

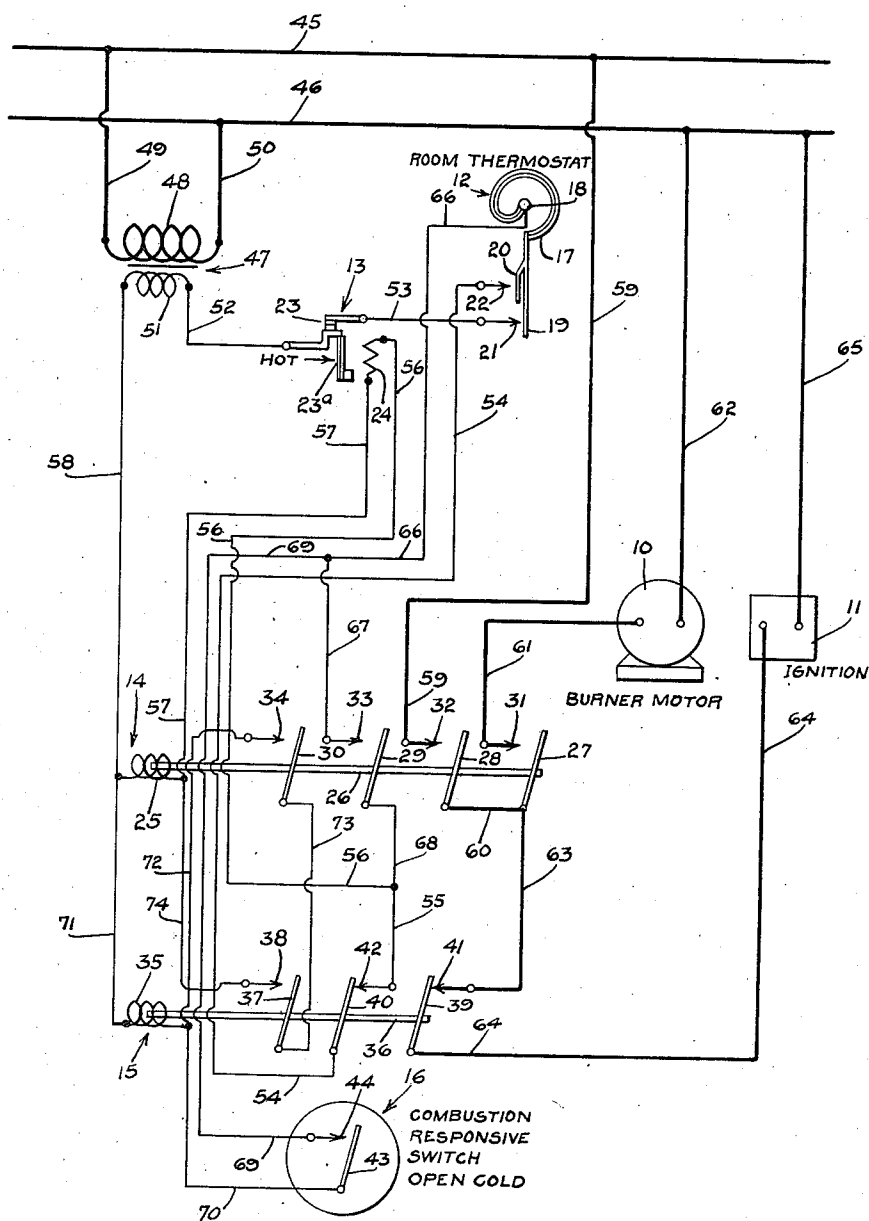
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ELECTRICAL CONTROL SYSTEM FOR FLUID FUEL BURNERS

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ELECTRICAL CONTROL SYSTEM FOR FLUID FUEL BURNERS

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The present invention relates to electrical systems of control for fluid fuel burners of the type that discontinue operation of the fluid fuel burner until manual intervention if combustion fails after successful initial ignition, as distinguished from those control systems for fluid fuel burners in which the controls recycle to attempt a re-ignition of the fuel under similar circumstances.

The failure of combustion after successful initial ignition and in the absence of power failure (commonly known as a flame failure) in a fluid fuel burning system very often indicates that there is a defect in the electrical control system. Many manufacturers prefer to have the entire fuel burning system shut down on a flame failure until the system has been inspected and repaired, if necessary, instead of having the system attempt to re-ignite the fuel.

Many systems of electrical control for fluid fuel burners that include a switching mechanism responsive to combustion conditions and in which there is provision whereby operation of the burner is discontinued until manual intervention upon the occurrence of a flame failure, have heretofore been proposed. However, all of these prior art systems have had certain objectionable features.

In one type of such prior art systems, it is necessary to use three electrical relays which is objectionable as to cost. In another type of such systems, one of the relays is dispensed with, but it is necessary to provide a mechanical inter-locking switching mechanism jointly operated by the two remaining relays, or else it is necessary to use a complicated combustion responsive switching mechanism which directly controls the high voltage ignition circuit besides performing its other functions.

It is a general object of this invention to provide an improved burner control system in which the burner operation is discontinued until there is manual resetting of a safety device upon the occurrence of flame failure.

More particularly, one of the objects of the present invention lies in the provision of an electrical control system for fluid fuel burners including only two relays, no mechanical inter-locking switching mechanism, and a simple combustion responsive switch that does not directly control the high voltage ignition circuit, which control system operates to discontinue burner operation until manual intervention on a flame failure.

Many of the electrical control systems for fluid fuel burners now in use include an electrically

heated time switch which renders the entire system inoperative if ignition—i. e. initial combustion when the burner is started—is not successful. Some of these systems, upon the occurrence of a flame failure, mechanically prevent the return of ignition and stop the burner motor by re-energizing the electrically heated time switch. When there is a flame failure in such a system, fluid fuel continues to flow into the fire-box after the combustion responsive member has responded to the flame failure and until the electrically heated time switch is opened as a result of its being energized for a predetermined length of time. A system of this type is objectionable in that a comparatively large amount of unconsumed fuel is deposited in the fire-box between the time of the flame failure and the shut down by the electrically heated time switch. The time lag between the action of the combustion responsive device and the shutting off of the oil supply is equal to the period allowed for ignition to take place initially.

One of the more specific objects of the invention is the provision of an electrical control system for fluid fuel burners of the general type discussed above in which the interval between action of a flame failure responsive device and the shutting off of the burner motor is less than the initial ignition period, whereby a decreased amount of unconsumed fuel is deposited in the fire-box. Specifically, this result is accomplished in the embodiment of the invention hereinafter described by increasing the current flow to the electrically heated time switch when there is a flame failure. Return of ignition after such a flame failure is also prevented, but this is accomplished entirely electrically and dispenses with all mechanical locking mechanisms.

A further object of the invention is the provision of an electrical control system which operates in the manner above described and, in addition, recycles if there is a failure in the supply of electrical power, so as to attempt to re-ignite the fuel when power is restored.

Further objects of the invention will become apparent as the description thereof proceeds.

For a more complete understanding of the invention, reference may be had to the following description and accompanying single drawing which is a schematic wiring diagram of one embodiment of the present invention.

Referring to the drawing, an electrically operated fuel supply controlling device herein disclosed as a burner motor is indicated at 10. An electrically controlled ignition means is indi-

means 11. The burner motor 10 and ignition means 11 are controlled by an electrical control system that includes a main switch herein specifically shown as a room thermostat 12, a time operated switching mechanism 13, first and second relays 14 and 15, and a combustion responsive switching mechanism 16.

The room thermostat or main switch 12 comprises a bimetallic element 17 one end of which is secured as shown at 18. The free end of bimetallic element 17 controls contact blades 19 and 20 in such a manner that contact blade 19 first engages a contact 21 and then contact blade 20 engages a contact 22 upon a lowering in the temperature to which bimetallic element 17 responds. When this temperature rises, bimetallic element 17 first moves contact blade 20 out of engagement with contact 22 and thereafter moves contact blade 19 out of engagement with contact 21.

The time operated switching mechanism 13 may be of any of the well-known types in which a normally closed switch 23, which is thermostatically controlled, is moved to open position and latched therein when its associated thermostatic element 23a has been heated to a predetermined degree. An electrical heating coil 24 is associated with switch 23 so as to heat its thermostatic element 23a to a predetermined degree when the electrical heating coil 24 has been traversed by a predetermined current flow for a predetermined length of time.

Relay 14 comprises a relay coil 25 which controls an armature 26. When relay coil 25 is energized, armature 26 is attracted and moves switch arms 27, 28, 29 and 30 respectively into engagement with contacts 31, 32, 33, and 34. Upon deenergization of relay coil 25, armature 26 moves under the influence of gravity to the position shown in the drawing wherein switch arms 27, 28, 29, and 30 are out of engagement with contacts 31, 32, 33, and 34. Relay 15, likewise, comprises a relay coil 35 which, when energized, attracts an armature 36 thereby moving switch arm 37 into engagement with contact 38 and switch arms 39 and 40 respectively out of engagement with contacts 41 and 42. When relay coil 35 is deenergized, its armature, under the influence of gravity, assumes the position shown in the drawing wherein switch arm 37 is disengaged from contact 38 and switch arms 39 and 40 are in engagement with contacts 41 and 42.

The combustion responsive switching mechanism 16 comprises a switch arm 43 which is out of engagement with a contact 44 when combustion is absent and moves into engagement therewith upon the successful establishment of combustion. The switch arm 43 may be controlled by combustion conditions in any desirable manner but it is preferably thermally controlled by the heat of combustion through a non-positive transmission mechanism, such, for instance, as shown in Cyr Patent 1,768,892.

Electrical power for the various electrical devices and control circuits is supplied by line wires 45 and 46 and a step-down transformer 47. The primary 48 of the step-down transformer 47 is connected to line wires 45 and 46 by wires 49 and 50. The low voltage secondary is indicated at 51. The various circuit connections will be described under the heading "operation".

Operation

When the temperature to which bimetallic element 17 responds begins to fall contact blade 19

will first engage contact 21, but this engagement will not result in the completion of any electrical circuits. As the temperature to which bimetallic element 17 continues to fall contact blade 20 will engage contact 22 which will result in energization of relay coil 25 and electrical heating coil 24 as follows: secondary 51, wire 52, switch 23, wire 53, contact 21, contact blade 19, contact blade 20, contact 22, wire 54, switch arm 40, contact 42, wire 55, wire 56, electrical heating coil 24, wire 57, relay coil 25, and wire 58, back to secondary 51. Energization of electrical heating coil 24 will result in heating of the thermostatic element which controls switch 23. Energization of relay coil 25 will attract armature 26 to move switch arms 27, 28, 29 and 30 into engagement with contacts 31, 32, 33, and 34 as heretofore described. Engagement of switch arms 27 and 28 with contacts 31 and 32 establishes energizing circuits for burner motor 10 and ignition means 11. The circuit for burner motor 10 is as follows: line 45, wire 59, contact 32, switch arm 28, wire 60, switch arm 27, contact 31, wire 61, burner motor 10, and wire 62, to line 46. The energizing circuit for ignition means 11 is as follows: line 45, wire 59, contact 32, switch arm 28, wire 60, wire 63, contact 41, switch arm 39, wire 64, ignition means 11, and wire 65 to line 46. Engagement of switch arm 29 with contact 33 establishes a holding circuit for relay coil 25 which is independent of contact 22 and contact blade 20. This holding circuit is as follows: secondary 51, 52, 23, 53, contact 21, contact blade 19, thermostatic element 17, wire 66, wire 67, contact 33, switch arm 29, wire 68, 56, electrical heating coil 24, 57, relay coil 25, and 58 to secondary 51. Engagement of switch arm 30 with contact 34 partially establishes a circuit which will be described hereafter.

The burner motor 10 is now operating to supply fuel to the burner and ignition means 11 is energized for the purpose of igniting the fuel thus supplied. Electrical heating coil 24 is heating the thermostatic element which controls switch 23. If combustion should not be successfully established within the predetermined time, switch 23 will be opened and latched in open position thereby deenergizing electrical heating coil 24 and relay coil 25. Deenergization of relay coil 25 will in turn deenergize burner motor 10 and ignition means 11. The whole system is therefore shut down until the switch 23 is manually reset.

Assuming that combustion is successfully established within the predetermined time, switch arm 43 will move into engagement with contact 44 to establish an energizing circuit for relay coil 35 as follows: secondary 51, 52, 23, 53, contact 21, contact blade 19, thermostatic element 17, wires 66, 69, contact 44, switch arm 43, wire 70, relay coil 35, wire 71, and 58 to secondary 51. In addition to the circuit just traced, it will be noted that relay coil 35 could be also energized upon the establishment of combustion through contact 42 and switch arm 40 but this circuit would be immediately broken upon separation of switch arm 40 from contact 42. This circuit is as follows: secondary 51, 52, 23, 53, contact 21, contact blade 19, contact blade 20, contact 22, 54, switch arm 40, contact 42, 55, 68, switch arm 29, contact 33, 67, 69, contact 44, switch arm 43, 70, relay coil 35, 71, and 58 to secondary 51. Energization of relay coil 35 attracts armature 36 which moves switch arm 37 into engagement with contact 38 and switch arms 39 and 40 out of engagement with contact 41 and 42. Movement of switch arm 40 out of engagement with

contact 42 interrupts the last described energizing circuit for relay coil 35 and likewise interrupts the original energizing circuit for relay coil 25. Relay coil 25 will be maintained energized, however, by the holding circuit previously described. Disengagement of switch arm 39 from contact 41 interrupts the circuit to ignition means 11. Engagement of switch arm 37 with contact 38 shunts electrical heating coil 24 to establish a new circuit for relay coil 25 as follows: secondary 51, 52, 23, 53, contact 21, contact blade 19, thermostatic element 17, wire 66, 69, contact 44, switch arm 43, 70, wire 72, contact 34, switch arm 30, wire 73, switch arm 37, contact 38, wire 74, relay coil 25, and wire 58 to secondary 51.

The apparatus is now operating normally with the burner motor 10 supplying fuel which is being burned at the burner, ignition means 11 is de-energized and electrical heating coil 24 is operatively deenergized by means of the shunt circuit just described. When the room temperature rises contact blade 20 will first disengage contact 22 but the system will remain in operation. On a further rise in room temperature contact blade 19 will disengage contact 21 interrupting the circuits to relay coils 25 and 35. Deenergization of relay coils 25 and 35 will allow their respective armatures 26 and 36 to return to the position shown in the drawing under the influence of gravity and the entire system will therefore be shut down.

If there should be a flame failure while the system is operating normally as above described, switch arm 43 will disengage contact 44. Relay coils 25 and 35 will remain energized but will now be connected in parallel and the full flow of current to both of these relay coils will pass through electrical heating coil 24. This series parallel circuit is as follows: secondary 51, 52, 23, 53, contact 21, contact blade 19, thermostatic element 17, 66, 67, contact 33, switch arm 29, 68, 56, electrical heating coil 24 to 57 at which point the circuit will branch, part of the current going by way of relay coil 25 and 58 to secondary 51 and the other part going by way of 74, contact 38, switch arm 37, 73, switch arm 30, 34, 72, relay coil 35, 71, and 58 to secondary 51. The resulting current flow through heating coil 24 will be considerably larger than the normal current flow therethrough when only relay coil 25 is in series therewith, with the result that switch 23 will be opened and latched in open position in a much shorter time than would be the case if combustion were not successfully established initially. Since relay coils 25 and 35 remain energized between the time of the flame failure and the opening of switch 23, the burner motor 10 will continue to supply unconsumed fuel to the burner and the ignition means 11 will be maintained deenergized. Although this system permits the depositing of a certain amount of unconsumed fuel into the fire-box after a flame failure it is to be noted that a much larger amount would be deposited therein if the time operated switching mechanism 13 were allowed to open only after the normal predetermined time period had expired. This system, therefore, diminishes the amount of unconsumed fuel that may be deposited in the fire-box after a flame failure by shortening the timing period of the time-operated switching mechanism so that it operates more quickly than it would under normal conditions wherein combustion was not initially established.

At this time, it would be well to explain the utility of switch arm 27 and contact 31. When relay coils 25 and 35 are de-energized as the result of opening of switch 23 after a failure of flame, switch arm 39 will move into engagement with contact 41 and switch arm 28 will disengage contact 32. If switch arm 27 and contact 31 were omitted, a complete electrical circuit would thereby be established from motor 10 through ignition means 11 as follows: motor 10, wire 61, wire 63, contact 41, switch arm 39, wire 64, ignition means 11, wire 65, line 46 and wire 62 back to motor 10. The motor 10, will coast for a short time after de-energization as the result of switch arm 28 moving out of engagement with contact 32 and in coasting will generate an electro-motive force which would momentarily re-energize ignition means 11 by the above-described circuit if switch arm 27 and contact 31 were omitted. This momentary re-energization of ignition means 11 would very likely ignite the unconsumed oil and/or oil vapors which collected in the combustion chamber after the occurrence of the flame failure and cause an explosion. This hazardous condition is eliminated by the insertion of switch arm 27 and contact 31 between motor 10 and ignition means 11.

If the system is operating normally and the supply of electrical power should fail, relay coils 25 and 35 would be deenergized and the system would return to its inoperative position as shown in the drawing. If the power should immediately return before switch arm 43 has disengaged contact 44 and if contact blades 19 and 20 are in engagement with their respective contacts 21 and 22, there will be energizing circuits for both relay coils 25 and 35. Armature 36 will be attracted first, however, partly by reason of the adjustment of the contact pressures and partly by reason of a smaller air gap. The energizing circuit for relay coil 25 will be interrupted at 40, 42 before its armature 26 has been attracted. Relay coil 35, therefore, remains energized until switch arm 43 disengages contact 44 whereupon the system will recycle and initiate a new trial ignition period during which combustion will either be successfully established or the system will be shut down until manual intervention. If the power failure should last until after switch arm 43 disengages contact 44, the system will recycle in an attempt to establish combustion just as soon as the electrical power returns.

From the foregoing description, it will be apparent that this invention provides a simple electrical control system for fluid fuel burners in which the entire system is rendered inoperative until manual intervention if the flame should fail after combustion has been initially successfully established. This system requires only two electrical relays and utilizes a simple single circuit combustion responsive switching mechanism and does away with all mechanical locking mechanisms operated either by the combustion responsive switching mechanism or one or more of the relays. In addition, this system provides for a recycling upon a failure of electrical power whether this power failure be momentary or for a substantial length of time.

While a specific embodiment of the invention has been herein illustrated and described, it is to be understood that various changes and modifications can be made and I intend to be limited only in the purview of the appended claims.

I claim as my invention:

1. A system of the class described, comprising, 75

in combination, a thermostatically controlled switch adapted to be opened and latched in open position when heated to a predetermined degree, an electrical heating element therefor, a main switch, a first electro-magnetic device, switching mechanism operated thereby, a second electro-magnetic device, switching means operated thereby, a single circuit combustion responsive switch open during the absence of combustion, an electrically operated fuel supply controlling device, electrically controlled ignition means, a series circuit for initially energizing the first electro-magnetic device and electrical heating element through the thermostatically controlled switch upon closure of the main switch, the current flow thus produced through the heating element being sufficient to open the thermostatically controlled switch after a predetermined length of time, circuits for the fuel supply controlling device and ignition means closed by said switching mechanism upon energization of the first electro-magnetic device, an energizing circuit for the second electro-magnetic device including the thermostatically controlled switch, main switch and combustion responsive switch in series, said switching means thereupon interrupting the circuit to the ignition means, a shunt circuit for the electrical heating element established by said switching means upon energization of the second electro-magnetic device, said electro-magnetic devices when energized effecting operation of said switching means and switching mechanism to complete a circuit connecting said electro-magnetic devices in parallel with each other and in series with said heater and a shunt circuit for said heater including said combustion responsive switch whereby upon opening of said combustion responsive switch with said electro-magnetic devices energized the current flow through said heater is materially increased over the initial current flow therethrough, thereby opening said safety switch in a time period materially less than said predetermined time through said electrical heating element to quickly open the thermostatically controlled switch and deenergize said electro-magnetic devices.

2. In a system having electrically controlled fuel feeding and ignition means, a main control

switch, an electrically actuated time limit cut-out switch operable to open in time periods varying in accordance with its rate of energization, switching mechanism including reactances and a combustion controlled switch, and circuit connections including the foregoing elements controlling energization of the fuel feeding and ignition means and the energization of the time switch and rate thereof and operable upon a demand for heat and closure of the main switch to: (1) energize the fuel feeding and ignition means and energize the time switch at a predetermined rate; (2) deenergize the ignition means and time switch upon the establishment of combustion; and (3) reenergize the time switch at a higher rate while maintaining energization of the fuel feeding means upon a failure of flame during normal operation, said switching mechanism including means to prevent reenergization of said ignition means upon occurrence of the aforesaid flame failure.

3. In combination with a fluid fuel burner and its fuel feeding means, ignition means for igniting the fuel, a control system including in circuit a main control member, an electrical safety time switch whose timing interval varies with the rate at which it is energized for discontinuing fuel feed to the burner at the conclusion of its timing interval, a combustion responsive device, and means responsive to the main control member for simultaneously initiating operation of said burner and ignition means and energizing said time switch at a first rate, and cooperating with the combustion responsive device to deenergize said time switch and ignition means upon the successful establishment of combustion, and to reenergize said time switch at a second rate higher than said first rate upon the occurrence of subsequent flame failure, whereby said time switch provides a longer timing interval upon initiation of operation of the burner than is provided upon the occurrence of flame failure, said means including switching mechanism to prevent reenergization of said ignition means upon occurrence of the aforesaid flame failure.

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