

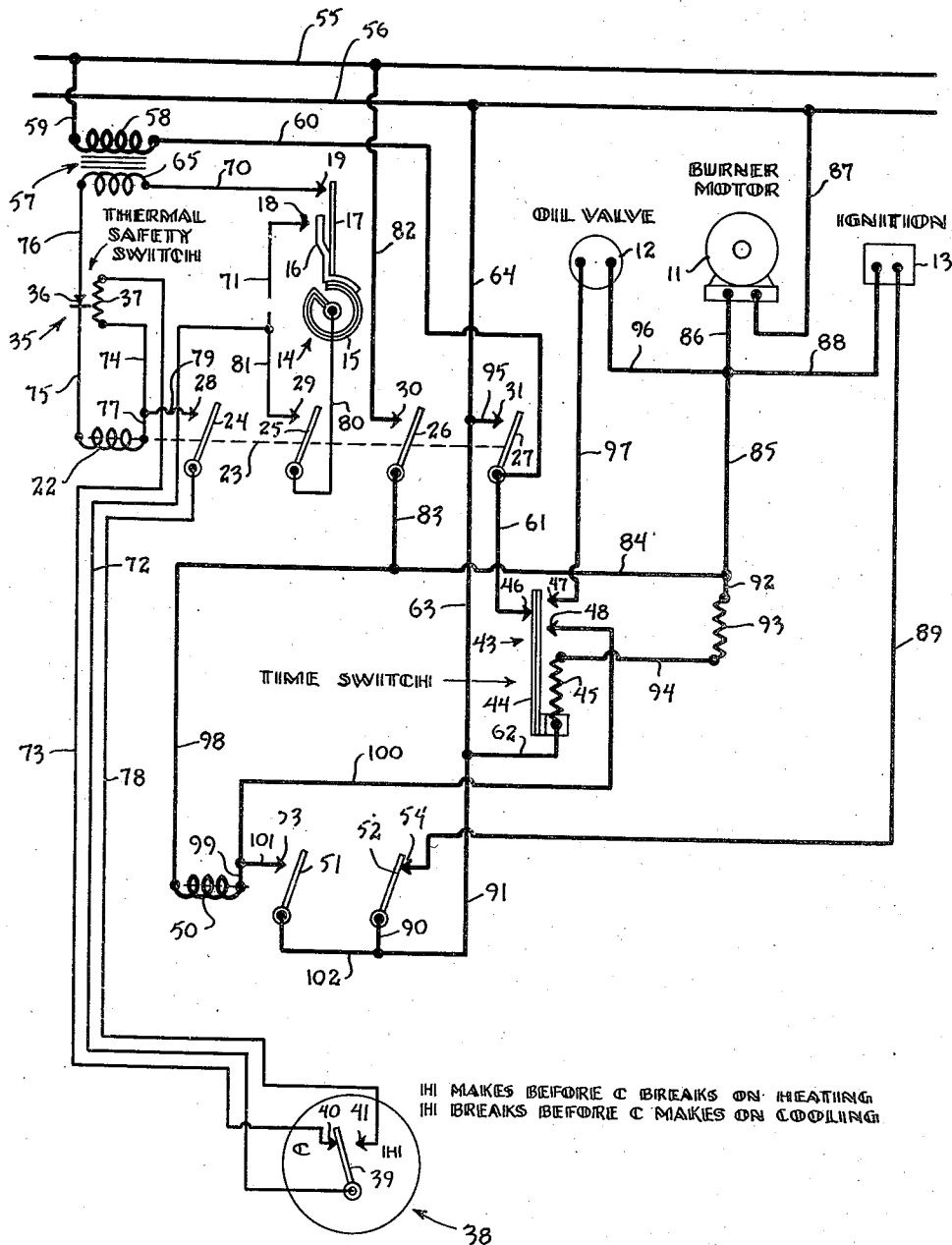
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FUEL BURNER CONTROL SYSTEM

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FUEL BURNER CONTROL SYSTEM

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This invention relates broadly to control systems for fuel burners, such as an oil burner, and has particular utility in the system in which it is desired to time the oil valve opening, the ignition period, and the period following a shut-down during which the system may not safely be restarted.

Particularly in the field of industrial burners it is desirable on starting the burner system to first start the burner motor and after it has attained normal speed open the oil valve to permit a flow of oil to the burner. The ignition will have been energized simultaneously with the burner motor and a predetermined time after the oil valve is opened it is desired to end the ignition period. Furthermore, after the system has been shut down, whether it be due to the demand for heat having been satisfied or due to flame or power failure, it is desired that a predetermined minimum period be established during which the system cannot be restarted. The purpose of this is to permit all unburned gases and so forth to be cleared from the furnace by the natural draft before the ignition means is again energized, and it is commonly referred to as the scavenger period.

It is a prime object of the present invention to provide a single timer for automatically timing the opening of the oil valve, the ignition period, and the scavenger period.

A further object is to provide a thermal timer capable of performing the above functions and which is connected directly to the high voltage supply, the controlling thermostat and relay being in the low voltage circuit.

A further object is to apply a thermal timer of the above type to an oil burner control system having the usual safety switch and heater therefor as well as a combustion switch for deenergizing the safety switch heater after combustion has been established.

These and other objects will readily become apparent to those skilled in the art as the following specification is read in the light of the accompanying drawing in which the single figure illustrates diagrammatically an oil burner control system embodying my invention.

The present system includes an oil burner which is driven by means of an electric motor indicated at 11 and an oil valve 12 is provided for the purpose of controlling the supply of oil to the burner. The reference numeral 13 indicates an ignition means for igniting the oil which is supplied to the burner by means of the oil valve 12.

The system is primarily under the control of a

room thermostat which is indicated generally at 14 and which comprises a coiled bimetallic element 15 which is fixed at its inner end and free at its outer end which carries a relatively stiff contact blade 16 and a flexible contact blade 17 for cooperation respectively with the stationary contacts 18 and 19. The thermostat is so arranged that on a decrease in temperature the flexible blade 17 will first engage its contact 19 and on a further decrease in temperature, for example 2°, the flexible blade 17 bends to permit the stiff blade 16 to engage its stationary contact 18.

A relay coil 22 when energized is adapted to pull in an armature which is diagrammatically indicated by the dotted line 23. The armature 23 when pulled in actuates the switch blades 24, 25, 26, and 27 to closed circuit position at which time they engage respectively the stationary contacts 28, 29, 30, and 31. When the coil 22 is deenergized the switch blades 24 to 27 are moved to open circuit position by gravity or some other suitable means.

A thermal safety switch generally indicated at 35 comprises normally closed switch contacts 36 and a heater 37 for the thermal element (not shown). The arrangement is such that after the heater has been energized for a predetermined period of time the thermal element of the switch flexes to separate the contacts 36 and latch them in open position so that a manual reset is required to reclose them. Switches of this type are in common use at the present time and it is therefore believed that a further description of the operation is not necessary. For the details of construction of one of the switches which may be used for this purpose reference may be had to the Denison Patent 1,958,081 which issued May 11, 1934.

Indicated generally at 38 is a combustion responsive switch which is provided with a movable switch arm 39 which is adapted to engage a cold contact 40 and a hot contact 41. The switch is operated by means of a thermal element (not shown) which is responsive to combustion within the furnace and it is connected to the switch arm 39 by means of a slip friction connection so that the arm 39 will be moved on a reversal of temperature change and will not be dependent upon any definite degree of temperature. The switch is so designed that on an increase in temperature the switch arm 39 will engage the contact 41 before it separates from the contact 40 and on a decrease in temperature, switch arm 39 will separate first from the contact 41 and later engage

the contact 40. Many switch mechanisms have been designed for producing this sequence of switch operation and a further description of the mechanism is therefore believed not necessary. One type of switch which may be used to perform this result is disclosed in the patent to Daniel G. Taylor 1,941,502 which issued January 2, 1934.

Indicated generally at 43 is a thermal timer which comprises a bimetallic blade 44 and an electric heater 45 for heating the blade. In its cold position the blade 44 is adapted to engage the stationary contact 46 and as it is heated by the heater 45 it first separates from the contact 46, then engages with contact 47, and later with the contact 48 remaining in contact with both of the contacts 47 and 48 in its hot position. Controlled by the thermal timer 43 is a second relay coil 50 which upon energization is adapted to actuate the switch arms 51 and 52 causing the arm 51 to engage contact 53. On deenergization of the coil 50 the blades are adapted to move by gravity or some other suitable means into the position shown in the drawing in which the blade 51 is separated from the contact 53 and the blade 52 is in engagement with contact 54.

The electrical power for the control system is supplied by means of line wires 55 and 56. Transformer 57 includes a primary winding 58, one end of which is connected to line wire 55 by the wire 59 and the other end of which is connected by means of the wires 60 and 61 to the cold contact 46 of the thermal timer and through the bimetallic blade 44, and wires 62, 63, and 64 back to the line wire 56. The transformer 57 is also provided with a secondary winding 65 which supplies electrical power to the low voltage part of the control circuit.

Operation

The drawing shows the position of the various parts when the temperature at the thermostat 14 is slightly above that at which it is desired to be maintained, and therefore the contact blades 16 and 17 are separated from their stationary contacts 18 and 19. The relay 22 is deenergized so that the switch blades 24, 25, 26, and 27 are in open circuit position. The relay 50 is deenergized so that the switch blade 51 is in open circuit position and the switch blade 52 is engaging its out contact 54. Combustion not being present in the furnace, the combustion responsive switch blade 39 is in engagement with its cold contact 40 and separated from its hot contact 41. The heating element 45 for the thermal control is deenergized so that the blade 44 is in engagement with its cold contact 46. The oil valve is closed and the burner motor and ignition means are deenergized. The primary winding 58 is connected across line wires 55 and 56 by the following circuit: wire 59, primary winding 58, wires 60 and 61, contact 46, bimetallic blade 44, and wires 62, 63, and 64. Under these conditions the temperature at the thermostat 14 will begin falling, which will first cause the resilient contact blade 17 to engage its contact 19. No circuit will be established at this time because the switch blade 25 is in open circuit position. The temperature will therefore continue to drop causing the blade 17 to flex and eventually permit the blade 16 to engage its contact 18. This will establish the following circuit: secondary winding 65, wire 70, contact 19, switch blades 17 and 16, contact 18, wires 71 and 72, switch blade

39, cold contact 40, wire 73, safety switch heater 37, wires 74 and 77, relay coil 22, wire 75, safety switch contacts 36 and wire 76 back to the secondary winding 65. This circuit will energize the relay coil 22 which will pull in its armature 23 and move the switch blades 24, 25, 26, and 27 to closed circuit position. Closure of the switch blade 24 will connect the hot contact 41 of the combustion responsive switch by means of wire 78, switch blade 24, contact 28, and wires 79 and 77 directly to the relay coil 22 without first passing through the safety switch heater 37. The purpose of this will be described later.

Closure of the switch blade 25 will connect the secondary winding 65 with wire 72 independently of contact blade 16 by means of the following circuit: wire 70, contact 19, contact blade 17, bimetallic element 15, wire 80, switch blade 25, contact 29, and wire 81 to wire 72. The result of the closure of this circuit is that the temperature may now increase slightly at the thermostat 14 to cause the disengagement of the contact blade 16 and contact 18, without breaking the control circuit.

Engagement of the switch blade 26 and contact 30 will establish the following circuit: line wire 55, wire 82, contact 30, switch blade 26, wire 83, wire 84, wire 85, wire 86, burner motor 11, and wire 87 back to line wire 56. This circuit energizes the burner motor and the ignition means 13 is energized at the same time by the following circuit in parallel with the burner motor 11: wire 88, ignition means 13, wire 89, contact 54, switch blade 52, and wires 90, 91, 93, and 94 back to the line wire 56. At the same time that the burner motor and ignition means are energized the heater element 45 for the thermal timer 43 is also connected across the line. This circuit may be traced as follows: from line wire 55, wire 82, contact 30, switch blade 26, wires 83, 84, and 92, protective resistance 93, wire 94, heater 45, and wires 62, 63, and 64 back to the line wire 56. Thus it will be seen that when the relay coil 22 is first energized by the thermostat 14 it closes four switches, the first of which (24) sets up a circuit with the hot contact 41 of the combustion responsive switch to be later made by the switch blade 39 upon the establishment of combustion which will deenergize the heater 37 for the safety switch, the second switch (25) closed by coil 22 sets up a holding circuit through the bimetal 15 so that the control system will not be shut down until the resilient blade 17 separates from contact 19. Closure of the third switch (26) simultaneously energizes the burner motor 11, the ignition means 13, and the electric heater 45 or the thermal timer 43. Closure of the fourth switch 27 sets up a holding circuit for the primary winding 58 of the transformer independently of the cold contact 46 of the thermal timer. This circuit may be traced as follows: line wire 55, wire 59, primary winding 58, wire 60, switch arm 27, contact 31, and wires 95 and 64 back to the other line wire 56. The primary winding 58 will now remain energized independently of the thermal timer 43 until the relay coil 22 is deenergized causing the switch blade 27 to drop out.

At this time no oil is being supplied to the burner and the burner motor is merely coming up to the proper speed for spraying and atomizing the oil. The heating of the bimetal blade 44 by the heater 45 causes it to first separate from the cold contact 46 which as set forth above has no effect on the primary winding 58 of the trans-

former 57 due to the closure of the holding circuit at 27, 31 by the relay winding 22. The bimetal element 44 will continue to flex until it engages the contact 47 which establishes the following circuit for opening the oil valve 12: line wire 55, wire 82, contact 30, switch blade 26, wires 83, 84, 85, 96, oil valve 12, wire 97, contact 47, bimetallic blade 44, and wires 62, 63, and 64 back to the line wire 56. At this time oil is supplied to the burner motor and ignited by the ignition means to produce combustion.

Continued heating of the bimetallic blade 44 will cause it to flex until it engages contact 48 which will energize the relay 50 through the following circuit: line wire 55, wire 82, contact 30, switch blade 26, wires 83 and 98, relay coil 50, wires 99 and 100, contact 48, bimetallic blade 44 and wires 62, 63, and 64 back to the line wire 56. Energization of the relay coil 50 causes the switch blade 52 to separate from contact 54 and as this switch is in series with the ignition means 13 the ignition means will therefore be deenergized at this time. Energization of the relay coil 50 also causes engagement of switch blade 51 and contact 53 which sets up the following holding circuit for the relay coil 50 independently of the bimetallic blade 44 and its contact 48: line wire 55, wire 82, contact 30, switch blade 26, wires 83 and 98, relay coil 50, wires 99 and 101, contact 53, switch blade 51, and wires 102, 91, 63, and 64 back to line wire 56.

At this time combustion has been established, the burner motor and oil valve are in running condition, and the combustion responsive switch 38 will now respond to the heat of combustion and cause the switch blade 39 to engage its hot contact 41 which will establish the following circuit: secondary winding 65, wire 70, contact 19, contact blade 17, bimetallic element 15, wire 80, switch blade 25, contact 29, wires 81 and 72, switch blade 39, contact 41, wire 78, switch blade 24, contact 28, wires 79 and 77, relay coil 22, wire 75, safety switch contacts 36, and wire 76 back to the secondary winding 65. It will be seen that this circuit is in parallel with the circuit through the safety switch heater 37 so that this heater will no longer be energized and on further heating of the combustion switch 38 the switch blade 39 will separate from its cold contact 40 and cut the heater 37 out of the circuit.

The entire control system is now in running condition and under these circumstances the temperature at the thermostat 14 will begin to increase. As set forth above, separation of the blade 16 from the contact 18 will have no effect upon the system due to the establishment of the holding circuit through the bimetallic element 15 by means of the switch arm 25. The temperature will therefore continue to increase until the flexible blade 17 separates from its stationary contact 19. This will break the circuit through the relay coil 22 causing it to drop out its armature 23 which will move the switch blades 24, 25, 26, and 27 to open circuit position. As the switch blade 26 moves to open circuit position it deenergizes the oil valve, the burner motor, the heater 45 for the thermal timer and the relay coil 50 thus shutting off the combustion within the furnace. As the switch blade 27 leaves its contact 31 it breaks the circuit between the primary 58 of the transformer 57 and the line wire 56 so that the transformer will now remain dead until the bimetallic blade 44 has cooled sufficient for it to engage its cold contact 46. This provides for a definite time interval during which the sys-

tem cannot be restarted and during this time any unburned gases and oil vapors may escape from the furnace by means of the natural draft therethrough. After the oil burner has become extinguished the combustion responsive switch 38 will start to cool causing the switch arm 39 to leave the hot contact 41 and eventually reengage the cold contact 40. It will be noted also that the thermostat 14 will be incapable of pulling in the relay coil 22 until the switch arm 39 engages the contact 40 due to the fact that the cold contact 40 is in the starting circuit for the coil 22. Under these conditions the parts will return to the positions shown in the drawing.

The above description of operation relates to the normal control of the oil burner system by the room thermostat 14 but there are certain features of this system which are designed to take care of different kinds of emergencies. Let us assume for example that the thermostat 14 is calling for heat and has energized the relay coil 22 which has in turn energized the burner motor, ignition means, and heater 45 for the thermal timer and that the blade 44 has heated up sufficiently to cause the oil valve 12 to open. If combustion does not take place for some reason or other, the combustion responsive switch blade 39 will not engage the hot contact 41 and the heating element 37 for the thermal safety switch will remain heated and if this condition prevails for a predetermined period of time the heater will cause its thermal element to open the contacts 36 and deenergize the relay coil 22 to shut off the oil valve, burner motor, and ignition means and deenergize the heater 45 of the thermal timer. The thermal safety switch is now latched out and must be manually reset and it will be noted that resetting of the safety switch cannot reenergize the relay coil 22 until the thermal timer blade 44 has had an opportunity to cool and engage its cold contact 46 because until this switch is closed the primary winding 58 of the transformer 57 will not be connected across the line wires 55 and 56. Therefore it is seen that this system is shut down after a predetermined period of time in case combustion does not take place on a call for heat.

Let us assume now that the room thermostat is calling for heat and that a normal start has been made as described above and the parts are all in running position. If for some reason the flame should become extinguished the combustion responsive switch 38 will immediately start to cool and the switch arm 39 will separate from the hot contact 41 which will break the circuit to the relay coil 22 dropping out its armature and moving the switch blades 24, 25, 26, and 27 to open circuit position. This action will close the oil valve, deenergize the burner motor, and also the heater 45 for the thermal timer as in the case of a normal shut down. Inasmuch as the room thermostat will still be calling for heat, the coil 22 will be reenergized as soon as the switch arm 39 engages its cold contact and as soon as the thermostatic blade 44 has had an opportunity to cool and engage its cold contact 46 to connect the primary winding 58 across the line wires 55 and 56 once more. At this time an attempt to make a normal start will take place and if combustion occurs, the parts will assume their normal running position as before, but if combustion is not established, the thermal safety switch will latch out as described above shutting the system down until it is manually reset.

Assume now that the parts are in running con-

dition and the thermostat is still calling for heat and that a momentary power failure occurs. This momentary cessation of power causes the relay coil 22 to drop out its armature 23 and move the switch blades 24, 25, 26, and 27 to open circuit position and as described above even though the power is now returned to the line the oil valve burner motor and heater 45 will be deenergized and the primary winding 58 disconnected from the line. The relay coil 22 cannot now be pulled in by the thermostat 14 until the combustion responsive switch blade 39 has cooled sufficiently to reengage cold contact 40 and the bimetallic blade 44 cooled sufficiently to engage its cold contact 46 and reconnect the primary winding 58 to the line wires 55 and 56. At this time the system will start up in the normal way providing for a delayed oil valve opening and a timed ignition period.

It is therefore seen that if the system is shut down for any reason whatever the thermal timer 43 provides for a minimum time delay within which the system cannot again be restarted thus providing for a proper scavenger period. It is seen further that this same thermal timer is also employed to delay the opening of the oil valve until the burner motor has come up to speed and that this timer also times the ignition period.

Certain changes and modifications of this invention may occur to those who are skilled in the art and it is therefore understood that I am to be limited by the scope of the appended claims rather than the specific embodiment disclosed.

I claim as my invention:

1. In a fuel burner control system, a burner motor, fuel control means, ignition means, a timer, and condition responsive means for energizing the timer, burner motor, and ignition means, said timer successively energizing said fuel control means and deenergizing said ignition means, said condition responsive means being capable of simultaneously deenergizing said burner motor and fuel control means independently of said timer.

2. In a fuel burner control system, a burner motor, a fuel valve, ignition means for the fuel controlled by said valve, a thermal timer, a heater for said thermal timer, and condition responsive means for energizing the heater for the timer, burner motor, and ignition means, said heater causing the timer to first open the fuel valve and then deenergize the ignition means, said condition responsive means being capable of simultaneously closing said fuel valve and deenergizing said burner motor independently of said timer.

3. In a fuel burner control system, a burner motor, fuel control means, ignition means, a timer, a condition responsive means, an actuating device energized by said condition responsive device for energizing the timer, burner motor, and ignition means, said timer successively energizing said fuel control means and deenergizing said ignition means, and means controlled by said timer for preventing reenergization of said actuating device after it has once been deenergized until said timer returns to its deenergized position.

4. In a fuel burner control system, a contact, a timer engaging said contact in its deenergized position, a source of power rendered active when said contact is engaged by said timer, a condition responsive device, a first means energized from said source of power by said condition responsive device, holding means operated by said first

means for maintaining said source of power active independently of said contact, a burner motor, an ignition means, a fuel control means, switch means operated by said first means for energizing said timer, burner motor, and ignition means, said timer disengaging said contact and successively causing energization of said fuel control means and later deenergization of said ignition means, deenergization of said first means causing opening of said switch means and deenergization of said holding means so that said first means cannot be reenergized from said source of power until said timer closes said contact.

5. In a fuel burner control system, a timer, a switch closed by said timer in its deenergized position, a relay, a condition responsive device for energizing said relay, said switch preventing such energization except when it is closed, holding means operated by said relay for maintaining it energized independently of said switch, a burner motor, an ignition means, an energizing means for said timer, means operated by said relay for energizing said burner motor, ignition means, and timer energizing means, a fuel valve, said timer when energized opening said first switch and sequentially opening said fuel valve and deenergizing said ignition means, deenergization of said relay causing deenergization of said burner motor, closing of said fuel valve, and deenergization of said timer energizing means, said relay being incapable of reenergization until said timer moves to its deenergized position and closes said switch.

6. In a fuel burner control system, a burner motor, a fuel supply valve, ignition means, a thermal timer, a heater for said timer, a condition responsive means, a relay energized by said condition responsive means for energizing said burner motor and ignition means and closing a circuit to said heater, said timer on heating successively opening said fuel valve and deenergizing said ignition means, and means preventing reenergization of said relay after it has once been deenergized including a switch which is closed by said thermal timer only in its cold position.

7. In a fuel burner system, a thermal timer having one cold contact and first and second hot contacts, means providing a source of electrical energy when said thermal timer is closing its cold contact but not when said contact is open, a relay, a condition responsive device for energizing said relay from said source of energy, a heater for said thermal timer, a burner motor, an ignition means, switch means closed by said relay for energizing said heater, burner motor, and ignition means, said relay also closing a switch in shunt with said cold contact whereby said source of electrical energy is maintained independently of said contact, and a fuel valve, said heater causing said thermal timer to operate to break said cold contact and successively close said first hot contact to open said fuel valve and close said second hot contact to deenergize said ignition means, deenergization of said relay causing opening of said shunt switch and said switch means whereby said relay cannot be reenergized until said thermal timer recloses its cold contact.

8. In a fuel burner system, a thermal timer having one cold contact and first and second hot contacts, means providing a source of electrical energy when said thermal timer is closing its cold contact but not when said contact is

open, a relay, a condition responsive device for energizing said relay from said source of energy, a heater for said thermal timer, a burner motor, an ignition means, switch means closed by said relay for energizing said heater, burner motor, and ignition means, said relay also closing a switch in shunt with said cold contact whereby said source of electrical energy is maintained independently of said contact, a fuel valve, a second relay, said heater causing said thermal timer to operate to break said cold contact and successively close said first hot contact to open said fuel valve and close said second hot contact to energize said second relay, and a switch in series with said ignition means, energization of said second relay opening said last named switch, deenergization of said first named relay causing opening of said shunt switch and said switch means whereby said relay cannot be reenergized until said thermal timer recloses its cold contact.

9. A fuel burner control system comprising in combination, a source of electrical energy, a transformer having a primary and secondary, a thermal timer having a cold contact and first and second hot contacts, a circuit connecting the primary of the transformer to the source of electrical energy through the cold contact of the thermal timer, a relay, a condition responsive device for energizing said relay from the secondary of said transformer, a burner motor, an ignition means, a heater for said thermal timer, switch means controlling energization of said burner motor, ignition means and heater, a switch in shunt with said cold contact, means actuated by said relay upon energization thereof for closing said switch means and said shunt switch whereby the primary is connected to said source of electrical energy independently of said cold contact, a fuel valve, said heater causing said thermal timer to heat up and break said cold contact and successively make said first hot contact to open said fuel valve and said second hot contact to deenergize said ignition means, deenergization of said relay causing opening of

said shunt switch and switch means whereby said primary is disconnected from said source of electrical energy until said thermal timer cools off and closes its cold contact.

10. A fuel burner control system comprising in combination, a high voltage supply, a step-down transformer having a primary and a secondary, a thermal timer having a cold contact, a circuit connecting said primary to the high voltage supply including the cold contact, a low voltage circuit connected to said secondary including a relay, a thermal safety switch having a heater, and a combustion responsive switch having hot and cold contacts which are overlappingly controlled on heating but not on cooling, a condition responsive device in said low voltage circuit for closing the low voltage circuit to said relay through the cold contact of the combustion switch and the heater for the safety switch, a first switch actuated by the relay for setting up a holding circuit for itself through the hot contact of the combustion switch and omitting the heater for the safety switch, a second switch actuated by the relay in shunt with the cold contact of the thermal timer thereby maintaining the primary energized independently of the thermal timer, a heater for the thermal timer, a burner motor, an ignition means, switch means closed by the relay for connecting said heater, burner motor, and ignition means to the high voltage supply, a fuel valve, said heater causing said thermal timer to break its cold contact and successively open said fuel valve and deenergize said ignition means, establishment of combustion causing said combustion switch to close its hot contact and break its cold contact, deenergization of said relay causing opening of said first and second switches and said switch means whereby said relay cannot be reenergized until the cold contact of the combustion switch and the cold contact of the thermal timer have been reclosed.

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