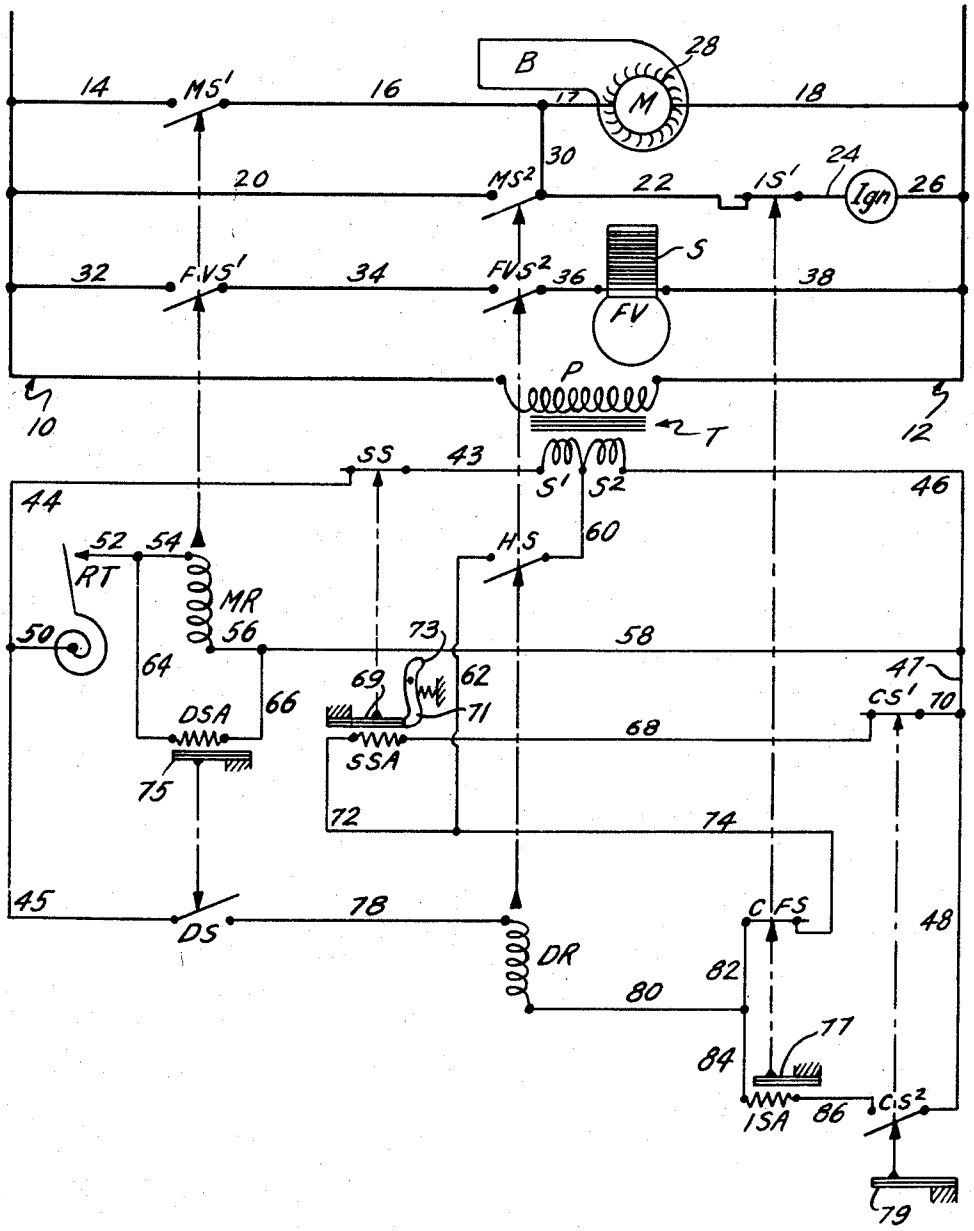
Dec. 14, 1954 P. SCHELL 2,696,874

OIL BURNER SAFETY CONTROL

Filed Feb. 10, 1951



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United States Patent Office 2,696,874 Patented Dec. 14, 1954

2,696,874

OIL BURNER SAFETY CONTROL

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Application February 10, 1951, Serial No. 210,329

9 Claims. (Cl. 158—28)

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 an initial purging period, a post purging period and protection for combustion failure subsequent to successful establishment thereof resulting in one or more recycles, and then if failure persists, results in shut-down.

One object of the invention is to provide an arrangement of relays and switch actuators for controlling the fuel valve, 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.

Another object is to provide a combination of main and delay relays for closing the blower motor circuit when the room thermostat first calls for heat to provide an initial purging period during which the ignition is on and close the circuit to the fuel valve which may be of the solenoid type by the energization of the delay relay so that combustion air and ignition are already supplied before the oil or other fuel is supplied to the burner.

Still another object is to provide the main relay and the delay relay so interconnected electrically that upon shut-down as a result of combustion failure subsequent to successful establishment of combustion, a post purge period occurs in which the motor continues to operate after the fuel valve is closed.

A further object is to provide the circuit with a safety switch for effecting the normal shut-down following initial combustion failure and also shut-down after attempts to recycle following subsequent combustion failure, the safety switch requiring manual resetting so that the trouble that caused shut-down must be remedied before such manual resetting operation can be performed.

Still a further object is to provide a combustion switch arrangement connected with the main and delay relays so as to cooperate with them in providing the recycling after subsequent combustion failure with final shut-down after recycling and initial shut-down after initial combustion failure.

An additional object is to provide an arrangement of two relays in a control circuit wherein one relay pulls in first and starts the burner operation and the second relay pulls in later and drops out last during the stopping operation, the desired sequence of operations being effected by a pair of motor switches connected in parallel and a pair of fuel valve switches connected in series with one switch of each pair actuated by the first relay and the other switch of each pair actuated by the second relay.

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 electrodiagrammatic view of an oil burner embodying my present invention.

On the accompanying drawings 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 **28**.

A fuel valve FV is provided for controlling the flow of fuel to the burner nozzle in a well known manner, this valve being of the solenoid type and its solenoid being

indicated at S. 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 S^1 and S^2 of low voltage, for instance 12 volts each, the primary being for the usual house current of 110 or 220 volts Supply wires **10** and **12** for the primary P are shown and these also supply current for the motor M, the ignition *Ign* and the solenoid S as follows; from wire **10** a wire **14** leads to a motor switch MS^1 and wires **16** and **17** lead from the motor switch to the motor M, another wire **18** connecting the motor to the line wire **12**. A second motor switch MS^2 is in parallel with the motor switch MS^1 through wires **20** and **30**.

The ignition switch *Ign* is in parallel with the motor M through wires **30**, **22**, **24** and **26**, an ignition switch IS^1 being in circuit therewith so that the current from **10** to **22** may come through either or both motor switches MS^1 and MS^2 through IS^1. Wires **32**, **34**, **36** and **38** connect the solenoid S across the line **10—12** with fuel valve switches FVS^1 and FVS^2 in series with each other and in circuit with the fuel valve solenoid S. This completes the 110 volt side of the transformer circuit.

The low voltage circuits supplied by the secondary coils S^1 and S^2 of the transformer consist of feed wires **43**, **44** and **45** for one side of the line and **46**, **47** and **48** for the other side. Interposed between the wires **43** and **44** is a safety switch SS which switch is normally closed and is adapted to be opened by a safety switch actuator SSA which may comprise an electrical heater. The heat of the heater affects a bimetal element **69** for warping it upwardly to open the switch SS after about 90 seconds of energization of SSA. A dog **71** drops under the bimetal element to retain the safety switch SS in the open position, and manual reset is required as by thumb pressure applied to the end **73** of the dog **71**.

A room thermostat RT is provided for controlling a main relay MR and a delay switch actuator DSA. The circuit for MR may be traced from S^1 through **43**, SS, **44**, **50**, RT, **52**, **54**, MR, **56**, **58** and **46** to S^2. At the same time some of the current shunts the coil of MR, passing from **52** through **64**, DSA and **66** to **58**. The delay switch actuator DSA is a heater coil for a bimetal **75** which is adapted to close a snap acting delay switch DS after a few seconds of energization of the heater DSA.

The delay switch DS controls a circuit for a delay relay DR from **45** through **78** to **80**. The main relay MR when energized closes the motor switch MS^1 and the fuel valve switch FVS^1 as indicated by dot-and-dash lines and arrowheads. The actuation of SS by SSA and DS by DSA are similarly indicated. Energization of the delay relay DR closes a holding switch HS, the fuel valve switch FVS^2 and the motor switch MS^2 as also indicated with dot-and-dash lines and arrowheads.

I also provide an ignition switch actuator ISA which is a heater acting on a bimetal element **77** adapted to open a combustion failure switch CFS and the ignition switch IS^1 as indicated by dot-and-dash lines and arrowheads. The opening of these switches occurs about 60 seconds after ISA is energized and whenever it is deenergized the switches CFS and IS^1 reclose in about two minutes. The switch CFS is initially in circuit with DR and SSA and with a combustion switch CS^1 from the wire **80** through **82**, CFS, **74**, **72**, SSA, **68**, CS^1, **70** and **47** back to **46**.

When the holding switch HS closes, the circuit for the coil of the delay relay DR is maintained from the coil S^1 of the transformer by the current from **74** flowing through **62**, HS, and **60** to the center tap of the transformer secondary. Subsequently the combustion switch CS^1 opens and another combustion switch CS^2 closes under the action of a bimetal element **79** which is responsive to combustion. The switches CS^1 and CS^2 are preferably not of the snap-acting type. When combustion has been established, the movement of **79** upwardly opens the switch CS^1 and closes the switch CS^2. Closure of CS^2 establishes a circuit from **80** through **84**, ISA, **86**, CS^2, and **48** to **47** to maintain the delay relay DR energized after CFS opens as will hereinafter appear.

PRACTICAL OPERATION

Normal starting

When the room thermostat RT calls for heat, it energizes the main relay MR and the delay switch actuator DSA. Energization of MR closes MS^1 to energize the burner motor M and the ignition Ign as IS^1 is normally closed, and closes FVS^1 to ready the circuit of the fuel valve FV for subsequent energization of the solenoid S when the delay relay DR closes.

In a few seconds DSA causes the bimetal element **75** to snap the delay switch DS closed so that DR is energized through CFS, SSA, and CS^1. This closes the motor switch MS^2 for subsequent post purge purposes, and closes FVS^2 to energize the fuel valve so that fuel is supplied after an initial purge period effected by energization of the motor M and ignition Ign between the time that MR is energized and the time that DS closes. Energization of DR also closes the holding switch HS for holding DR energized even though CS^1 opens subsequently due to combustion establishment.

Combustion establishment also closes CS^2 to energize ISA and thereby open the ignition IS^1 about 60 seconds after combustion has heated the bimetal **79**. This is usually sufficiently long to insure that combustion will be maintained. The burner is now in normal running condition and the combustion failure switch CFS is opened by ISA so that the relay DR will be subsequently de-energized to open the motor switch MS^2 and the fuel valve switch FVS^2 upon combustion failure opening the switch CS^2 as will be later described.

Normal shut-down

When RT becomes satisfied, it opens the circuit through MR and DSA. De-energization of MR opens the motor switch MS^1. The circuit, however, through the motor is still maintained through the second motor switch MS^2 so that the burner motor continues to operate to provide a post purge period after normal shut-down of the burner to purge the furnace of any fumes or explosive gases that might be contained therein after the fuel valve closes because of FVS^1 being opened. The motor is then turned off in about 30 seconds when DS or CS^2 opens, that is, which ever opens first.

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, upon cooling, permits the bimetal element **79** to also cool for reclosing the combustion switch CS^1 and reopening the combustion switch CS^2. The opening of CS^2 breaks the circuit for the coil DR as the only circuit at the time is through ISA and CS^2. This immediately stops the flow of oil because of FVS^2 opening but the motor M is kept energized for a post-purge period because even though switch MS^2 opens, switch MS^1 remains closed. Even a reclosure of the combustion switch CS^1 causes nothing further to happen until the ignition switch actuator ISA has cooled sufficiently to reclose the ignition switch IS^1 thus providing ignition through MS^1 still closed at **30**.

Cooling of ISA takes about two minutes and will cause re-establishment of the ignition circuit through IS^1 and re-establishment of the delay relay circuit through CFS, SSA and CS^1. Energization of DR then recloses the fuel valve FVS^2 to give the burner a chance to try to start again. If the fault causing the recycling can correct itself as is often the case, normal combustion will again be established.

After one or more recycling attempts, however, if combustion is not re-established, a shut-down will occur because when CFS recloses, the safety switch actuator SSA is re-energized and if CFS does not open because of CS^2 closing to energize ISA, the safety switch actuator SSA will open the safety switch SS thus de-energizing both relays MR and DR. Then, of course, the trouble must be remedied and the safety switch manually reset at **73** for placing the burner back in operation.

Initial combustion failure

If the burner fails to start properly there should follow shut-down without recycling. This is accomplished by CS failing to open so that SSA heats sufficiently (in about 90 seconds) to trip the safety switch SS off as in shut down after subsequent combustion failure.

The arrangement disclosed using two relays, one of them delayed in relation to the other, each relay operating a motor switch, the motor switches being in parallel, and each relay operating a fuel valve switch, the valve switches being in series, provides the desired features of initial and post-purging, recycling after subsequent combustion failure and delayed ignition tripping in addition to eventual shut-down after subsequent combustion failure if the fault that caused the failure does not become remedied.

The disclosure also provides the motor M started and operated a short period of time before the oil valve is opened to secure initial purge. Post purge is provided by M required to operate a short period of time following opening of RT at which time the oil is turned off. Delayed ignition tripping is provided by ISA requiring some time to trip ignition after the combustion thermostat indicates that combustion has been established, and is therefore dependent on same. The recycling operation gives the burner a successive chance to start after flame failure following normal burner operation.

The ignition switch actuator ISA has a resistance high enough to hold the relay DR in once its circuit has been established, yet prevent it from being pulled in when there is a momentary opening of the delay switch DS. Normally this would not occur but if the room thermostat is tampered with, it may be left open long enough to de-energize the delay switch actuator DSA a sufficient length of time that the bimetal **75** opens the switch DS. Then if the room thermostat is closed so as to result in DS closing again before CS^2 opens and CS^1 closes, the current from S^1 through **43**, SS, **44**, **45**, DS, **78**, DR, **80**, **84**, ISA, **86**, CS^2, **48**, **47** and **46** to S^2 will not be sufficient to pull DR in. This is particularly necessary to prevent danger from absence of ignition because of IS^1 being open when DS closes after the momentary interruption therethrough referred to.

Some changes may be made in the construction and arrangements 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, its ignition means and fuel supply 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 and adapted to be controlled by the room thermostat, a motor switch, burner motor and ignition circuits controlled thereby, a relay coil operable upon energization by closure of the room thermostat to close said motor switch and thereby initiate operation of the burner motor and its ignition means, a delay switch actuator included in said room thermostat circuit, a delay switch actuated thereby, a delay relay having an actuating coil in circuit with said delay switch and having a switch operable to control the fuel supply means, combustion switch contacts and a safety switch actuator in the delay relay coil circuit, said combustion switch contacts being closed in the absence and open in the presence of combustion, a safety switch included in said 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 delay relay coil and connected between said delay relay coil and said intermediate tap, a normally open combustion switch which is closed in the presence of combustion, said last switch being in circuit with said delay relay coil across said secondary, an ignition switch actuator also in said last named circuit, and an ignition switch for said ignition means opened by energization of said ignition switch actuator, said last combustion switch shunting said combustion switch contacts and said safety switch.

2. In an oil burner control mechanism to control a burner motor, its ignition means and fuel supply 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 and including a room thermostat, a motor switch, burner motor and ignition circuits controlled thereby, a relay coil operable upon energization by closure of the room thermostat to close said motor switch and thereby initiate operation of the burner motor and its ignition means, an ignition switch for the ignition means, a delay switch actuator included in said room thermostat circuit, a delay switch actuated thereby, a delay relay having an actuating coil in circuit with said delay switch and having a switch operable to control the fuel supply means, a delayed safety switch actuator and a combustion failure switch and combustion switch contacts in the delay relay circuit, said combustion switch contacts being closed in the absence and open in the presence of combustion, a safety switch connected in said room thermostat circuit and normally closed, said safety switch being operatively associated with and opened by said safety switch actuator upon energization thereof for a predetermined period of time, holding contacts closed by energization of said delay relay coil and connected between said combustion failure switch and said intermediate tap, an ignition actuator of delayed type operatively associated with said ignition switch and said combustion failure switch, a normally open combustion switch which is closed in the presence of combustion, said last switch and said ignition switch actuator being in circuit with said delay relay coil across said secondary and in shunt relation to said safety switch actuator, combustion failure switch and combustion switch contacts.

3. In a burner control to control a burner motor, fuel supply means including a fuel valve 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 pair of switches therein connected in parallel with each other, a circuit adapted to connect the ignition mechanism in shunting relation to the motor and having a normally closed ignition switch therein, a fuel valve circuit having a pair of switches therein connected in series with each other, a transformer having a pair of secondary coils connected in series with each other, a main relay coil, a circuit across said secondary coils adapted to be controlled by the room thermostat and including said main relay coil, a delay switch actuator, a circuit connecting said actuator in shunting relation to said main relay coil, a delay switch actuated by said delay switch actuator, a delay relay coil, a circuit therefor through said delay switch, a normally closed combustion switch and a normally closed combustion failure switch in circuit with said delay relay coil, each of said fuel valve switches being controlled by one of said relay coils, each of said motor switches also being controlled by one of said relay coils, a holding switch for said delay relay coil connected between said secondary coils and said delay relay coil through said combustion failure switch, a normally open combustion switch and an ignition switch actuator also in circuit with said delay relay coil, said ignition switch actuator being operable to open said ignition switch and said combustion failure switch a time period after closure of said normally open combustion switch, said normally open combustion switch and said ignition switch actuator being in shunt relation to said normally closed combustion switch and said combustion failure switch.

4. In a burner control to control a burner motor, its ignition mechanism and a fuel valve in response to a room thermostat; said control comprising a transformer, an initial room thermostat circuit adapted to be controlled by a room thermostat, a main relay having a coil, a delay switch, a delay switch actuator, a delay relay having a coil in circuit with and adapted to be energized upon closing of said delay switch, a burner motor circuit having a pair of parallel connected motor switches therein, a fuel valve circuit having a pair of series connected fuel valve switches therein, an ignition circuit for the ignition mechanism having an ignition switch therein, said ignition circuit being connected in shunt with the motor and thereby controlled by said motor switches, said main and delay relay coils being each operable to close one of said motor switches and one of said fuel valve switches upon energization of said relay coils, combustion responsive delayed acting means for opening said ignition switch, a switch operated by said delayed action means and in circuit with said delay relay coil, said combustion responsive delayed acting means upon responding to combustion failure deenergizing said delay relay coil to permit opening of the motor switch and the fuel valve switch controlled thereby to stop the flow of fuel but permit the motor to operate because of the other motor switch being closed, said ignition switch upon reclosing due to the deenergization of said delayed acting means reestablishing ignition, and the circuit of said delay relay coil being reestablished by said combustion responsive delayed acting means to recycle the burner if the fault that caused flame failure is by then remedied.

5. A burner control for controlling a burner having a motor for operating said burner, a fuel valve for the fuel to said burner and ignition mechanism for the burner in response to a room thermostat; said control comprising an operating circuit for the burner including a pair of motor switches in parallel with each other, an operating circuit for the fuel valve including a pair of fuel valve switches in series with each other and an operating circuit for the ignition mechanism including an ignition switch, controlling circuits for the foregoing elements comprising a main relay coil and a delay relay coil, a room thermostat circuit adapted to be controlled by the room thermostat for energizing said main relay coil and said delay relay coil, delay means interposed between said circuit and said delay relay coil to energize said delay relay coil a time period after energization of said main relay coil, each of said relay coils being operatively associated with one of said motor switches and one of said fuel valve switches to close the same upon energization of the relay coils, a normally closed combustion failure switch and a normally closed combustion switch in series circuit with said delay relay coil, an ignition switch actuator and a normally open combustion switch also in series circuit with said delay relay coil and shunting said combustion failure switch and said normally closed combustion switch, said ignition switch actuator being operatively associated with said combustion failure switch and with said ignition switch to open them upon predetermined energization of said ignition switch actuator under control of said normally open combustion switch, and a holding switch connected through said delay relay coil and said combustion failure switch and closed by energization of said delay relay coil.

6. A burner control to control a burner having a motor for operating the burner, a fuel valve for the fuel to the burner and ignition mechanism for the burner under control of a room thermostat; said control comprising an operating circuit for the burner including a pair of motor switches in parallel with each other, an operating circuit for the fuel valve including a pair of fuel valve switches in series with each other and an operating circuit for the ignition mechanism including an ignition switch, controlling circuits for the foregoing elements having a safety switch, a main relay coil and a delay switch actuator therein, said circuits being adapted to be energized by the room thermostat, a delay relay coil, a delay switch therefor closed by said delay switch actuator to energize said delay relay coil a time period after energization of said main relay coil, each of said relay coils being operatively associated with one of said motor switches and one of said fuel valve switches to close the same upon energization of the relay coils, a normally closed combustion failure switch, a safety switch actuator for said safety switch, a normally closed combustion switch in series circuit with said delay relay coil, an ignition switch actuator and a normally open combustion switch also in series circuit with said delay relay coil and shunting said combustion failure switch and said normally closed combustion switch, said ignition switch actuator being operatively associated with said combustion failure switch and with said ignition switch to open them upon predetermined energization of said ignition switch actuator under control of said normally open combustion switch, and a holding switch connected through said delay relay coil and said combustion failure switch and closed by energization of said delay relay coil.

7. In a control for controlling a burner having a blower motor, a fuel valve and ignition means under control of a room thermostat; said control comprising a pair of motor switches connected in parallel with each other for controlling the motor and the ignition means, a normally closed ignition switch connected in series with said motor switches for additionally controlling the ignition means,

a fuel valve circuit, a pair of fuel valve switches in series therein for controlling the fuel valve, a main relay coil and a delay relay coil each operable to close one of said motor switches and one of said fuel valve switches, a room thermostat circuit having said main relay coil therein, a delay relay coil circuit having said delay relay coil therein, delayed acting means energized with said main relay, a switch operatively associated with said delay acting means and connected to energize said delay relay coil a time period after energization of said main relay coil, a pair of combustion switches, one normally closed and the other normally open, a combustion failure switch and a safety switch actuator connected in series circuit with said delay relay coil and said one combustion switch, an ignition switch actuator connected in series circuit with said delay relay coil and said other combustion switch and in shunting relation to said combustion failure switch actuator and said one combustion switch, said ignition switch actuator being operatively associated with and arranged to open said ignition switch after a delayed period of time and also to open said combustion failure switch at substantially the same time, and a safety switch connected to open said room thermostat circuit and thereby shut down the operation of the burner, said safety switch being actuated by said safety switch actuator and operable to locked-out position requiring manual resetting.

8. In a control for controlling a burner having a blower motor, a fuel valve and ignition means under control of a room thermostat; said control comprising a pair of motor switches connected in parallel with each other, a circuit for the ignition means in series with said switches, a normally closed ignition switch connected in series in said last circuit, a fuel valve circuit, a pair of fuel valve switches in series therein for controlling the fuel valve, a main relay coil and a delay relay coil each operable to close one of said motor switches and one of said fuel valve switches, a room thermostat circuit having said main relay coil therein, a delay relay coil circuit having said delay relay coil therein, delayed acting means energized with said main relay, a switch operatively associated with said delay acting means and connected to energize said delay relay coil a time period after energization of said main relay coil, a pair of combustion switches, one normally closed and the other normally open, a combustion failure switch and a safety switch actuator connected in series circuit with said delay relay coil and said one combustion switch, an ignition switch actuator connected in series circuit with said delay relay coil and said other combustion switch and in shunting relation to said combustion failure switch actuator and said one combustion switch, said ignition switch actuator being operatively associated with and arranged to open said ignition switch and said combustion failure switch after a delayed period of time following closure of said second combustion switch, and a safety switch in said room thermostat circuit connected to open said room thermostat circuit and thereby shut down the operation of the burner under actuation by said safety switch actuator and operable to locked-out position requiring manual resetting.

9. In a control to control a burner having a blower motor, a fuel valve and ignition means under control of a room thermostat; said control comprising circuits adapted to control said motor, fuel valve and ignition means, a pair of motor switches connected in said motor circuit and in parallel with each other, said ignition circuit being in series with said motor switches and adapted to be connected in shunt relation to the blower motor, a pair of fuel valve switches in series in said fuel valve circuit for controlling said fuel valve, a main relay coil and a delay relay coil each operable to close one of said motor switches and one of said fuel valve switches, a room thermostat circuit for said main relay coil, delayed acting means interposed between the room thermostat circuit and said delay relay coil to energize the latter a time period after energization of said main relay coil, a pair of combustion switches, one normally closed and the other normally open, a combustion failure switch connected in series circuit with said delay relay coil and said one combustion switch, and a combustion failure switch actuator connected in series circuit with said delay relay coil and said other combustion switch, said actuator being operable to open said combustion failure switch following closure of said other combustion switch.

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