

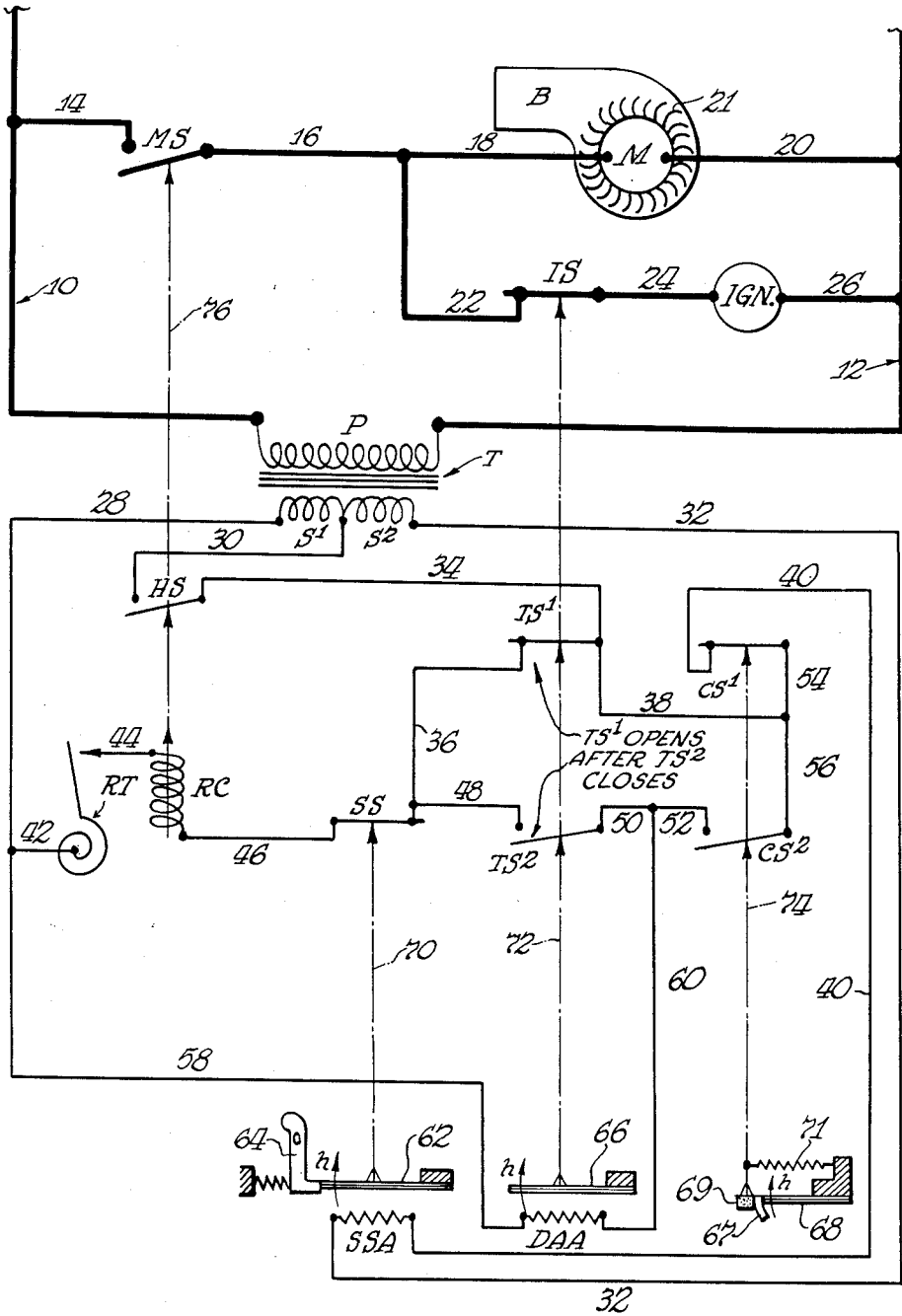
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OIL BURNER SAFETY CONTROL

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OIL BURNER SAFETY CONTROL

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This invention relates to an oil burner control which, besides handling the regular functions of the usual oil burner control including an initial combustion failure shut-down and delayed ignition tripping, has the additional features of low voltage protection without the necessity of balancing impedances, and protection for combustion failure subsequent to successful establishment thereof which results in shut-down.

One object of the invention is to provide a main relay, a combustion thermostat and an arrangement of switch actuators for controlling the burner blower motor and the ignition of an oil burner or the like in such manner that all the mentioned features can be obtained with complete safety of operation in connection with each feature and low voltage protection is had by reducing the current flow in the main relay immediately after it is energized so that it will drop out upon a predetermined lowering in line voltage.

In explanation of this feature, I provide a main relay which is operable to cut in at as low as 85% of the full line voltage and to cut out at a point not lower than approximately 70% thereof in contrast with the usual arrangement wherein relays are used for burner control circuits and the relay when properly designed to give sufficient motion for operation of the contacts cuts out at about 35% of the full line voltage. Provision for low voltage protection is particularly important because at about 65% of the full line voltage the burner functions improperly, its efficiency being low, the air velocity being subnormal, oil pressure, in some types of burners, being also subnormal and the opening of the solenoid (when provided to control the oil supply) being restricted. Also low voltage in the ignition transformer occurs which causes either entire loss of spark or irregular occurrence thereof which results in the burner "popping" and sometimes in an explosion. The problem is worse in small communities where consumption varies greatly and in almost all localities when sleet gathers on the transmission wires and causes a temporary drop in voltage which may last sometimes for an hour or more. It is therefore obvious that cut-out of the relay at or above 70% of the full line voltage is desirable.

Another object of this invention is to provide a circuit arrangement for a relay to make it possible for the relay to cut in at one voltage and be thereafter maintained in the cut-in position by a reduced voltage making it easier to drop out subsequently when the line voltage drops. The relay drop-out occurs preferably before an excessive drop in the full line voltage occurs; whereas maintenance of the initial full line voltage would result in there having to be an excessively low voltage before drop-out would occur.

Still another object is to provide a combination of main relay for closing the blower motor and ignition circuits when a room thermostat calls for heat and a circuit through an ignition circuit switch which is controlled by a delayed action actuator.

A further object is to provide the circuit with a safety

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switch for effecting normal shut-down following initial combustion failure, and following subsequent combustion failure if a recycle is not effected, the safety switch requiring manual resetting so that the trouble that caused shut-down must be remedied before such manual resetting operation can be effective for placing the circuit back in automatic operation.

A further object is to provide a switching arrangement electrically connected with the main relay so as to cooperate therewith in providing an initial high voltage circuit therefor and a subsequent lower voltage circuit conducive to the low voltage protection features already referred to.

A further object is to provide a circuit arrangement that affords low voltage protection, the arrangement being such that the relay pulls in from the entire secondary of a transformer and thereafter remains in from a portion only thereof so that if, under poor voltage conditions, the relay will pull in, a subsequent drop in line voltage will effect drop-out of the relay.

An additional object is to provide a control circuit arrangement wherein the current for the room thermostat is substantially constant during initiation and running of the burner and during all steps in the cycling of the burner, a transfer switch being provided for this purpose to transfer the current through the relay from one portion of a circuit to the other and the resistance in the various circuits being substantially the same so as to eliminate a critical requirement with respect to balancing the impedances of various components of the circuit.

With these and other objects in view, my invention consists in the construction, arrangement and combination of the various parts of my oil burner control, whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims and illustrated in the accompanying drawings, wherein:

The figure is an electro-diagrammatic view of an oil burner embodying my present invention.

On the accompanying drawing I have used the reference character M to indicate the blower motor of a burner B which is shown diagrammatically and is the usual type of oil burner used in oil heated furnaces. The blower of the motor is shown at 21. For igniting the combustible mixture of atomized oil and air, ignition mechanism is shown diagrammatically at Ign.

A transformer T is shown having a primary P and a pair of secondary coils S¹ and S² of low voltage, for instance 12 volts each, the primary being for the usual house current of 115 or 230 volts. Supply wires 10 and 12 for the primary P are shown and these also supply current for the motor M as follows: from wire 10 a wire 14 leads to a main switch MS and wires 16 and 18 lead from the main switch to the motor M, another wire 20 connecting the motor to the line wire 12.

The ignition Ign is in parallel with the motor M through wires 22, 24 and 26, an ignition switch IS being in circuit therewith so that the current from 10 through 14, MS, 16 and 22 and through 24, Ign and 26 is controlled thereby. This completes the 110 volt side of the transformer circuit.

The low voltage circuits supplied by the secondary coils S¹ and S² of the transformer T consist of feed wires 28 and 58 for one side of the line and 32 for the other side thereof. It will be noted that the transformer secondary is center tapped and a wire 30 leads therefrom. This wire extends to a holding switch HS from which a wire 34 extends to one pole of a transfer switch TS¹ and also through wires 38 and 54 to one pole of a combustion switch CS¹. The switch HS is normally open and the switches TS¹ and CS¹ are normally closed as shown. A wire 42 leads from the junction of wire 28 with wire 58 to a room thermostat RT, the other side of which extends through a wire 44 to a relay coil RC. From the

relay coil, a wire 46 extends to one side of a safety switch SS, the other side of which is connected by wires 36 and 48 to the other poles of the transfer switch TS¹ and a second transfer switch TS² respectively. The other pole of the switch TS² is connected by wires 50 and 52 to one pole of a second combustion switch CS², the other pole of which is connected by a wire 56 to the junction between the wires 38 and 54.

The room thermostat RT, of course, is normally open, closing only when the room calls for heat. The safety switch SS, the transfer switch TS¹ and the combustion switch CS¹ are normally closed, while the transfer switch TS² is normally open and the combustion switch CS² is normally open, all as illustrated.

The wire 58 extends to a delayed action actuator DAA in the form of a heater, the other side of which is connected by a wire 60 to the junction between the wires 50 and 52. The wire 32 and a wire 40 from the combustion switch CS¹ are connected to a safety switch actuator SSA, also in the form of a heater. A bimetal blade 62 is affected by the heater SSA to warp upwardly and thereupon open the safety switch SS in about ninety seconds through a mechanical connection indicated at 70 (by a dot-and-dash line and an arrow head). A latch 64 at that time latches the bimetal in the raised position but can be reset manually as will hereinafter appear. The bimetal 66, when it warps upwardly in response to heat from the actuator DAA, closes the switch TS², opens the switch TS¹ and opens the switch IS through a mechanical connection indicated at 72. The switches TS¹ and TS² have overlapping contacts and therefore operate in a sequence as indicated by the legend on the drawing "TS¹ Opens After TS² Closes." In the reverse direction TS¹ closes before TS² opens.

The bimetal element 68, when it warps upwardly due to combustion in the furnace, carries a friction surface 67 with it with which a friction shoe 69 is engaged by a spring 71 to close the switch CS² and opens the switch CS¹ through a mechanical connection to the shoe indicated at 74. The friction connection insures immediate operation of the switches CS¹ and CS² upon either a rise or a drop in temperature. The switches CS¹ and CS² do not have overlapping contacts.

The relay coil RC, when it is energized, effects closure of the holding switch HS and also closure of the main switch MS through a mechanical connection 76. The actuators DAA and SSA, when deenergized, reverse the positions of their respective switches in about two minutes.

Practical operation

Normal starting and running.—When the room thermostat RT calls for heat, it energizes the relay coil RC to close the main switch MS and thereby energize the burner motor M and the ignition Ign, the switch IS being closed at that time. The circuit for RT may be traced from the left end of S¹ through 28, 42, RT, 44, RC, 46, SS, 36, TS¹, 38, 54, CS¹, 40, SSA and 32 to the right-hand end of S². The relay coil RC is thereby energized by the entire secondary of the transformer T with a slight voltage drop occurring through SSA.

As soon as the holding switch HS closes, two circuits are established, one through the secondary coil S¹ and the other through the secondary coil S². The one through the secondary coil S¹ is now the room thermostat circuit through the switch TS¹, but instead of through the wire 38, the circuit is now through the wire 34, the holding switch HS, and the wire 30 to the center tap of the transformer secondary. The circuit of S² is established from this center tap through 30, HS, 34, 38, 54, CS¹, 40, SSA, and 32 to the right-hand end of S².

Accordingly the relay coil RC is energized by S¹ and the safety switch actuator SSA by S², each independent of the other. Combustion establishment acts on the bimetal 68 to close the switch CS² and open the switch CS¹. Closure of the switch CS² is for the purpose of partially

establishing a subsequent combustion failure circuit. Opening of the switch CS¹ breaks the circuit of the safety switch actuator SSA so that the safety switch will not trip out since combustion has been successfully established. The switches CS¹ and CS² are operated usually in sixty seconds; whereas the safety switch actuator SSA will cause the safety switch SS to trip out in about ninety seconds, thus giving leeway to prevent undesirable safety switch actuation.

The delayed action actuator DAA is also operable in about sixty seconds to operate the switches TS¹, TS² and IS. The switches TS¹ and TS² effect transfer of the circuit of the relay coil RC from through the switch CS¹ to through the switch CS², the circuit then being from RC through 46, SS, 48, TS², 50, 52, CS², 56, 38 and 34 to HS. The opening of the switch IS, of course, de-energizes Ign which is no longer needed.

Normal shutdown.—When RT becomes satisfied, it opens the circuit through RC and thereby MS in order to de-energize the motor M. DAA soon cools so as to reclose IS, reclose TS¹ and reopen TS² to condition these switches for the next cycle of operations. CS¹ and CS² soon return to their initial positions due to cooling of the combustion responsive bimetal element 68. All parts are then in position for recycling when the next call for heat occurs at the room thermostat.

Initial combustion failure.—If the burner fails to start properly, the burner shuts down as will now be described. CS¹ fails to open since no heat is being applied to 68 and accordingly the safety switch actuator SSA remains energized through the holding switch HS from the secondary coil S². Accordingly, in about ninety seconds, the safety switch actuator so affects the bimetal element 62 as to trip the safety switch SS off. The relay coil RC is thereby de-energized for opening the main switch MS. Then, of course, the trouble must be remedied and the safety switch manually reset by swinging the latch 64 clockwise on its pivot, thus placing the burner back in operation.

Subsequent combustion failure.—This is combustion failure after combustion has been successfully established and is the result of some fault such as water in the fuel extinguishing the flame. The combustion chamber or stack, as soon as it starts to cool, permits the bimetal element 68 to also cool for reclosing the combustion switch CS¹ and reopening the combustion switch CS². The opening of CS² breaks the circuit of the relay coil RC so that it drops out and thus de-energizes the motor M at the main switch MS. Thereupon a recycle condition is established when DAA cools to reclose IS and TS¹ and open TS², CS¹, of course, being reclosed and CS² reopened due to the cooling of 68. The burner then gets a fresh start and will run normally if the trouble that caused subsequent combustion failure has by then remedied itself. If it hasn't, the safety switch SS will open in about ninety seconds due to energization of SSA so that remedy of the trouble and resetting of SS are then necessary as explained in the previous paragraph.

The arrangement disclosed provides an oil burner control circuit which will not require a balancing of impedances for the starting and running circuits in order to have the advantage of low voltage protection. When running, the control supplies current from S¹ for the relay coil RC, and for the delayed action actuator DAA in parallel to the relay coil. The transfer switches TS¹ and TS² in either position do not throw in or remove any impedances with respect to the relay coil circuit as in one instance the current passes through the switch TS¹ to the holding switch HS and in the other instance through the switches TS² and CS² to the holding switch, all of which are wired directly together. The coils S¹ and S² are of such value as to require the voltage from more than S¹ alone and less than S¹ plus S² to pull the relay in; whereas S¹ alone is sufficient to hold it in and cause it to drop out when the voltage drops about 30%, the

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coil S¹ at the same time furnishing sufficient current for the delayed action actuator DAA.

Some changes may be made in the construction and arrangement of the parts of my oil burner control without departing from the real spirit and purpose of my invention, and it is my intention to cover by my claims any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope.

I claim as my invention:

1. In an oil burner control mechanism to control a burner motor and its ignition means in response to a call for heat by a room thermostat; said burner control mechanism comprising a primary circuit, a transformer connected therewith and having a secondary provided with a center tap, a room thermostat switch, an initial room thermostat circuit connected across said secondary and controlled by said room thermostat switch, a main switch, burner motor and ignition circuits controlled thereby, a relay coil in said initial room thermostat circuit for closing said main switch and operable upon energization by closure of said room thermostat switch to initiate operation of the burner motor and its ignition mechanism, a delayed safety switch actuator and combustion switch contacts in said initial room thermostat circuit, said combustion switch contacts being closed in the absence and opened in the presence of combustion, a safety switch in said initial room thermostat circuit normally closed but opened by said safety switch actuator upon energization thereof for a predetermined period of time, holding contacts closed as a result of energization of said relay coil and connected to said initial room thermostat circuit at a junction between said relay coil and said combustion switch contacts and with said center tap of said transformer to reduce energization of said relay coil, said room thermostat switch and safety switch being located in said initial circuit on the coil side of said junction and said safety switch actuator being located in said initial circuit on the other side of said junction, a normally open combustion switch which is closed in the presence of combustion, a pair of transfer switches for transferring the circuit from said room thermostat switch to said holding switch through said normally open combustion switch whereby opening thereof due to combustion failure will break the relay holding circuit, one of said transfer switches being normally closed and in said initial room thermostat circuit on the coil side of said junction, the other of said transfer switches being normally open and in a circuit with said normally open combustion switch which circuit shunts said normally closed transfer switch, and a circuit including a delayed action actuator for said transfer switches, the circuit of said delayed action actuator being from one side of said secondary and through said normally open combustion switch and said holding switch to said center tap of said secondary and being energized by closure of said normally open combustion switch.

2. In an oil burner control mechanism to control a burner motor and its ignition means in response to a call for heat by a room thermostat; said burner control mechanism comprising a primary circuit, a transformer connected therewith and having a secondary provided with an intermediate tap, a room thermostat switch, an initial room thermostat circuit connected across said secondary and controlled by said room thermostat switch, a main switch, burner motor and ignition circuits controlled thereby, a relay coil in said initial room thermostat circuit for closing said main switch and operable upon energization by closure of said room thermostat switch to initiate operation of the burner motor and its ignition mechanism, a combustion switch in the initial circuit of said room thermostat which is closed in the absence and opened in the presence of combustion, holding contacts closed as a result of energization of said relay coil and connected with said initial room thermostat circuit at

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a junction between relay coil and said combustion switch and with said intermediate tap of said transformer to reduce energization of said relay coil, said room thermostat switch being located in said initial circuit on the coil side of said junction, a normally open combustion switch which is closed in the presence of combustion, a pair of transfer switches for transferring the circuit from said room thermostat switch to said holding contacts through said normally open combustion switch whereby opening thereof due to combustion failure will break the relay holding circuit, one of said transfer switches being normally closed and in said initial room thermostat circuit on the coil side of said junction, the other of said transfer switches being normally open and in a circuit with said normally open combustion switch which circuit shunts said normally closed transfer switch, and a circuit including a delayed action actuator for said transfer switches, the circuit of said delayed action actuator being from one side of said secondary and through said normally open combustion switch and said holding contacts to said center tap of said secondary and being energized by closure of said normally open combustion switch.

3. In a burner control to control a burner motor and ignition mechanism for the burner in response to a call for heat by a room thermostat; said burner control comprising a motor circuit having a main switch therein, a circuit connecting the ignition mechanism in shunting relation to the motor and having a normally closed ignition switch therein, a transformer having a pair of secondary coils connected in series with each other, a room thermostat switch, a relay coil circuit across said coils controlled by said room thermostat switch and including a main relay coil, and normally closed combustion and transfer switches, all in series with said relay coil, said main switch being controlled by said relay coil, a holding switch connected to said main relay coil circuit by having one side connected at a junction between said combustion and transfer switches and its other side connected between said pair of secondary coils to reduce energization of said relay coil, said holding switch being closed by said relay coil, normally open combustion and transfer switches connected in series in a circuit branch shunting said normally closed transfer switch, a delayed action actuator for said transfer switches connected in a circuit branch shunting said room thermostat, relay coil, and said normally open transfer switch and controlled by said normally open combustion switch, said transfer switches having overlapping contacts whereby the second one is closed before the first one is opened and the second one being in circuit with said normally open combustion switch and said holding switch to open the relay coil holding circuit when said normally open combustion switch opens as a result of combustion failure, a safety switch actuator also in said main relay coil circuit on the combustion switch side of said junction, and normally closed contacts opened thereby, said contacts and said room thermostat switch being in said relay coil circuit on the transfer switch side of said junction for shutting down operation of the control upon said normally closed combustion switch remaining closed due to initial combustion failure or reclosing after opening due to subsequent combustion failure.

4. In an oil burner control mechanism to control a burner motor and its ignition means in response to a call for heat by a room thermostat; said burner control mechanism comprising a primary circuit, a transformer connected therewith and having a secondary provided with a center tap, a room thermostat switch, an initial room thermostat circuit connected across said secondary and including in sequence said room thermostat switch, a relay coil for controlling the energization of the motor and ignition circuits, a safety switch, a normally closed transfer switch, a normally closed combustion switch and a safety switch actuator for said safety switch, a holding switch connected with said center tap and with said initial room thermostat circuit between said transfer switch and

said combustion switch to reduce energization of said relay coil by energizing it across part only of said secondary, normally open transfer and combustion switches serially connected in a circuit branch shunting said normally closed transfer switch, and circuit means including a delayed action actuator for said transfer switches in series with said holding switch and said normally open combustion switch and thereby under their control, whereby re-opening of said normally open combustion switch will break the holding circuit of said relay coil, said ignition means including a normally closed ignition switch which is opened by said delayed action actuator.

5. In an oil burner control mechanism to control a burner motor and its ignition means in response to a call for heat by a room thermostat; said burner control mechanism comprising a primary circuit, a transformer connected therewith and having a secondary provided with a center tap, a room thermostat switch, an initial room thermostat circuit connected across said secondary and including in sequence said room thermostat switch, a relay coil for controlling the energization of the motor and ignition circuits, a safety switch, a normally closed transfer switch, a normally closed combustion switch and a safety switch actuator for said safety switch, a holding switch connected with said center tap and with said initial room thermostat circuit between said transfer switch and said combustion switch whereby closure of said holding switch reduces the current in said relay coil by energizing it from only a part of said secondary coil, normally open transfer and combustion switches serially connected in a circuit branch shunting said normally closed transfer switch, and circuit means including a delayed action actuator for said transfer switches energized through said holding switch from said part of said secondary coil by closure of said normally open combustion switch, said normally open combustion switch being thereby operable after closure of said normally open transfer switch to break the holding circuit of said relay coil upon combustion failure.

6. In an oil burner control mechanism to control a burner motor and its ignition means in response to a call for heat by a room thermostat; said burner control mechanism comprising a primary circuit, a transformer connected therewith and having a secondary provided with an intermediate tap, an initial room thermostat circuit connected across said secondary, a room thermostat switch, a safety switch actuator and a relay coil in said initial room thermostat circuit, a main switch operated by said relay coil, burner motor and ignition circuits controlled thereby and operable upon energization by closure of the room thermostat switch to initiate operation of the burner motor and its ignition means, an ignition switch for the ignition means, normally closed combustion responsive contacts and a safety switch in said initial room thermostat circuit, said safety switch being normally closed but opened by said safety switch actuator upon energization thereof for a predetermined period of time, holding contacts closed by energization of said relay and connected to said initial room thermostat circuit by a junction between said relay coil and said normally closed combustion responsive contacts, said room thermostat switch and said safety switch being located in said initial circuit on the coil side of said junction and said safety switch actuator being located in said initial circuit on the other side of said junction, a pair of transfer switches, a delayed action actuator, said ignition switch and said pair of transfer switches being operated by said delayed action actuator, one of said transfer switches being normally closed and in said initial room thermostat circuit

on the coil side of said junction and the other of said transfer switches being normally open, normally open combustion responsive contacts, circuit means whereby upon combustion establishment said relay coil is connected in circuit with said holding contacts through said normally open transfer switch and said normally open combustion responsive contacts after said delayed action actuator closes said normally open transfer switch and thereafter opens said normally closed transfer switch, said circuit means including a holding circuit established by said holding contacts when they are closed by said relay from one end of said transformer secondary through said normally open combustion responsive contacts to said intermediate tap of said transformer whereby said relay coil then operates on reduced current and whereby opening of said normally open combustion responsive contacts due to combustion failure will break said holding circuit.

7. In an oil burner control mechanism to control a burner motor and its ignition means in response to a call for heat by a room thermostat; said burner control mechanism comprising a primary circuit, a transformer connected therewith and having a secondary provided with an intermediate tap, an initial room thermostat circuit connected across said secondary, a room thermostat switch, a safety switch actuator and a relay coil in said initial room thermostat circuit, a main switch operated by said relay coil, burner motor and ignition circuits controlled thereby and operable upon energization by closure of the room thermostat switch to initiate operation of the burner motor and its ignition means, an ignition switch for the ignition means, normally closed combustion responsive contacts and a safety switch in said initial room thermostat circuit, said safety switch being normally closed but opened by said safety switch actuator upon energization thereof for a predetermined period of time, holding contacts closed by energization of said relay and connected to said initial room thermostat circuit at a junction between said relay coil and said normally closed combustion responsive contacts, said room thermostat switch and said safety switch being located in said initial circuit on the coil side of said junction and said safety switch actuator being located in said initial circuit on the other side of said junction, a transfer switching mechanism, a delayed action actuator, said ignition switch and said transfer switching mechanism being operated by said delayed action actuator, said transfer switching mechanism including normally closed contacts in said initial room thermostat circuit on the coil side of said junction, normally open combustion responsive contacts, circuit means whereby upon combustion establishment said relay coil is connected in circuit with said holding contacts through said normally open combustion responsive contacts, said circuit means including a holding circuit established by said holding contacts when they are closed by said relay from one end of said transformer secondary through said normally open combustion responsive contacts to said intermediate tap of said transformer whereby said relay coil then operates on reduced current.

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