or shut-off value. This additional shunt consists of a flame sensitive element or heat responsive device 74 and an adjusting resistance element 76 therefor. These elements may be connected in parallel circuit with the valve 16 and cut-out 60 by way of a wire 78 connected at one end to the wire 56, and at the other end to one end of the flame sensitive element 74. The other end of the element 74 is connected by a wire 80 to one end of the adjusting resistance element 76 and the other end of the element 76 is connected by a wire 82 to the wire 54. The flame sensitive element 74 may be in the form of a coil of wire formed from material having normally a relatively low resistance and a positive temperature coefficient of resistance. Such elements are known as ballast resistors and will thus be referred to hereinafter, but other types of flame sensitive or heat responsive devices or thermal resistance elements having the required characteristics may be substituted.

The purpose of the cut-out 60 in series with the solenoid valve 16 is now apparent as being for the protection of this valve in the event that an open circuit occurs in the ballast resistor 74. The excess current which will be diverted to the circuit of the solenoid valve 16 upon such failure of the ballast resistor 74 during the normal running period of the apparatus will cause the cut-out to operate and open the circuit. During the starting period when the current to the solenoid valve is large the thermally sensitive element of the cut-out has not become sufficiently heated to permit the cut-out to operate. Consequently, although at this time there is sufficiently large current to the cut-out to cause it to operate, the thermal time lag effectively prevents this undesired occurrence. However, upon expiration of the starting period when the circuit elements are heated, the current to the cut-out is correspondingly reduced and does not increase in the absence of unusual occurrence, such as open circuiting of the ballast resistor. It will further be apparent that as only the ignition coil 28 and the ballast resistor 74 are required to be housed within the chamber 84 of an oven or like device wherein the burner 10 is situated, there is no exposure of any other elements of the apparatus to the heat or fumes emanating from the burner 10.

Further protection is provided for the apparatus in the event of burnt out or otherwise damaged parts, by the provision of means to complete the circuit should the ignition coil 28 fail and cause an open circuit. This means takes the form of a manually operated switch 86 which is normally held open by a spring 88 and is connected in parallel circuit with the igniter 28. The connections may be traced by way of a wire 90 connected at one end to the wire 46 and at the other end to one terminal of the switch 86, and by a wire 92 extending from the other terminal of the switch 86 to the wire 40. A suitable electrical resistance element 94 may be included in the wire 92 in series with the switch 86 to compensate for the loss of the resistance of the ignition coil 28 when this coil becomes open-circuited for any cause.

The operation of the device is as follows. Manual or thermostatic closing of the main switch of valve 14 effects opening of this valve as described and permits fuel to flow in the main fuel

pipe 12 as far as the solenoid valve 16 which is normally closed. The current from the transformer 20 is conducted by the wires 22 and 24 through the main switch to one end of the parallel mesh comprised of the valve control resistor 32, series resistance element 30, ignition coil 28 and the time delay switch 26 having the long time delay period. From the other end of this parallel mesh the current is conducted by way of the wires 50 and 54 to the parallel circuit comprising the short time delay switch 62 which shunts the solenoid valve 16. The circuit from the switch 62 to the transformer 20 is completed by way of the wires 66 and 58, as previously described. It will thus be apparent that while the short time delay switch 62 remains closed the ignition coil 28 becomes energized and the solenoid valve 16 is shunted.

Simultaneously with the energization of the ignition coil 28 the operating coil 68 of the control relay is also energized through the wires 70 and 72 which extend one from each end of the coil to the wires 56 and 24, respectively. Consequently, after the specified time delay period, which in this instance may be five seconds, the ignition coil 28 has reached igniting temperature and the short time delay switch 62 opens. The opening of the switch 62 removes the shunt from the solenoid valve 16 and the current then passes from the wire 50 through the wire 54 to one terminal of the solenoid valve 16, and by way of the wire 56 from the other terminal of the solenoid valve to the wire 58 connected to the transformer. However, part of the current passes through the ballast resistor 74 and the adjusting resistance element 76 by way of the wires 82, 80 and 78 which connect these elements to the wires 50 and 56, respectively. As the burner 10 is not yet ignited, the ballast resistor 74 is unheated and its resistance has consequently not increased. It will be apparent that the selection of a suitable established value of resistance for the ballast resistor depends upon the voltage to be used in the system and may vary in accordance therewith and with the results sought to be obtained. The resistance of the valve control resistor 32, series resistor 30 and the ignition coil 28 is insufficient to reduce the current flowing to the solenoid valve 16 to prevent actuation of this valve to open position. Consequently, fuel then passes through the fuel pipe 12 to the burner 10 where it is ignited by the ignition coil 28.

The flame of the burner 10, if ignited, causes the ballast resistor which is exposed thereto to become heated and thus increase its resistance in response thereto. After sufficient time has elapsed for the ballast resistor 74 to become thus heated, which should occur in the specified time delay of thirteen seconds, the long time delay switch 26 opens. The opening of this switch 26 breaks the circuit of the ignition coil 28 which, consequently, becomes deenergized. Such operation of the long time delay switch 26 to open position is entirely automatic and occurs regardless of whether the ballast resistor is heated or even whether the burner 10 has become ignited. Thus, when the switch 26 opens, unless the ballast resistor 74 has become heated and its resistance increased sufficiently to raise the resistance of the shunt circuit by an amount to compensate for the increase in total circuit resistance, then the current through the valve coil will decrease below holding value and the valve 16 will close.

It is thus apparent that the determination whether the fuel continues to flow to the burner after the ignition coil 28 is removed from the circuit depends upon whether the burner has previously become ignited. Moreover, if at any time during operation of the apparatus the flame of the main burner 10 ceases, then the ballast resistor will cool and its resistance be lowered sufficiently to render the current through the valve coil insufficient to retain the solenoid vave 16 in open position whereupon this valve will close to shut off the fuel supply to the burner.

Operation of the switch of the main valve 14 in an on-off-on cycle will cause the foregoing sequence of events to be repeated due to the reset features of the switches 26 and 62. Thus, a period for purging the vicinity of the main burner 10 of unburned fuel is provided for at least as long as the switch 62 having the shorter time delay takes to open. Since the temperature condition of the ballast resistor 74 does not influence the actuation of the solenoid valve 16 but only the holding and release of the valve, the circuit need only be adjusted to obtain the proper release current in the valve actuating coil under operating conditions. Thus, the circuit adjustments are less critical than in apparatus where the temperature condition of the ballast resistor is relied upon to actuate and release the valve. No chattering of the solenoid valve occurs due to the positive actuation as soon as the first time delay switch opens.

Where inclusion of a pilot burner is desired then the ignition coil 28 and the ballast resistor 74 would be located near the pilot burner flame instead of the main burner flame. The destruction of the ignition coil 28 by burning out or other causes need not prevent use of the apparatus with all the safety features intact. Thus, if the switch 86 is held closed while the main switch of valve 14 is moved to closed position, then the fuel flowing from the burner after the short time delay switch 62 opens may be lighted with a match. The apparatus will operate thereafter in the same manner as if the ignition coil 28 was fully operable.

The circuit arrangement described and shown herein permits considerable variation in the value of the respective resistances without detracting from the desired operating characteristics. Moreover, while the preferred form in arrangement of parts has been illustrated and described, it will be apparent that the apparatus is not limited to this particular embodiment but various changes may be made within the scope of the following claims.

I claim:

1. A safety control for fuel burners comprising in combination, electrically operated means for controlling the supply of fuel to the burner, an energizing circuit for said controlling means, an electric igniter in said energizing circuit adapted to produce a flame at the burner, a holding circuit shunting said controlling means, a thermal resistance element in said holding circuit adapted to vary its resistance in accordance with the presence or absence of a flame at said burner, and means for deenergizing said igniter after said thermal resistance has had time to vary its resistance, whereby the value of the energizing current to said controlling means becomes insufficient to maintain the supply of fuel to the burner unless said thermal resistance has varied.

2. A safety control for fuel burners comprising in combination, electrically operated means for controlling the supply of fuel to the burner, an

electric igniter adapted to produce a flame at said burner, a constant resistance element in shunt with said igniter and connected therewith in series circuit with said controlling means, a thermal resistance element in shunt with said controlling means and adapted to vary its resistance in accordance with the presence or absence of a flame at said burner, and means for deenergizing said igniter after said thermal element has had time to vary its resistance, whereby the total resistance of said circuit is increased sufficient to cause said controlling means to shut-off the fuel supply unless said thermal element has varied its resistance.

3. A safety control for fuel burners comprising in combination, electrically operated means for controlling the supply of fuel to the burner, an electric igniter adapted to produce a flame at said burner, a constant resistance element in shunt with said igniter and connected therewith in series circuit with said controlling means, a thermal resistance element in shunt with said controlling means and exposed to the heat of the flame at said burner, said element being adapted to increase its resistance when heated, and a control relay having a timing device for deenergizing said igniter after said thermal element has had time to become heated, whereby the total resistance of said circuit is increased sufficient to cause said controlling means to shut-off the fuel supply unless said thermal element has become heated.

4. A safety control for fuel burners comprising in combination, a normally closed valve intercepting the supply of fuel to the burner, electrically actuated means for opening said valve, and energizing circuit for said actuating means, means in said circuit for igniting said burner upon opening of said valve, means operative for introducing electrical resistance in shunt with said valve opening means in increased amount as said means becomes heated by a flame at the burner, means for deenergizing said igniting means after said heat responsive means has had time to become heated, and means for introducing sufficient resistance into said circuit to cause deenergization of said valve opening means and closure of said valve unless said heat responsive means has become fully operative.

5. A safety control for fuel burners comprising in combination, a normally closed valve intercepting the supply of fuel to the burner, electrically actuated means for opening said valve, an energizing circuit for said actuating means, means in said circuit for igniting said burner upon opening of said valve, heat responsive means operative to introduce electrical resistance in shunt with said valve opening means in increased amount as said heat responsive means becomes heated by a flame at the burner, a control relay having a timing device for deenergizing said igniting means after said heat responsive means has had time to become heated, and a constant electrical resistance element in shunt with said igniting means and operable to increase the total resistance of said circuit, whereby said valve opening means becomes sufficiently deenergized upon deenergization of said igniting means to cause closure of said valve unless said heat responsive means has become fully operative.

6. A safety control apparatus for fuel burners having means for controlling the supply of fuel thereto, said apparatus comprising an electric igniter for producing a flame at said burner energized by operation of said controlling means, a normally closed solenoid valve in series circuit with said igniter and intercepting the fuel supply to the burner, a control relay device having a normally closed switch connected in parallel circuit with said solenoid valve, said switch being automatically actuated to open position but with time delayed action to delay actuation of said valve to open position until said igniter has reached igniting temperature, a thermal resistance element connected in another parallel circuit with said solenoid valve and exposed to the burner flame, said element being adapted to increase its resistance when heated, a constant resistance element connected in series circuit with said solenoid valve and forming a parallel mesh with said igniter, a second normally closed switch associated with said relay device and connected in said parallel mesh in series circuit with said igniter, said second switch being automatically actuated to open position but with longer time delayed action than the first said switch upon operation of said controlling means to cause deenergization of said igniter after said thermal resistance element has had time to become heated, said deenergization causing a corresponding increase in the resistance of the valve energizing circuit sufficient to cause release of said valve to closed position unless said thermal resistance is heated and its resistance increased sufficient to cause the current through the valve to remain above the holding value of said solenoid valve.

7. In a safety control system for fuel burners having a starting and a running period, electrically operable means having an open position for supplying fuel for combustion by the burner to establish desired temperature conditions of the burner, an energizing circuit for said fuel supplying means including resistance elements so proportioned and arranged that during the starting period sufficient current is supplied to said fuel supplying means for actuation thereof to open position but during the running period only sufficient current to maintain said position, at least one of said elements being adapted to vary in resistance according to the condition of the burner, and means operable for opening said circuit upon failure of said variable resistance causing an increase in current to said fuel supplying means beyond that required during the running period, said means having time-delayed operation after initial energization and being thereby inoperable to open said circuit during the starting period.

8. In a safety control for fuel burners, electrically operated means for controlling flow of fuel to the burner, an energizing circuit for said controlling means including an electric igniter for the burner, control relay means having a timing device adapted to short-circuit said controlling means for a limited period during which said igniter may reach igniting temperature, and a second timing device associated with said relay means and adapted to render said igniter inoperative upon expiration of a predetermined period following termination of said short-circuit period.

9. In a safety control for fuel burners, electrically operated means for controlling flow of fuel to the burner, an energizing circuit for said controlling means including an electric igniter for the burner, control relay means having a normally closed switch connected in parallel circuit with said controlling means, said switch being automatically actuated to open position upon en-

ergization of said relay means but with time-delayed action sufficient for said igniter to reach igniting temperature, and a second normally closed switch associated with said relay means and connected in series circuit with said igniter, said second switch being automatically actuated to open position upon energization of said relay but with longer time-delayed action than the first said switch, said second switch being adapted to open the igniter circuit after the first said switch has opened to discontinue said parallel circuit.

10. A safety control for fuel burners comprising electrically operated means for controlling flow of fuel to the burner, an energizing circuit for said controlling means, an electric igniter in said circuit and adapted to produce a flame at the burner, control relay means having a normally closed switch connected in parallel circuit with said controlling means, said switch being automatically actuated to open position upon energization of said relay means but with time-delayed action sufficient for said igniter to reach igniting temperature, a second normally closed switch associated with said relay means and connected in series circuit with said igniter, said second switch being automatically actuated to open position upon energization of said relay but with longer time-delayed action than the first said switch, said second switch being adapted to open the igniter circuit after the first said switch has opened to discontinue said parallel circuit, and a thermal resistance element connected in another parallel circuit with said controlling means and adapted to vary in its resistance in accordance with the presence or absence of a flame at the burner, said resistance element being adapted to cause movement of said controlling means upon operation of said second switch in the absence of a flame at the burner.

11. A safety control and ignition system for fuel burners having a source of electrical energy, comprising electrically operable means for controlling the supply of fuel to the burner and being actuable to a fuel supplying position when energy of sufficient value is supplied thereto and being movable to a position for preventing said fuel supply when energy of insufficient value is supplied thereto, an electric igniter adapted when energized to produce a flame at the burner, a first circuit for supplying energy of said sufficient value to said controlling means and including the source, said controlling means, said igniter, and a control relay having a timing element operable after a predetermined period for electrically disconnecting said igniter from said circuit, a thermal resistance element having a preselected temperature coefficient of resistance located in proximity of the burner flame and electrically connected to said controlling means for varying the energy value supplied thereto upon variations in the resistance of said element due to the presence or absence of said flame, and means for establishing a second circuit for said controlling means effective upon operation of said timing element for increasing the total circuit resistance to cause energy of said insufficient value to be supplied to said controlling means unless said thermal resistance element is being heated by said flame.

12. A safety control and ignition system for fuel burners having a source of electrical energy, comprising electrically operable means for controlling the supply of fuel to the burner and being actuable to a fuel supplying position when energy of sufficient value is supplied thereto and being movable to a position for preventing said fuel supply when energy of insufficient value is supplied thereto, an electric igniter adapted when energized to produce a flame at the burner, a first circuit for supplying energy of said sufficient value to said controlling means and including the source, said controlling means, said igniter, and a control relay having a timing element operable after a predetermined period for electrically disconnecting said igniter from said circuit, a thermal resistance element having a preselected temperature coefficient of resistance located in proximity of the burner flame and electrically connected to said controlling means for varying the energy value supplied thereto upon variations in the resistance of said element due to the presence or absence of said flame, and means including a second resistance element for establishing a second circuit for said controlling means effective upon operation of said timing element for increasing the total circuit resistance to cause energy of said insufficent value to be supplied to said controlling means unless said thermal resistance element is being heated by said flame.

13. A safety control and ignition system for fuel burners having a source of electrical energy, comprising electrically operable means for controlling the supply of fuel to the burner and being actuable to a fuel suppplying position when energy of sufficient value is supplied thereto and being movable to a position for preventing said fuel supply when energy of insufficient value is supplied thereto, an electric igniter adapted when energized to produce a flame at the burner, a first circuit for supplying energy of said sufficient value to said controlling means and including the source, said controlling means, said igniter, and a control relay having a timing element operable after a predetermined period for electrically disconnecting said igniter from said circuit, a thermal resistance element having a preselected temperature coefficient of resistance located in proximity of the burner flame and electrically connected to said controlling means for varying the energy value supplied thereto upon variations in the resistance of said element due to the presence or absence of said flame, means effective upon operation of said timing element for establishing a second circuit including the source in series with said controlling means and thermal resistance element in parallel, and a second resistance element in series therewith for increasing the total circuit resistance to cause energy of said insufficient value to be supplied to said controlling means unless said thermal resistance element is being heated by said flame.

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