Nov. 19, 1935. A. F. ERICKSON 2,021,407

FUEL CONTROL SYSTEM

Filed Nov. 30, 1931 2 Sheets-Sheet 1

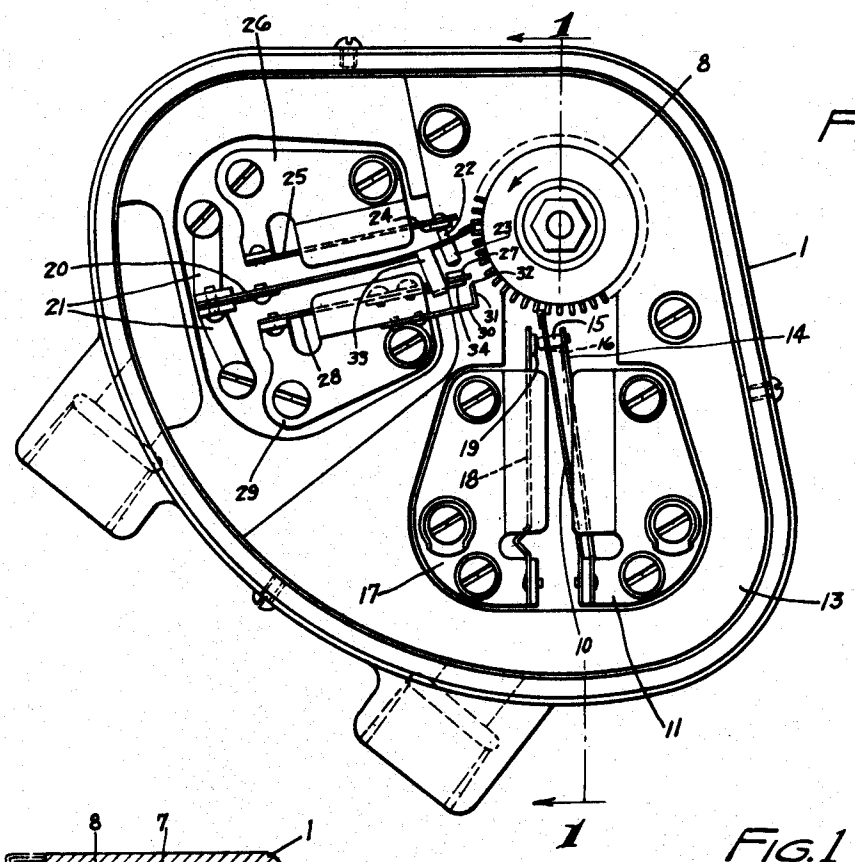


FIG. 2

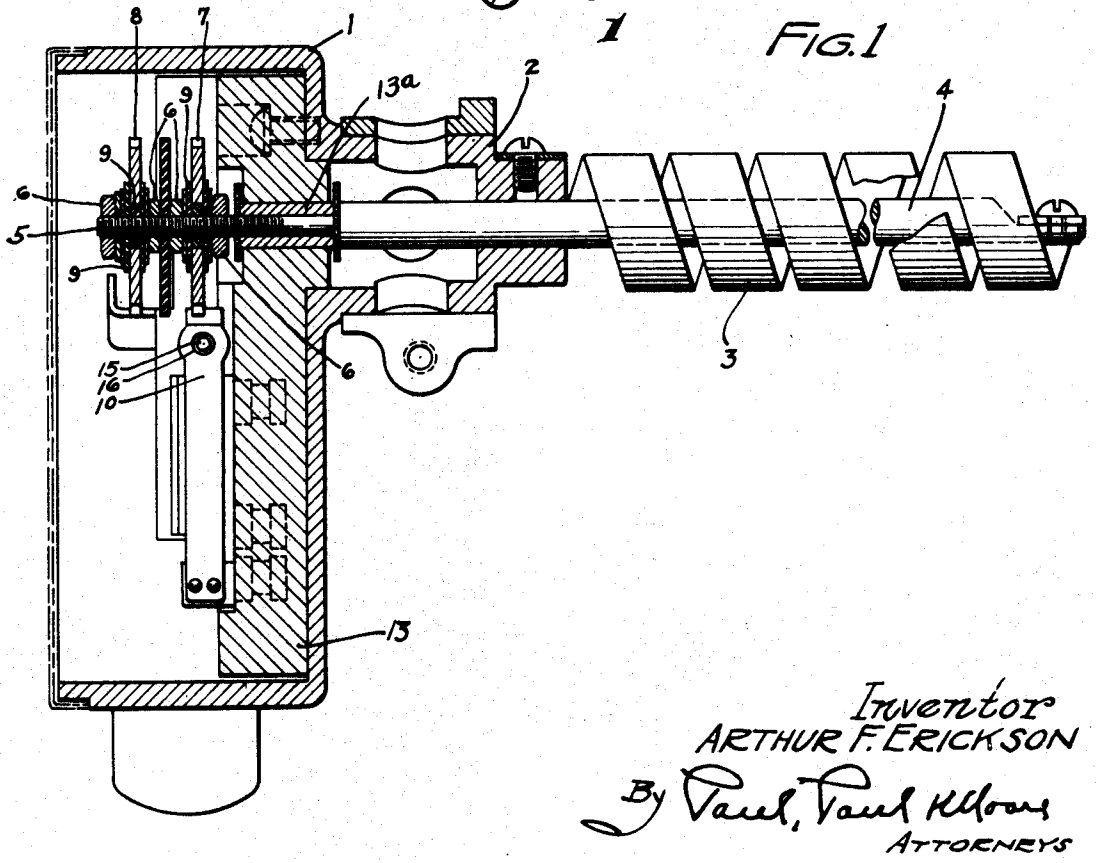


FIG. 1

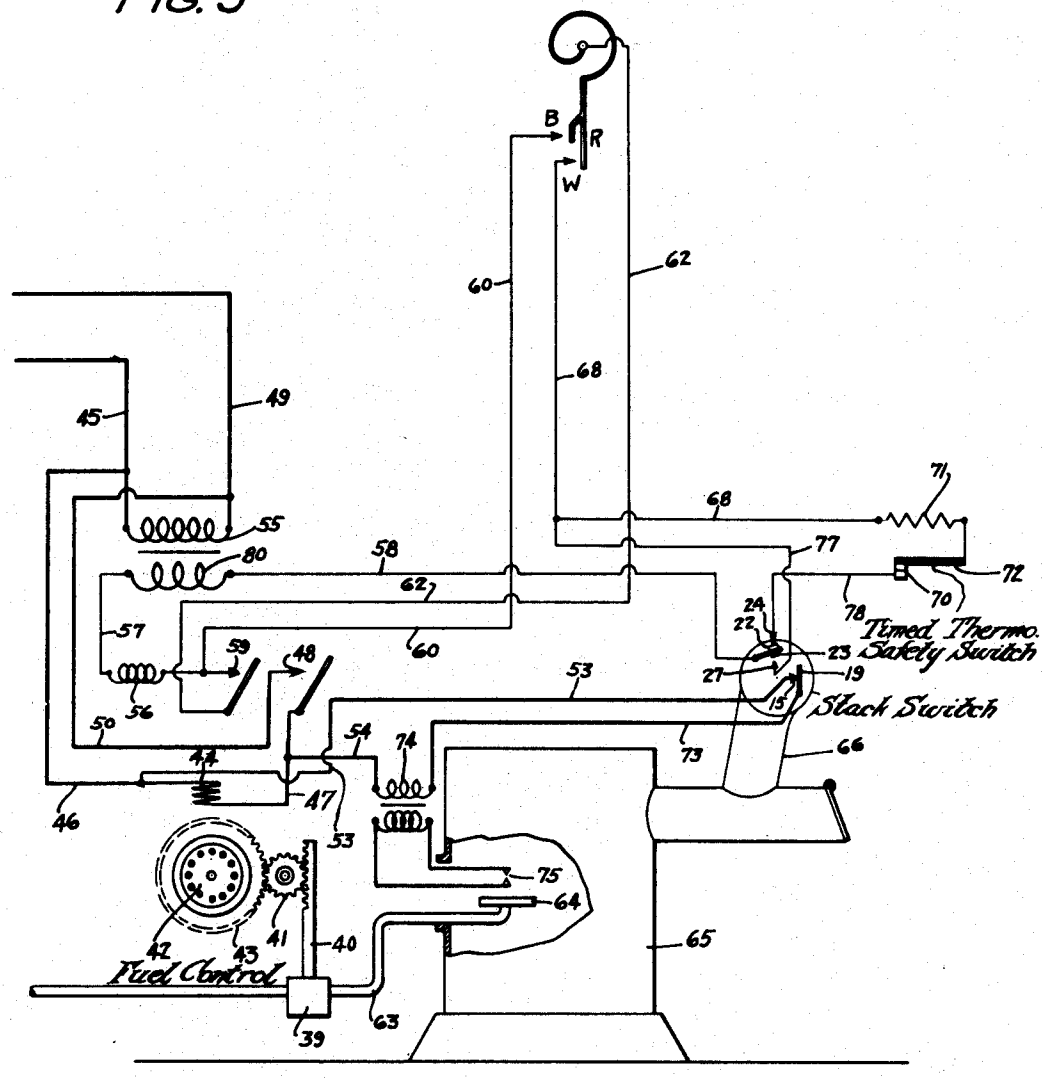
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FIG. 3



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2,021,407

FUEL CONTROL SYSTEM

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Application November 30, 1931, Serial No. 578,053

8 Claims. (Cl. 158—28)

This invention relates to improvements in systems for automatically controlling heat regulation.

Objects of the invention are: to provide an efficient system in which the starting circuit for the relay must pass through a contact of the stack switch which is normally closed when the stack is cold, and in which this circuit also passes through a safety switch and its heating coil; to provide a circuit which shunts out the safety switch heater after flame is produced and which is also operated by stack temperature; to provide a stack temperature controlled switch in the ignition circuit which is normally closed when the stack is cold, and to control the stack switches by a common thermal element; and to so control the shunt and starting switches that the starting switch will not be closed for a predetermined time after combustion failure, to the end that a start may not be had until explosive gases in the fire pot are disseminated.

Features of the invention include the use of a stack thermostat for controlling initial starting of the system, shunting of the safety switch after combustion is produced, and obtaining energization and de-energization of the igniter respectively before and after ignition; the overlapping control of starting and heater-shunt switches on temperature rise to assure maintenance of relay energization by establishment of a shunt holding circuit therefor, before the starting switch is opened as a result of rising temperature; and non-overlapping control of these switches on fall in temperature to obtain a stand-by period to delay a re-start after cessation of combustion; the use of a stack temperature controlled switch in the ignition circuit; the relay control of the ignition and motor circuits; the control of the stack switches by means of a common thermally controlled element; and the detailed arrangement of the circuits.

Objects, features and advantages of the invention will be set forth in the description of the drawings forming a part of this application and in said drawings

Figure 1 is a vertical longitudinal section through the thermostatically controlled stack switch structure on line 1—1 of Figure 2;

Figure 2 is a face view with the cover removed showing the switches; and

Figure 3 is a diagrammatic view of the system in its cold-stack, warm-room condition.

The present embodiment of the invention includes, in addition to the control circuits: a room thermostat, a fuel controller, an igniter, a safety switch including a heater, a relay, and a plurality of thermostatically controlled switches, controlled by a common thermostatic element responsive to presence or absence of combustion, in this instance (though not always) indicated by stack temperature, the device being placed on the stack.

The thermostatically controlled device is illustrated in detail in Figures 1 and 2. This device is disclosed and claimed in my copending application Serial Number 578,054. The device comprises a suitable housing 1 having a tubular extension 2 to which one end of a helically coiled bimetallic element 3 is secured. The opposite end of this element is secured to a rod 4 which passes through the coil and is rotatably journaled in the extension 2, and which passes through the extension, through an insulating block 13 within the housing, and through a bushing 13a held by this insulating block. The end of this rod terminates within the housing and is threaded as at 5. Arranged on this rod are toothed wheels respectively designated 7—8 and these wheels are secured by nuts 6 for rotation with the rod. Washers and disks 9 properly insulate the ratchet wheels from the rod.

Mounted also within the casing and secured by one end to an extension of plate 11, is a control arm 10 which has a free end engageable with the toothed wheel 7. The plate 11 is mounted on the insulating block 13, and has a suitable binding post. Also upon this plate is secured a contact arm 14 which carries contact pin 15 at its free end, which contact passes freely through an aperture 16 of the control arm 10. A plate 17 is also attached to the insulating block 13 and has a suitable binding post and has attached thereto spring arm 18 which is provided with contact disk 19 cooperative with contact 15. Pin 15 and disk 19 are viewed herein as constituting a switch, otherwise designated the third or ignition switch, or contact. The manner of controlling element 10 by the toothed wheel 7 is substantially identical with the disclosure of Patent No. 1,768,892, issued to Benjamin Cyr, July 1, 1930, and in itself forms no part of the present invention. The switch 15—19 is normally closed, that is when the ribbon 3 is substantially cold.

Attached to the block 13 are a pair of bars 21 to which is attached, by one end, a resilient control arm 20. This arm carries two contact pins one at each opposite side respectively indicated by numerals 22—23. The contact 22 cooperates with the contact disk 24 carried by spring arm 25 attached at its opposite end to

plate 26 also mounted on insulating block 13. Contact 23 cooperates with contact disk 27 carried by resilient arm 28, the opposite end of which is secured to plate 29 also mounted on the block 13. Upon an outward extension of plate 29 is attached a spring arm 30 which has at its free end, an angularly related portion 31, the end of which is bevelled as at 32. The portion 31 is adapted to be frictionally engaged by the outer end of the arm 28 when this arm is forced against the extension 31 by means of the control arm 20. A frictional lock is thus provided which secures the spring arm 28 in the position mentioned, while the arm 20 moves away. In order that the arm 28 may be released to again assume the position shown in the drawings, the control arm 20 is provided with a hook 33 which engages an insulating plate 34 secured to the arm 28, this release taking place only after contacts 23 and 27 have been separated.

Pin 22 and disk 24 are viewed as constituting a first or starting switch or contact. Pin 23 and disk 27 constitute a second or heater shunt switch or contact. The character of the control means necessary for use with the type of switches herein used, differs radically from means used for the control of mercury tube switches. A feature of the invention is the control of the movable contact type of switch (as distinguished from the mercury tube switch) overlappingly on temperature rise and non-overlappingly on temperature fall, in the manner described.

It is one of the objects of this invention to so control the switches that the first and second are overlappingly controlled on rise in combustion temperature to open the first and close the second, and so that these switches are non-overlappingly controlled in reverse order on a fall in temperature, the second switch being opened before the first is closed.

Another feature of this invention is the control of all three switches by a common thermostatically controlled element. This is true because the toothed wheels 7 and 8 are fixed to a common thermally controlled element 4.

A specific feature of the invention is the latch arrangement by which the arm 28 is held latched while the control arm 20 travels away to open the second switch 23—27 before the first switch 22—24 closes. The operation of these switches is again referred to under the heading "Operation".

Referring to Figure 3: The primary of the transformer is indicated at 55 and the secondary at 80. The relay coil is indicated at 56. The fuel valve assembly may be a self-contained structure including any of the usual mechanisms. As herein shown, the valve 39 is operated by a rack bar 40 meshing with pinion 41, in turn driven from the motor rotor through suitable reduction gearing diagrammatically indicated at 43. The rotor 42 is provided with a field coil 44 one end of which is connected by conductor 46 with the power line 45 and the other end of which is connected by conductor 47 through a movable switch element with contact 48 of the relay. The burner is indicated at 64 and is suitably arranged in furnace 65. The burner is connected with a suitable supply pipe 63 which is controlled by the valve. The smoke pipe or stack is indicated at 66 and it is on this stack that the casing having the three switches is mounted.

The ignition device includes a step-up transformer the primary of which is indicated at 74. One end of the primary is connected to line 47 and the opposite end is connected to one side of switch 15—19. The secondary is connected to suitable electrodes 75 arranged adjacent the burner 64. The safety switch comprises the usual bimetallic elements 72 here indicated as a contact maker engageable with contact 70. The usual heater coil is indicated at 71. The safety switch is latched in open position in the usual manner, after having been moved to that position as a result of sufficiently prolonged heating of the coil 71. The latching mechanism is not shown. For the sake of brevity, the various circuit connections are not described at this time, but are referred to by numeral under the heading "Operation".

Operation

Referring to Figure 3: The position of the parts corresponds to cold stack and warm room condition. Upon sufficient fall in room temperature, the room thermostat closes at R, B, W, and the relay 56 is energized through the following circuit: 80, 57, relay coil 56, 60, B, W, 68, heater coil 71, safety switch contacts 72—70, 76, starting switch 24—22, 58, to 80. It will be noted that this starting circuit is through stack switch 22—24, and the safety switch, and its heater.

On closure of the relay, contact 59 establishes the usual holding circuit as follows: 80, 57, 56, holding contact 59, 62, R, W, 68, 71, 72, 70, 76, 24—22, 58, to 80. On closure of the relay, the field coil 44 of the fuel controller or motor is energized to open the fuel valve. The circuit for the field coil is as follows: line 45, 46, coil 44, 47, 48, 50 to line 49. The ignition circuit is as follows: 45, 46, 53, stack contact 15—19, 73, 74, 54, 47, 48, 50, line 49. The valve, when opened, stalls the motor, and is thus held open.

If combustion is successful, the stack thermostat is heated and 23 closes with 27, after which 22 breaks with 24. Making at 27 establishes a shunt circuit around the safety switch heater 71 as follows: 80, 57, relay coil 56, 59, 62, R, W, 68, 77, shunt switch 23—27, 58 to 80. When successfu combustion occurs, the contacts 15—19 open to de-energize the igniter, while the motor remains energized.

In further explanation of the action of the stack controlled switches: Referring to Figure 2, the rotation of the toothed wheels as the temperature rises is in anti-clockwise direction, as indicated by the arrow. The parts are shown in the cold position. On temperature rise, the disks 7 and 8 move the arms 10 and 20, the first to the right and the second downwardly, and after a sufficient movement, 10 engages 14 and moves 15 away from 19, and 23 engages 27, and finally moves arm 28 to latched position. Continued motion of the disks in the same direction merely results in idling action while an open circuit relation is maintained the idling action is due to the relations of the tip of the arm 20 to the teeth of the disk 8, which are such that the disk can continue to rotate while the control arm 20 remains in the same circuit control position. The same action occurs between arm 10 and toothed disk 9. See the Cyr patent previously referred to. Switch 22—24 remains closed until switch 23—27 closes, and thereafter the latching of arm 28 is accomplished. After latching, idling takes place without opening switch 23—27. Arm 25 is biased to follow control arm 20 for a short distance, as arm 20 moves from its position in Figure 2.

Upon temperature fall, the rod and disks with it rotate in clockwise direction, resulting in sub-

stantially immediately moving arm 28, opening switch 23—27. As arm movement continues, hook 33 engages arm 28 and moves it from frictional engagement with the extension 31. This control of the contacts overlappingly on temperature rise and non-overlappingly on temperature fall is an important feature of the invention.

During the first part of temperature rise, switch 22—24 remains closed until switch 23—27 closes after which 22, 24 opens and then the arm 28 is moved to frictionally locked position. On temperature fall, 23—27 is immediately opened and at some predetermined time thereafter, the starting switch 22—24 is closed, and thereafter the hook restores 28 to its initial unlatched position.

The sequence of operation of the various contacts is as follows: On temperature rise in the stack, contacts 23—27 (for maintaining fuel supply) are first to close after which contacts 22—24 (starting contacts) open. On further continued rise in the stack temperature, contacts 15—19 (ignition contacts) open. When the stack temperature falls, contacts 23—27 are first to open. On continued fall in stack temperature, contacts 15—19 (ignition contacts) close, and on further fall in stack temperature, contacts 22—24 close. By having the contacts 23—27 close first on temperature rise, and by having contacts 22—24 open before the ignition contacts 15—19 open, there is given a slightly longer ignition period which tends to insure the establishment of proper ignition. On cooling of the stack, it is quite necessary that the hot contacts or contacts 23—27 open before the ignition contacts close. This is evident if flame failure is assumed. Under such conditions, fuel will continue to be supplied to the combustion chamber until the hot contacts or contacts 23—27 open. If ignition is returned by closure of contacts 15—19 before the supply gas is discontinued (by opening contacts 23—27) an explosion would result. It is one of the objects of this invention to delay starting for a predetermined time after combustion failure to prevent explosion. On the other hand, when contacts 23—27 open first, the supply of the gas is discontinued, and the relay is de-energized (fuel supply stopped) and thus a subsequent closure of the ignition contacts 15—19 has no result insofar as combustion is concerned, until the relay or fuel controlling device is again energized by reclosure of contacts 22—24, which reclosure is delayed. Contacts 15—19 should close before the contacts 22—24 so that the ignition will be ready to operate as soon as the relay is reenergized.

An important feature of this invention is the control of a system of the nature described by the use of only a single relay, operating in conjunction with the switches, all of which are controlled by a common thermostatic element. Another feature is the control of these switches by stack temperature.

I claim as my invention:

1. A device of the class described including a fuel controller, an igniter, a timed safety switch and an actuator therefor, and combustion responsive means and circuits operable thereby, on a call for heat to close fuel controller and igniter and actuator starting circuits, and after combustion to close a fuel controller holding circuit which is in shunt circuit around the actuator before the fuel controller starting circuit is broken, and after combustion failure to open the shunt circuit and close the starting circuit for the controller only after a timed period.

2. A device of the class described including a fuel controller, an igniter, a timed safety switch and an actuator therefor, and common combustion responsive means and circuits controlled thereby on a call for heat to close fuel controller and igniter and actuator starting circuits, and after combustion to close a fuel controller holding circuit which is in shunt circuit around the actuator before the fuel controller starting circuit is broken, and after combustion failure to open the shunt circuit and close the starting circuit for the controller only after a timed period.

3. A device of the class described, comprising a room thermostat, a fuel controller, an igniter, first, second and third switches which are controlled in response to combustion conditions, a timed safety switch including an actuator, a relay and circuits by which it controls the fuel controller and igniter, the igniter circuit including therein the third combustion responsive switch, a circuit for initially energizing the relay which includes therein the thermostat, the first combustion responsive switch, and the safety switch and actuator, a holding circuit in shunt around the safety switch actuator which includes therein said relay, room thermostat and second combustion responsive switch, means by which the switches are controlled, the first and second switches overlappingly to close the second and open the first on temperature rise, and non-overlappingly controlled to open the second and after a time period close the first on fall in temperature.

4. In combination, an electrically operated fuel controller, an electro-magnetic coil, a normally open switch movable to closed position by said electro-magnetic coil when energized, an energizing circuit for the fuel controller including said switch, an actuator responsive to the presence or absence of combustion, switching mechanism controlled thereby, a main switch, a first circuit including the main switch and combustion responsive switching mechanism for initially energizing the electro-magnetic coil when combustion is absent, and a second circuit including the main switch and combustion responsive switching mechanism, which circuit is closed prior to opening of the first circuit when combustion is established, for maintaining energization of the electro-magnetic coil, said switching mechanism operating first to open the second circuit and subsequently to close the first circuit upon cessation of combustion, whereby, in the event of flame failure during operation of the system, the feeding of fuel is interrupted for a period of time after which the supply of fuel is resumed.

5. In combination, an electrically operated fuel controller, an electro-magnetic coil, a timed safety switch and an electrical actuator therefor, a main switch, a first circuit, a second circuit, a device responsive to the presence or absence of combustion, switching mechanism controlled thereby for closing the second circuit prior to opening of the first circuit on the establishment of combustion and for delaying closing of the first circuit for a time period after opening of the second circuit upon the cessation of combustion, said first circuit including the main switch, the safety switch and its actuator, and the electro-magnetic coil, said second circuit including the main switch and the electro-magnetic coil, a normally open switch adapted to be closed by said electro-magnetic coil when energized, and a fuel

controller circuit including said last named switch.

6. In combination, an electrically operated fuel controller, a relay coil, a thermal safety switch and an electrical heating element therefor, a main switch, a first circuit, a second circuit, a device responsive to the presence or absence of combustion, switching mechanism controlled thereby for closing the second circuit prior to opening of the first circuit on the establishment of combustion and for delaying closing of the first circuit for a time period after opening of the second circuit on the cessation of combustion, said first circuit including the main switch, the safety switch and its electrical heating element, and the relay coil in series, said second circuit including the main switch and relay coil in series and operating to shunt the electrical heating element during that period in which both circuits are closed, a normally open switch adapted to be moved to closed position by the relay coil when energized, and a fuel controller circuit including said switch.

7. In combination, a fuel controller, a timed safety switch and electrical actuator therefor, first and second combustion responsive switches, a main switch, a circuit including the main switch, safety switch and its actuator and the first combustion responsive switch, a shunt circuit for said actuator and first combustion responsive switch controlled by the second combustion responsive switch, means controlled by said circuits for causing the fuel controller to supply fuel to a combustion chamber when said circuits are energized in their normal sequence, and means by which said first and second combustion controlled switches are overlappingly controlled to close the second and then open the first upon the establishment of combustion, and non-overlappingly controlled to open the second and after a time period to close the first upon cessation of combustion, whereby the safety switch actuator is operatively de-energized upon closure of the second combustion responsive switch, and whereby the circuit thereto is opened upon the opening of the first combustion responsive switch.

8. In combination a fuel controller, a timed thermal safety switch and electrical heating element therefor, first and second combustion responsive switches, a room thermostat, a circuit including the thermostat, safety switch and its electrical heating element and the first combustion responsive switch, a shunt circuit for said electrical heating element and first combustion responsive switch controlled by the second combustion responsive switch, means controlled by said circuits for causing the fuel controller to supply fuel to a combustion chamber when said circuits are energized in their normal sequence, and means by which the first and second combustion controlled switch are overlappingly controlled to close the second and then open the first upon establishment of combustion, and non-overlappingly controlled to open the second and after a timed period to close the first upon cessation of combustion, whereby the electrical heating element is operatively de-energized upon closure of the second combustion responsive switch and whereby the circuit thereto is opened upon opening of the first combustion responsive switch.

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