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F. FISCHER ET AL

ELECTRICAL SAFETY CONTROL CIRCUITS FOR BURNERS OF EXPLOSIVE FUELS

Filed August 25, 1925 3 Sheets-Sheet 1

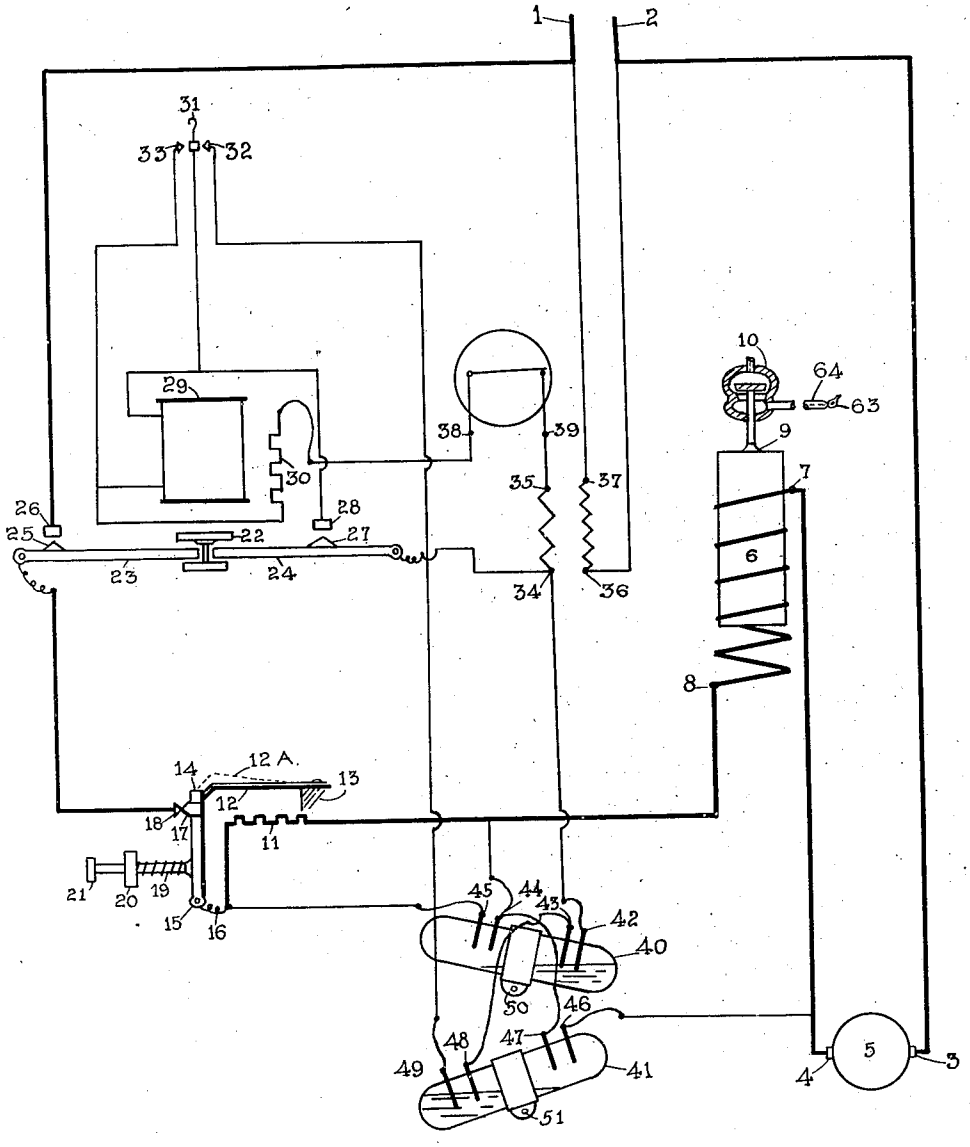


Fig. I

WITNESSES.

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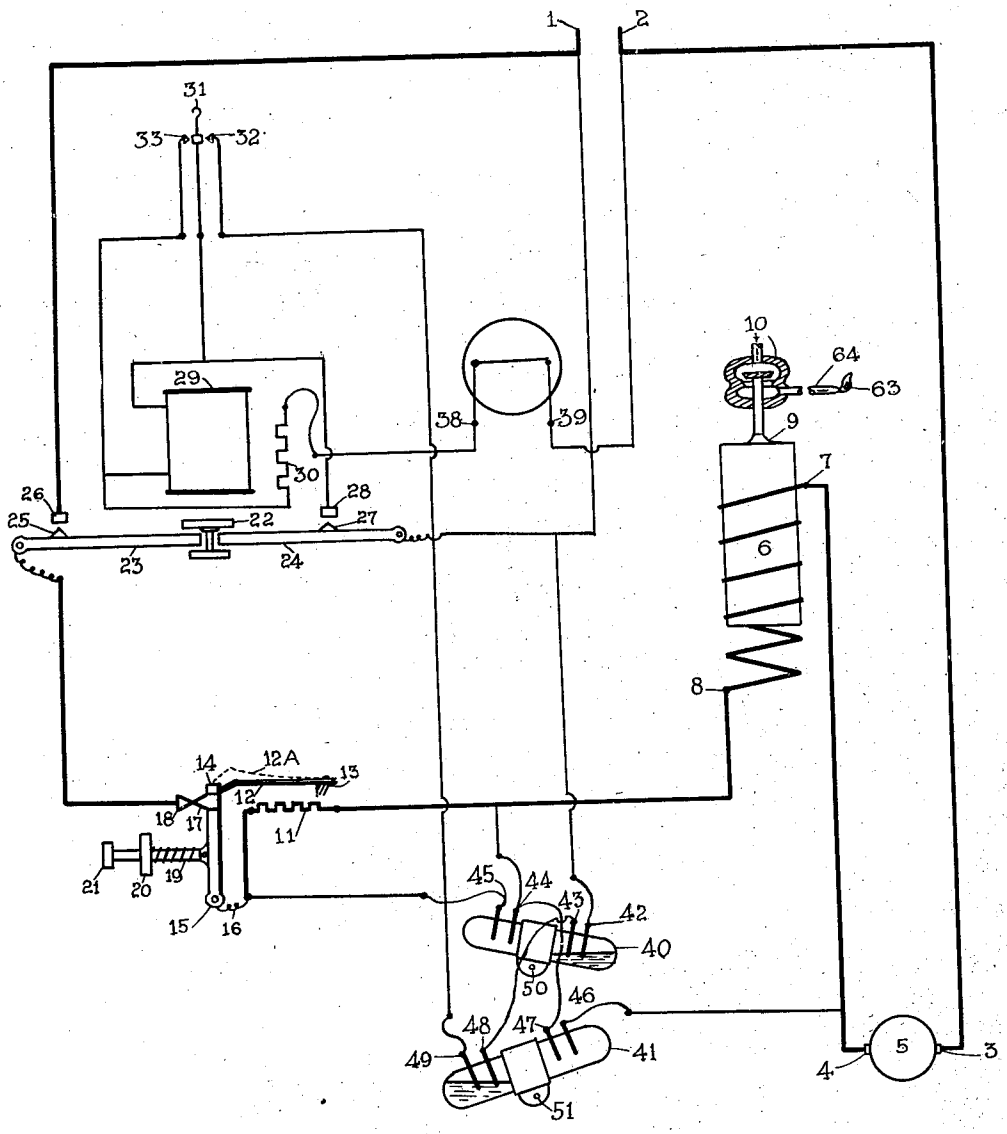


Fig. II

WITNESSES.

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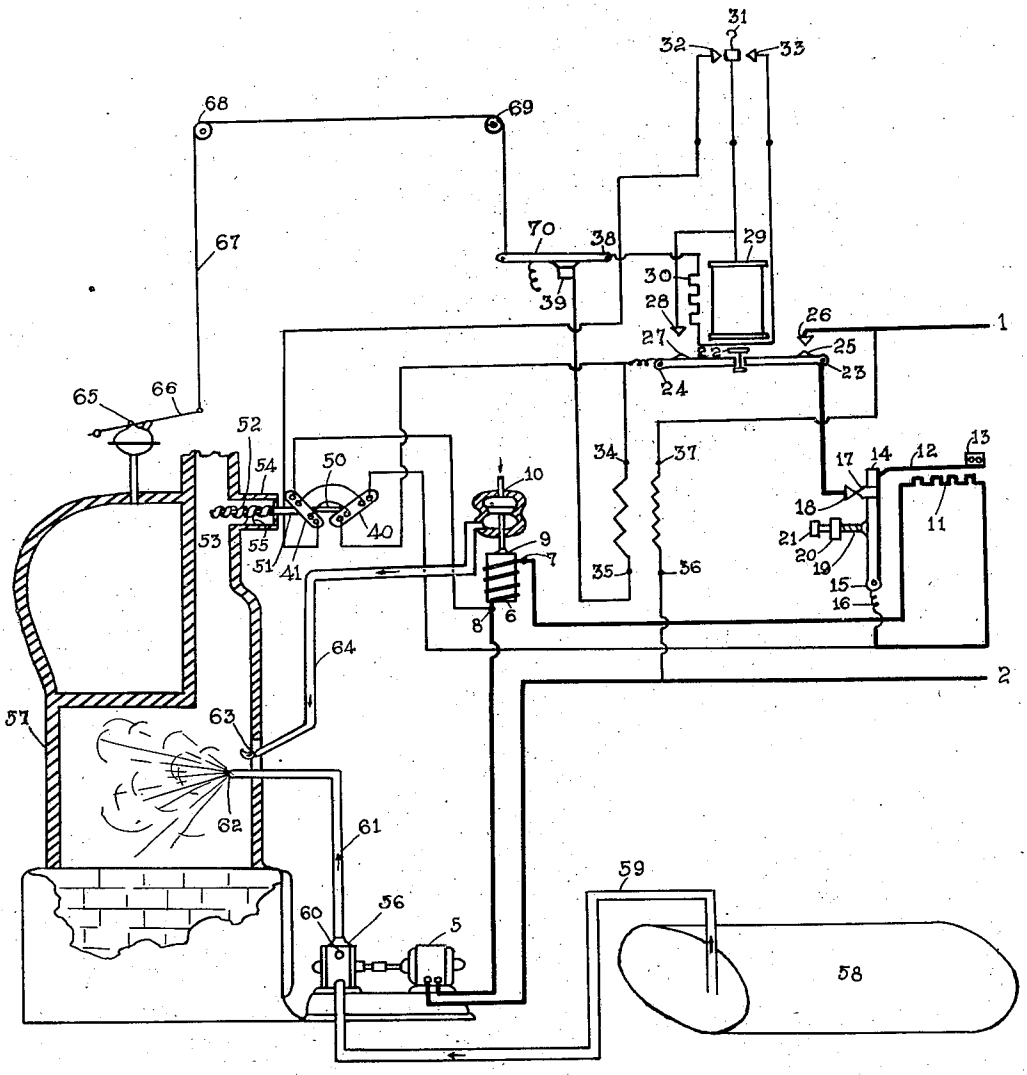


Fig. III

WITNESSES.

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1,583,586

UNITED STATES PATENT OFFICE.

FRANK FISCHER, OF LARCHMONT, NEW YORK, AND ARNOLD FRANCIS VAN PELT, OF INTERLAKEN, NEW JERSEY.

ELECTRICAL SAFETY CONTROL CIRCUITS FOR BURNERS OF EXPLOSIVE FUELS.

Application filed August 25, 1925. Serial No. 52,447.

To all whom it may concern:

Be it known that we, FRANK FISCHER and ARNOLD F. VAN PELT, citizens of the United States, residing at Larchmont, in the county of Westchester and State of New York, and at Interlaken, in the county of Monmouth and State of New Jersey, respectively, have invented certain new and useful Improvements in Electrical Safety Control Circuits for Burners of Explosive Fuels, of which the following is a specification.

This invention relates to control circuits, of the class described in our Patent No. 1,546,640, for automatically fed burner equipment for fluids such as oil and gas, although it can readily be adapted to control the burning of powdered-coal and other fuels which can be ignited by means of electric spark, gas or oil flame, etc.

The main object of this invention is to prevent the burner from starting and feeding an explosive fuel into the furnace when the fire-box is hot.

Another object is to provide independent switch connections with fast and slow operating switches for deenergizing the time-limit cut-out and the ignition means in short and long time intervals respectively after starting the burner. A time-limit cut-out permits an electric current of a given strength to flow through it for only a limited period of time, unless otherwise prevented from functioning.

Another object is to prevent starting the burner until both slow and fast switches are in their normal operating positions.

Other objects will hereinafter appear.

The nature and scope of this invention are more fully explained in the following description taken in connection with the accompanying drawings forming part of these specifications, in which:

Fig. I is a diagram of our control circuit adapted to alternating current, and having a low voltage thermostat and boiler control properly connected to our circuit.

Fig. II is a diagram of our control circuit similar to Fig. I but arranged for operating on direct current.

Fig. III shows an oil burning furnace equipped with our alternating current control circuit.

Similar numerals refer to similar parts throughout the several figures.

In Fig. I, 1 and 2 are alternating current power leads of any voltage or frequency—2 being preferably the grounded side of the line, if the line is grounded.

3 and 4 are terminals of electric motor 5 which drives the pump or other apparatus supplying fuel to the burner. 6 is a solenoid with terminals 7 and 8, and movable core 9; although a rotary form of motor could readily be substituted here for performing the mechanical work of operating a valve, switch, or other ignition apparatus. 6 will therefore be referred to hereafter as the ignition-motor.

10 is a gas valve operated by ignition-motor 6.

11 to 21 inclusive comprise a time-limit cut-out in which 11 is a resistance wire or heating-coil; 12 is a piece of thermostatic metal with one end fastened rigidly at 13 and the other end bearing against brass member 14 which is pivoted at 15.

Thermostatic metal 12 is superimposed above the resistance wire or heating-coil 11 and bends upward when heated, as indicated by dotted lines 12^a. Member 14 is connected through flexible lead 16 to coil 11, and carries contactor 17 which is held against contactor 18 by the end of thermostatic metal 12. 19 is a compression-spring bearing against brass member 14 at one end and against fixed piece 20 at the other. Compression-spring 19 provides a quick break between contactors 17 and 18 when thermostatic metal 12 has been heated by coil 11, and has moved above the end of member 14 as indicated by broken lines 12^a.

21 is a re-setting member which passes through a hole in fixed piece 20, through compression-spring 19, and fastens to member 14. Its purpose is to enable member 14 with its contactor 17, to be pulled over against contactor 18 so as to allow thermostatic metal 12 to spring downward and reset against member 14 when thermostatic metal 12 has cooled sufficiently.

22 to 37 inclusive are parts of a commercial relay, a thermostat, and a transformer, all interconnected for the purpose of automatically closing and opening the power circuit, at predetermined temperature or pressures. 22 is the relay armature, carrying an insulated hook for lifting relay arms 23 and 24.

25 and 26 are contactors on the relay in the main power circuit. 27 and 28 are low

voltage contactors. 29 is an electro-magnet. 30 is a resistance coil. 31, 32 and 33 are contactor points on a low voltage thermostat. 34 and 35 are the terminals of the secondary winding of a transformer; 36 and 37 are terminals of primary winding of the said transformer. 38 and 39 are terminals of a switch or similar device usually connected mechanically or electrically in some suitable manner to the boiler or furnace or other apparatus which contains the burner, as in Fig. III.

40 and 41 are mercury switches, 40 being designated as the fast-switch and 41 the slow-switch. Since there is always a conspicuous lapse of time between the operation of switches 40 and 41, it is convenient to designate them as the fast switch and slow switch respectively, although it will be evident hereafter that both switches are in reality controlled by temperature, and that time is a resulting and not a controlling factor in their operation.

42 to 45 inclusive are electrodes of fast-switch 40, and 46 to 49 inclusive are electrodes of slow-switch 41. 50 and 51 represent the ends of shafts upon which are swingingly supported the fast-switch 40 and slow-switch 41 respectively.

Hereafter, 6 to 9 will be referred to as an ignition-motor; 11 to 21 will be referred to as a time-limit cut-out; 22 to 29 will be referred to as a relay; 31 to 33 will be referred to as a thermostat; 38 and 39 will be referred to as a boiler-control; and 40 and 41 will be referred to as the fast-switch and slow-switch respectively.

The descriptive name "time-limit cut-out" explains the function of this cut-out apparatus; which function is to open an electric circuit passing through it, and thereby cut out any other apparatus connected in series with it, after the lapse of a certain predetermined time constituting the "time-limit" factor. The operation of the time-limit cut-out is hereinafter more fully described.

Fig. II contains no additional parts over Fig. I, but on the other hand shows our control circuit without the transformer and low-voltage circuit previously described.

The solenoid ignition-motor, gas valve, time-limit cut-out, relay, transformer, and boiler-control switch, may be considered as located on a suitable panel-board all enclosed in a metal case or panel box. These parts are enlarged in the drawing to enable the circuit to be traced more readily.

Fast and slow mercury switches 40 and 41 are shown mounted in housing 54 attached to the stack 53 of the furnace, with the thermostatic metal coil 52 projecting into the stack.

The inner end of thermostatic metal coil 52 is connected by means of central shaft 50 to fast-switch 40; and the outer or less exposed end of thermostatic coil 52 is connected by means of hollow-shaft 51 with the slow-switch 41. Thermostatic coil 52 is rigidly supported in the housing 54 at point 55 between the two ends of the coil.

The combined slow and fast switch employed herein is not claimed in detail as part of this invention. It will be observed that the particular type of switches 40 and 41, chosen here to illustrate our invention, are double circuit switches used to connect either one of two electrical circuits, according to the temperature of the actuating mechanism.

The fuel-supply motor 5 and pump 56 are placed conveniently with relation to the boiler or furnace 57.

The thermostat is placed in the particular room or place, the temperature of which is to be controlled.

Oil supply tank 56 is connected by means of pipe 59 with the pump 56 which entrains oil from tank 58 and air through port 60; and after mixing them in the proper proportions, discharges them through burner supply pipe 61 and nozzle 62 into the fire-box of the furnace.

Gas pilot flame 63 is fed through gas pipe 64 and gas valve 10, the latter being controlled by solenoid ignition-motor 6. Gas valve 10 permits, when closed, enough leakage of gas to supply the minimum size pilot flame 63.

In Fig. III the boiler-control is shown as a diaphragm piston 65 connected, through weighted lever 66 and chain or cable 67 passing over pulleys 68 and 69, with switch 70; although the whole boiler-control apparatus may be installed as a unit on the top of the boiler if preferred.

The operation of our oil-burner control mechanism is as follows:

The power current is always presumed to be on lines 1 and 2.

Assuming that the temperature or pressure of the boiler or furnace is below a predetermined point, above which it is to be maintained, the low temperature contacts 31 and 32 of the thermostat, and boiler-control leads 38 and 39 will be closed (see Fig. I). The transformer, usually of the type to transform the normal 110 volt lighting current to a lower voltage (usually 24 volts), is energized, and is therefore in a position to supply current to the relay.

When the thermostatic member 31 of the thermostat makes contact with 32 current flows from transformer terminal 34 through electrodes 42 and 43 of fast-switch 40 and electrodes 48 and 49 of slow-switch 41 and energizes the magnet 29, completing the circuit through resistance coil 30 and the boiler-control to the other transformer terminal 35. This pulls up armature 22 and the adjacent contactor arms 23 and 24 which in turn close contactors 25 to 26 and 27 to 28. The closing of contactors 27 and 28 magnetically

locks the armature 22 in place, and the closing of the main line contactors 25 and 26 completes the circuit for the current to travel from the supply line 2, through the fuel-supply motor 5, through the solenoid 6, through the time-limit cut-out, through the main contactors 25 and 26 of the relay, and back to line 1.

This forms a series circuit in which the breaking of any of the lines or connections in the circuit would cause the entire circuit to become open and therefore inoperative.

The instant the relay picks up, the motor 5 starts, which in turn starts the pump and sprays oil into the furnace; the solenoid 6 is energized, which forces plunger 9 upward thereby opening the gas valve 10 and expanding the pilot to an ignition flame. At the same time the heating-coil 11 of the time-limit cut-out begins to heat up. If nothing further takes place, the heat generated in the coil 11 of the time-limit cut-out will cause thermostatic metal 12 to bend upward and pass the end of member 14. This in turn will allow compression-spring 19 to force member 14 out of its position and break contractors 17 and 18 which open the circuit and thereby de-energize the solenoid 6 and the motor 5. The plunger 9 falls to its normal position thereby substantially closing the gas valve 10 and the fuel-supply motor 5 stops, thereby stopping the flow of oil into the boiler or furnace.

However, when the motor 5 starts, the solenoid 6 opens the gas valve 10, and expands the pilot light 63, which is being fed by this gas valve; so that the fuel oil which is being sprayed into the furnace is thereby ignited.

After ignition has taken place, the temperature in stack 53 (see Fig. III) rises, thereby heating thermostatic coil 52. The end of thermostatic coil 52 which is exposed to the hot gases in the stack, moves more rapidly under the rapid change of temperature to which it is subjected, than the sheltered end thereof. Consequently, central shaft 50 tilts fast-switch 40 in a short predetermined time, thereby opening electrodes 42 and 43, and connecting electrodes 44 and 45. The opening of electrodes 42 and 43 prevents starting the burner again, if for any reason it should shut down, until fast-switch 40 has returned to its original position; and the connecting of 44 and 45 shunts out the heating-coil 11 of the time-limit cut-out. Shunting out heating-coil 11 permits 11 to cool down, and therefore thermostat member 12 does not move and contactors 17 and 18 are thereby unable to be forced apart by compression-spring 19 and the burner continues to function normally.

In a predetermined time after the operation of fast-switch 40, the slow-switch 41 is tilted by means of the sheltered end of thermostatic coil 52 and hollow-shaft 54 connecting them. This opens electrodes 48 and 49, and closes electrodes 46 and 47.

Opening 48 and 49 prevents starting the burner again, (if for any reason it should shut down) until slow-switch 41 returns to its original position. This cannot occur until thermostat coil 52 indicates that the fire-box has cooled to a point where it would not ignite the oil if for any reason the burner should start and run a short period with the ignition system failing to function.

Closing electrodes 48 and 49 shunts out solenoid 6 and allows the gas valve 10 to close, thereby contracting the pilot to its normal position.

If, as presumed above, the gas pilot should for any reason fail to expand, or the electric or other ignition system which is started in operation by the solenoid 6 should fail to operate, it will be seen that oil would be sprayed into the furnace but not ignited.

Under these circumstances the thermostatic coil 52 would receive no heat, and consequently would not move fast-switch 40, so that the current taken to operate the motor would continue to pass through the time-limit cut-out (particularly through heating-coil 11). The heat generated in the resistance wire of heating-coil 11 under these circumstances would be sufficient, in a predetermined time, to cause thermostatic member 12 to move upward and allow compression-spring 19 to break the contact at 17 and 18 and thereby open the main circuit and shut down all of the apparatus which would remain inoperative until manually re-set as previously described.

This absolute shut-down invites inspection of the burner and prevents a gradual accumulation of oil in the furnace, and a possible explosion when the mixture becomes enriched or the pilot suddenly ignites the accumulated fuel.

If the burner should be functioning normally and the oil supply should become exhausted, combustion would of course cease. This would allow thermostatic coil 52 to cool and assume its normal position as indicated in the several figures. This would then permit all of the current which is being taken by the motor to pass through heating-coil 11 of the time-limit cut-out, which would again result in opening contactors 17 and 18 in the main motor circuit as above described.

It has been shown that the completion of the control circuit for starting the burner depends upon the closure of the low-voltage circuit through electrodes 42 and 43 of fast-switch 40 and electrodes 48 and 49 of slow-switch 41. It is essential, therefore, that both switches 40 and 41 be in their normal starting position as indicated in the drawings before the relay can operate and the main line circuit be closed through contacts

25 and 26. Consequently, by timing slow-switch 41 so that it will not return to its cool or starting position until the fire-box of furnace 57 has cooled to a safe temperature, it is possible to prevent explosions which sometimes occur with a failure of the ignition system when the thermostat 31 to 33 calls for heat before the fire-box has cooled to a safe temperature after its previous run. This is an important feature of our invention.

We are aware that prior to our invention, relays, solenoids, and various forms of thermostatic controls have been used commercially for sundry purposes, and do not claim these individual circuits in detail.

What we claim and desire to secure by Letters Patent is: —

1. In an electrical control circuit for burners, the combination of a fuel-supply motor, an ignition-motor, and a time-limit cut-out, all connected in series, a heat-actuated switch for shunting out the time-limit cut-out, and a second heat-actuated switch for shunting out the ignition-motor.

2. In an electrical control circuit for burners, the combination of a fuel-supply motor, an ignition-motor, and a time-limit cut-out, all connected in series, a heat-actuated fast-switch for shunting out the time-limit cut-out in a short time after ignition, and a heat-actuated slow-switch for shunting out the ignition-motor after longer time following ignition of the burner.

3. In an electrical control circuit for burners, the combination of a fuel-supply motor, an ignition-motor, a time-limit cut-out, and a main circuit switch, all connected in series, a heat-actuated switch for preventing closure of the main circuit switch unless said heat-actuated switch is in its low temperature position.

4. In an electrical control circuit for burners, the combination of a fuel-supply motor, an ignition-motor, a time-limit cut-out, and a main circuit switch, all connected in series, a heat-actuated fast-switch, and a second heat-actuated slow-switch connected in another series circuit for preventing closure of the main circuit switch unless said heat-actuated switches are in their low temperature positions.

5. In an electrical control circuit for burners, the combination of a fuel-supply motor, an ignition-motor, and a time-limit cut-out, all connected in series, a pair of heat-actuated switches for closing a second series circuit when in their low temperature positions and for shunting out the time-limit cut-out and the ignition-motor when in their high temperature positions.

6. In an electrical control device for burners, a power circuit and a control circuit, a heat-actuated fast-switch and a heat-actuated slow-switch connected in series in the control circuit when both switches are cool, a time-limit cut-out means for opening the power circuit, the fast-switch being adapted when heated to prevent operation of the cut-out, the slow switch being adapted to retard the re-energizing of the cut-out until the slow-switch is relatively cool, and automatic means for preventing the cut-out when open from automatically remaking the circuit.

7. In an electrical control device for burners having a control circuit and a power circuit, a fuel-supply motor and a switch in series in the power circuit, a time-limit cut-out means for automatically opening said switch, manual means for closing said switch, a heat-actuated fast-switch and a heat-actuated slow-switch connected in series in the control circuit when said fast-switch and said slow-switch are both cool, said slow-switch being adapted to retard the successive energizing of the cut-out means, and said fast-switch when heated being adapted to prevent operation of the cut-out means.

8. In an electrical control circuit for burners, a time-limit cut-out, a heat-actuated double-circuit switch adapted when cool to close the circuit, and adapted when relatively hot to shunt out the cut-out.

9. In an electrical control circuit for burners, an ignition-motor, a starting circuit, a heat-actuated double-circuit switch connected in the starting circuit when cool, said switch when relatively hot being adapted to shunt out said ignition-motor.

10. In an electrical control circuit for burners, a time-limit cut-out, an ignition-motor, a pair of heat-actuated double circuit switches connected in series when cool, one of said switches when relatively warm being adapted to shunt out the time-limit cut-out, and the other of said switches when relatively warm being adapted to shunt out the ignition-motor.

11. In an electrical control circuit for burners, a time-limit cut-out, an ignition-motor, a heat-actuated double circuit fast-switch and a heat-actuated double circuit slow-switch connected in series when cool, said fast-switch when relatively warm being adapted to de-energize the time-limit cut-out, and said slow-switch when relatively warm being adapted to de-energize the ignition-motor.

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