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SAFETY CONTROL FOR FUEL BURNERS

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Fig. 1.

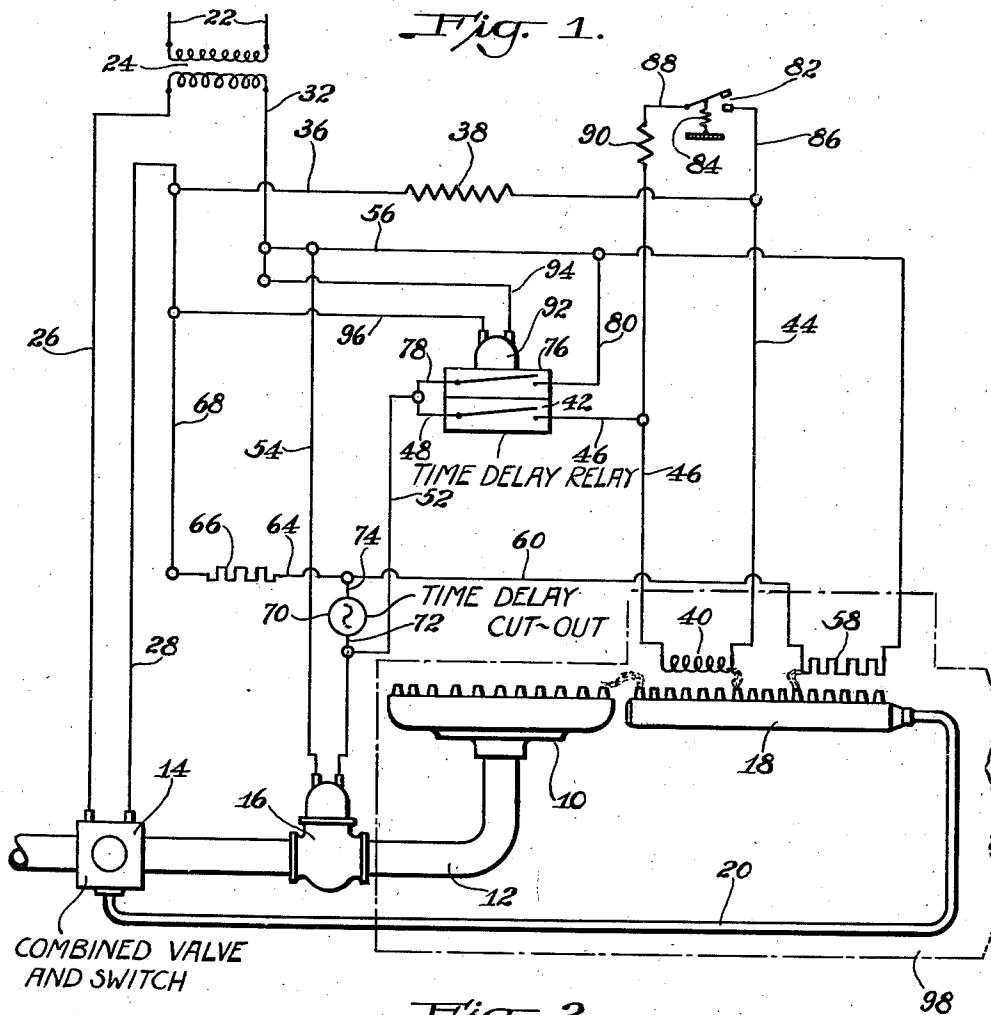
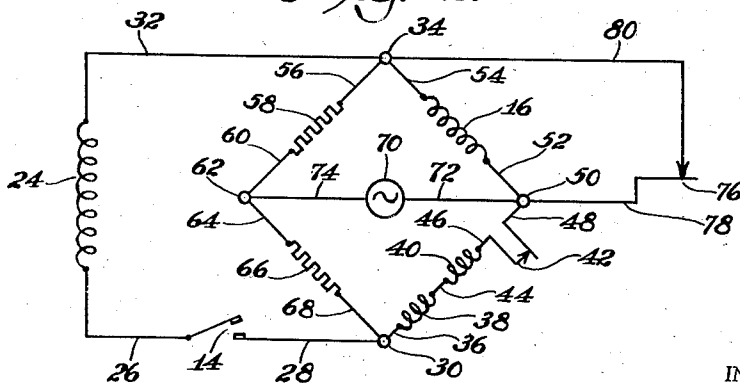


Fig. 2.



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SAFETY CONTROL FOR FUEL BURNERS

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7 Claims. (Cl. 158—117.1)

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 fuel to the main burner if a flame sensitive portion of the apparatus has previously been heated by a pilot burner. The flame sensitive device may comprise an electrical resistance element which changes its resistance when heated and thus, changes the value of the energizing current supplied to a solenoid valve controlling the supply of fuel. The current values in the circuit are adjusted so that during the starting period (before the flame sensitive device has heated) the current to the solenoid valve is sufficient to cause actuation to open position. During the operating period (after the flame sensitive device is heated) the current through the solenoid valve is only sufficient to maintain it open. Hence, immediately upon cooling of the flame sensitive device due to extinguishment of the pilot burner, the current values in the circuit automatically change causing insufficient current to flow through the solenoid valve to maintain it open, whereupon the fuel supply to the main burner is promptly cut off.

In such systems the occurrence of an undesired open circuit, such as from fracture of the flame sensitive device in cases where a coil is used, would eliminate the safety feature by permitting the solenoid valve to remain open even though the pilot burner became extinguished. The addition of a thermal time-lag type of cut-out in circuit with the solenoid valve and operable upon failure of the flame sensitive device has been proposed. This expedient introduces the disadvantage of undesired closing of the solenoid valve if a number of on-off-on cycles of the main control device are performed in quick succession permitting the large starting period current to operate the cut-out when the time-lag has expired.

An object of this invention is to maintain complete safety in apparatus of the type described without rendering such apparatus subject to undesired functioning during any manipulation or sequence of manipulations performed upon the main control device. Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawing, wherein:

Fig. 1 is a schematic view of a safety control apparatus for a gaseous fuel burner embodying this invention, and

Fig. 2 is a circuit diagram showing the electrical connections.

Referring more particularly to the drawing, a gaseous fuel burner 10 is shown in Fig. 1 as being supplied with fuel by a main fuel pipe 12. The fuel supply is controlled by a main valve 14 which, in this instance, is adapted for manual operation but which may be arranged for thermostatic operation if desired. 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 deenergization thereof. A pilot burner 18 is provided for igniting the main burner 10 and is supplied with fuel from a conduit 20 connected to the main valve 14 to receive fuel from the pipe 12 when the main valve is open.

Electric current for the operation of the apparatus is supplied by the line wires 22 connected to the primary of a transformer 24. 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 to both the main and pilot burners. Accordingly, a main switch 26 for the electric current from the transformer 24 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.

The electrical circuit for the safety control and ignition system of this invention, as shown more particularly in Fig. 2, includes the main switch of valve 14 which has one terminal connected by a wire 28 to one terminal of the secondary of the transformer 24 and the other terminal of the main switch connected by a wire 30 to a junction 32. The other terminal of the secondary of the transformer 24 is connected by a wire 34 to a junction 36. It may be noted that the various electrically operated elements of the system are connected, upon initial closure of the main switch 14, in a bridge type of circuit.

Connected to junction 36 are series resistor 38, ignition means comprising a coil 40 and the normally closed switch 42 of a control relay having time-delayed operation, all of which form one arm of the aforesaid bridge circuit. These elements are connected in series circuit which may be traced by a wire 36 from junction 36 to the resistor 38, wire 44 connecting the resistor 38 to the ignition coil 40 and a wire 46 connecting the ignition coil 40 to the switch 42. The switch 42 is connected by a wire 48 to a junction 50 and a wire 52 extending therefrom serves to connect the one terminal of the electromagnetic valve 16

thereto, the other terminal of this valve being connected by a wire 54 to the junction 34. The electromagnetic valve 16 and the connections described form the second arm of the aforesaid bridge circuit.

Connected by a wire 56 to the junction 34 is a resistance element 58 which may be designated as a control resistance for the electromagnetic valve 16 for reasons which will appear hereinafter. Preferably, the resistance element 58 is in the form of a coil of wire of material having normally a relatively low resistance and a positive temperature coefficient of resistance, commonly termed a "ballast resistor" and being thermally responsive to the passage of current therethrough. Primarily, however, this element is responsive to the heat of the pilot burner flame to which it is exposed as shown in Fig. 1 and will vary in resistance in response thereto. The opposite end of the resistance element 58 is connected by a wire 60 to the junction 62 and forms the third arm of the aforesaid bridge circuit.

Connected by a wire 64 to the junction 62 is a second resistance element 66 which is also formed from a coil of wire having normally a relatively low resistance and a positive temperature coefficient of resistance. As indicated in Fig. 1, this second resistance element 66 is not however exposed to the flame from the pilot burner 18 and is adapted to vary its resistance only due to the passage of current therethrough. The opposite end of the resistance element 66 is connected by a wire 68 to the junction 30 and forms the fourth arm of the aforesaid bridge circuit.

The detector arm of the bridge circuit comprises a cut-out 70 having one terminal thereof connected by a wire 72 to the junction 50 and the other terminal thereof connected by a wire 74 to the junction 62. Preferably, the cut-out 70 is of the thermal type having time-lag 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.

The electrical circuit is completed by the provision of a second normally closed switch 76 of the control relay having time-delayed operation connected from one terminal by a wire 78 to the junction 50 and the other terminal thereof connected by a wire 80 to the junction 34. The switch 76 is therefore connected in shunt with the electromagnetic valve 16 which remains in closed position while the shunt is effective.

Means are provided to complete the circuit manually in order that the pilot burner 18 may be lighted with a match should the ignition coil 40 fail and cause an open circuit. This means takes the form of a manually operated switch 82 which is normally held open by a spring 84 and is connected in shunt with the igniter 40. The connections may be traced by way of a wire 86 connected at one end to the wire 44 and at the other end to one terminal of the switch 82 and by a wire 88 extending from the other terminal of the switch 82 to the wire 46.

A suitable electrical resistance element 90 may be included in the wire 88 in series with the switch 82 to compensate for the loss of the resistance of the ignition coil 40 when this coil becomes open circuited for any cause.

The control relay of which the switches 42 and 76 form part may be provided with a single actuating coil 92 (see Fig. 1) having one terminal

thereof connected by a wire 94 to the wire 32 and the other terminal thereof connected by a wire 96 to the wire 68. As previously indicated, the switches 42 and 76 are similar in that both open after a specified time-delay, but the switch 42 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 42 may have a time-delay of eighteen seconds before opening following the closing of the main switch 14 and is adapted for instantaneous closing upon opening of the main switch valve 14 or otherwise deenergizing the actuating coil 92. The switch 76 may have a time-delay of five seconds before opening following the closing of the main switch 14 and also have instantaneous closing. It is not essential, however, that the switch 42 having the longer time-delay period also have an instantaneous closing upon operation of the main switch of valve 14 to open position or other deenergizing of coil 92 it being only necessary that it assume a closed position before the switch 76 is again actuated to open position. In this embodiment, where such a short time-delay as five seconds is established for opening of the switch 76, it is preferable to arrange the switch 42 with an instantaneous closing action as will be apparent.

As indicated by the broken lines in Fig. 1, the chamber 98 of an oven or like device is adapted to contain the main burner 10, pilot burner 18, ignition coil 40 and resistance element 58. Both the ignition coil 40 and resistance element 58 are exposed to the flame of the pilot burner 18 and the latter is arranged in proximity to the main burner 10 to serve its intended purpose of igniting fuel flowing therefrom.

The operation of the device is as follows: Manual or thermostatic closing of the main switch of valve 14 is effective upon opening of this valve as described and permits fuel to flow to the pilot burner 18 and also in the main fuel pipe 12 as far as the electromagnetic valve 16 which is normally closed. The current from the transformer 20 is conveyed by the wires 26 and 32 to the junctions 30 and 34 of the bridge circuit. As the elements comprising the bridge circuit are at this time unheated and the electromagnetic valve 16 is shunted by the time-delay switch 76, the bridge network is considerably unbalanced. Therefore, the current through wires 72 and 74 to cut-out 70 is large. Within a few seconds the circuit elements heat up and the bridge balance is improved resulting in a decrease in current through the cut-out 70. There is a further decrease in the current to cut-out 70 to considerably below normal operating value after opening of the switch 76 having the shorter time delay period and this serves to remove the shunt from electromagnetic valve 16 further improving the balance of the bridge. Due to the time-lag of the cut-out 70 the large inrush current upon initial closing of the main switch of valve 14 is ineffective to cause operation of the cut-out 70 at this time. Upon expiration of the specified five seconds time-delay period upon opening of the switch 76 and removal of the shunt from the electromagnetic valve 16, the ignition coil 40 has reached igniting temperature. Thus, upon opening of the electromagnetic valve 16 the fuel flowing from the main burner 10 is ignited by the flame from the pilot burner 18 which is ignited by the ignition coil 40.

The resistance elements 58 and 66 have now become heated, the former due to the flame from the pilot burner and the passage of current there-through, and the latter due to the passage of current therethrough only. Consequently, the bridge balance is improved to such an extent that the current through the cut-out 70 is reduced to a value insufficient to cause operation thereof regardless of whether the main switch is manipulated in on-off-on cycles. At the expiration of the 18 seconds time-delay, if such is chosen for delaying opening of the switch 42, the ignition coil 40 and series resistor 38 become deenergized. The bridge nature of the circuit is thus eliminated unless the network is considered a bridge with infinite impedance in one arm.

Operation of the long time-delay switch 42 to open position is entirely automatic and occurs regardless of whether the resistance element 58 is heated by the pilot burner flame or even whether the pilot burner 18 has become ignited. Thus, when the switch 42 opens, unless the ballast resistor 58 has become heated and its resistance increased sufficiently to raise the resistance of the shunt established thereby around the valve 16 and cut-out 70 and to compensate for the increase in total circuit resistance then the current through the electromagnetic valve 16 will decrease below holding value and the valve 16 will close. If at any time during operation of the apparatus the flame of the pilot burner 18 ceases then the resistance element 58 will cool and its resistance be lowered in consequence so that the current through the electromagnetic valve 16 is rendered insufficient to retain this valve in open position, whereupon closure thereof will occur.

The invention is thus particularly directed toward the means to cause closing of the electromagnetic valve 16 in the event of failure of the resistance element 58 by fracture or other destructive means. While the resistance element 58 remains intact, no interference with normal operation of the control by the cut-out 70 will occur regardless of the manner of operation of the main switch 14. It will be apparent that should the resistance element 58 become open-circuited then the presence or absence of the flame from the pilot burner 18 would have no effect thereon and the electromagnetic valve 16 would remain open. However, due to the provision of the cut-out 70 the increase in current through the circuit of the solenoid valve 16 upon fracture of the resistance element 58 will cause the cut-out to operate at any time subsequent to expiration of the time-lag thereof which renders it inoperative during the initial starting period when the inrush current may be large.

It will be understood that various changes can be made in the arrangement and combination of parts and in the form of the elements herein disclosed within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A safety control and ignition system for fuel burners having main and pilot burners comprising an initially unbalanced electrical bridge circuit adapted to be energized from a source of current supply, one arm of said bridge including an electric resistance igniter for the pilot burner, a second arm comprising electrically operable means controlling supply of fuel to the main burner, a pair of resistors in the third and fourth arms one of which is exposed to the heat of the pilot burner flame and the other being thermally

responsive to energizing current in said circuit, said resistors being adapted to increase in resistance value when heated thereby, a cut-out connected across opposite junctions of said first and second arms and said third and fourth arms of said bridge and being inoperative during the initial unbalanced period, said cut-out being adapted to receive a reduced supply of current as said bridge balance improves when said resistors increase in resistance value, and means for connecting opposite junctions of said first and fourth arms and said second and third arms to said source of current supply.

2. A safety control and ignition system for fuel burners having main and pilot burners comprising an initially unbalanced electrical bridge circuit adapted to be energized from a source of current supply, one arm of said bridge including an electric resistance igniter for the pilot burner, a second arm comprising electrically operable means controlling supply of fuel to the main burner, a pair of resistors in the third and fourth arms one of which is exposed to the heat of the pilot burner flame and the other being thermally responsive to energizing current in said circuit, said resistors being adapted to increase in resistance value when heated thereby, a cut-out having time delayed action for the initially unbalanced period and connected across opposite junctions of said first and second arms and said third and fourth arms of said bridge to receive a reduced supply of current as said bridge balance improves when said resistors increase in resistance value, and means for connecting opposite junctions of said first and fourth arms and said second and third arms to said source of current supply.

3. A safety control and ignition system for fuel burners having main and pilot burners comprising an initially unbalanced electrical bridge circuit adapted to be energized from a source of current supply, one arm of said bridge including an electric resistance igniter for the pilot burner and a switch for said igniter having time delayed action, a second arm comprising electrically operable means controlling fuel supply to the main burner, a pair of resistors in the third and fourth arms one being exposed to the heat of the pilot burner flame and the other being thermally responsive to energizing current in said circuit, said resistors being adapted to increase in resistance value when heated thereby, a cut-out having time delayed action for the initially unbalanced period and connected across opposite junctions of said first and second arms and said third and fourth arms of said bridge to receive a reduced supply of current as said bridge balance improves when said resistors increase in resistance value, said bridge being converted upon operation of said switch to a circuit containing said burner heated resistor in parallel with said electrically operable means and cut-out in series, and means for connecting opposite junctions of said first and fourth arms and said second and third arms to said source of current supply.

4. A safety control and ignition system for fuel burners having main and pilot burners comprising an initially unbalanced electrical bridge circuit adapted to be energized from a source of current supply, one arm of said bridge including an electric resistance igniter for the pilot burner and a switch having time delayed action to open position for deenergizing said igniter, a second arm comprising electrically operable means con-

trolling fuel supply to the main burner, a pair of resistors in the third and fourth arms one being exposed to the heat of the pilot burner flame and the other being thermally responsive to energizing current in said circuit, said resistors being adapted to increase in resistance value when heated thereby, a cut-out having time delayed action for the initially unbalanced period and connected across opposite junctions of said first and second arms and said third and fourth arms of said bridge to receive a reduced supply of current as said bridge balance improves when said resistors increase in resistance value, a second switch having time delayed action short-circuiting said electrically operable means for a period terminating prior to deenergizing of said igniter, said bridge being converted upon operation of the first said switch to a circuit containing said burner heated resistor in parallel with said electrically operable means and cut-out in series, and means for connecting opposite junctions of said first and fourth arms and said second and third arms to said source of current supply.

5. A safety control and ignition system for fuel burners having main and pilot burners, comprising electrically operable means having an open position when energized for supplying fuel to the main burner, an energizing circuit for said fuel supplying means, an electric igniter in said circuit and being thermally responsive to energizing current therein for igniting the pilot burner, a control relay having a timing element shunting said fuel supplying means until said igniting reaches igniter temperature, a second control relay having a timing element in series circuit with said igniter and operable to open the circuit thereof upon expiration of a predetermined period after operation of the first said control relay, said opening of the igniter circuit marking the end of the starting period and the inception of the normal running period of the burner, a plurality of resistance elements in said circuit one of which is exposed to the heat of the flame of the pilot burner and another being thermally responsive to energizing current in said circuit, said elements being adapted to vary in resistance when heated as aforesaid during the starting period and permit sufficient energizing current to said fuel supplying means to maintain the open position during the running period, said elements during said starting period forming the third and fourth arms respectively of an electrical bridge, said arms being arranged in a sequence in which said fuel supplying means forms the second arm and said igniter and first control relay form the first arm thereof, means for connecting the opposite junctions of said first and fourth arms and said second and third arms to said energizing circuit, and a thermal protector for said fuel supplying means connected across the opposite junctions of said first and second arms and of said third and fourth arms as the detector arm of said bridge to receive a supply of current during the starting period which becomes reduced as said elements become heated as aforesaid and by removal of said shunt from said fuel supplying means, said protector being operable to open the circuit of said fuel supplying means upon failure of said pilot heated resistance element but being inoperable for said purpose during the starting

and normal running periods in the absence of said pilot heated element failure.

6. A safety control and ignition system for fuel burners having main and pilot burners, comprising a source of current, a main switch, a bridge circuit controlled by said switch and having an unbalanced period upon initial operation of said switch, said bridge having arms arranged in a sequence including an electric igniter for the pilot burner and a control relay for said igniter in the first arm operative to deenergize said igniter after a time-delay period, an electromagnetic valve in the second arm actuable to a position permitting operation of the main burner, a resistance element in the third arm adjacent said second arm and exposed to a flame from the pilot burner, and a second resistance element in the fourth arm being thermally responsive to current from said source, said resistance elements being adapted to vary in resistance when heated as aforesaid and improve the balance of said bridge before said igniter becomes deenergized, a second control relay short-circuiting said valve and operable after a time-delay period to permit actuation of said valve by removal of the short-circuit, means for connecting the opposite junctions of said first and fourth arms and said second and third arms to said energizing circuit, and a cut-out connected across the opposite junctions of said first and second arms, and of said third and fourth arms forming the detector arm of said bridge and having sufficient time-delay in operation to remain inoperative during the initial unbalanced period when the current in the detector arm is sufficiently large for operation thereof, said cut-out being operable after deenergization of said igniter to open the circuit of said valve should an open circuit occur in the resistance element exposed to the pilot burner flame.

7. A safety control and ignition system for fuel burners having main and pilot burners comprising an energizing circuit, a main switch controlling said circuit, and an initially unbalanced electrical bridge in said circuit having arms arranged in a sequence including a first arm comprising an electric igniter for the pilot burner and a switch having time delayed action to open position for deenergizing said igniter, a second arm including electrically operable means controlling fuel supply to the main burner, a third arm having a resistor exposed to the heat of the pilot burner flame and adapted to increase in resistance value when heated thereby, a fourth arm containing another resistor adapted to increase in resistance value when heated by passage of current therethrough, a thermal cut-out connected across the opposite junctions of said first and second arms and said third and fourth arms, said bridge being converted upon operation of said time delayed switch to a circuit containing said burner heated resistor in parallel with said electrically operable means and cut-out in series, said cut-out having time delayed action sufficient to prevent operation thereof upon initial closure of said main switch, and means for connecting opposite junctions of said first and fourth arms and said second and third arms to said source of current supply.

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