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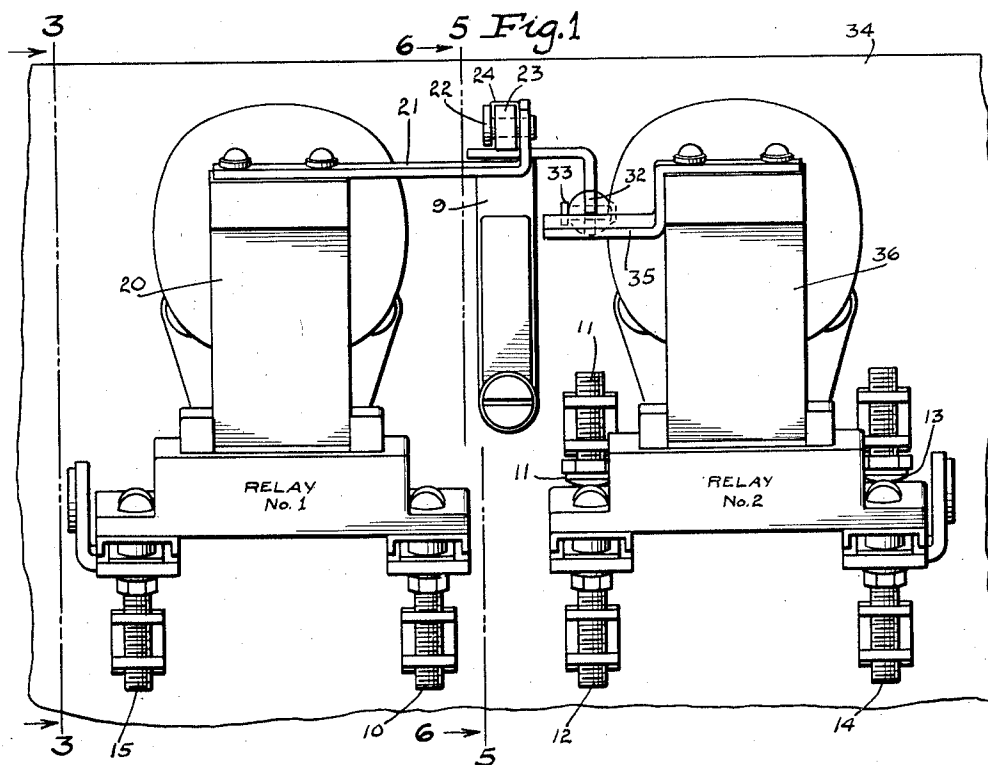
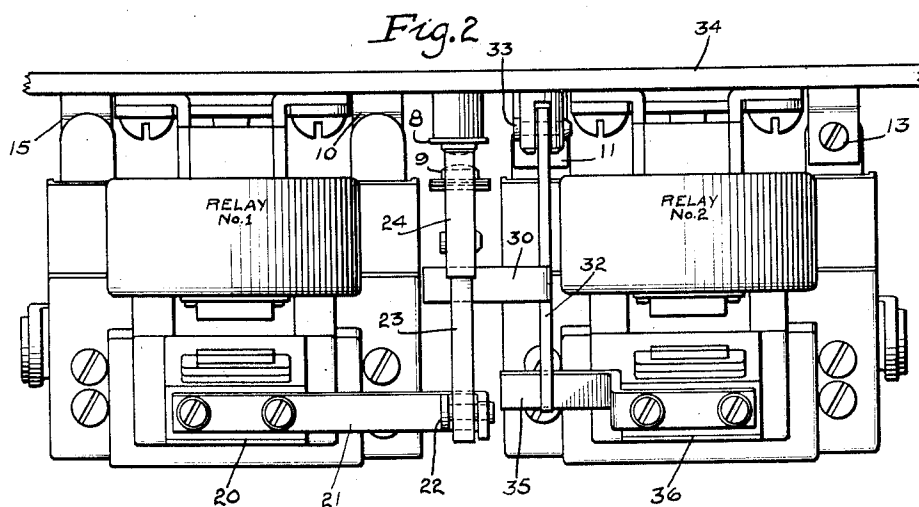
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2,064,231

BURNER CONTROL SYSTEM

Filed March 5, 1932

3 Sheets-Sheet 1



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Dec. 15, 1936.

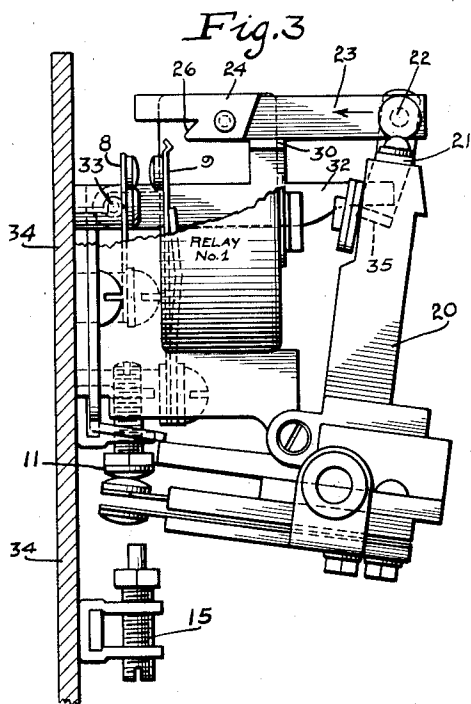
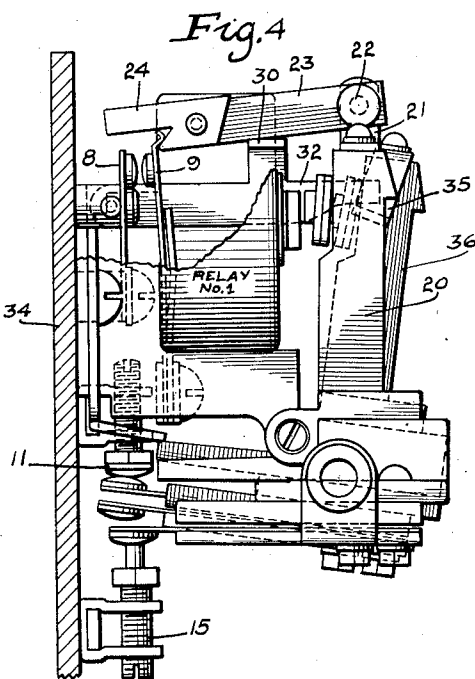
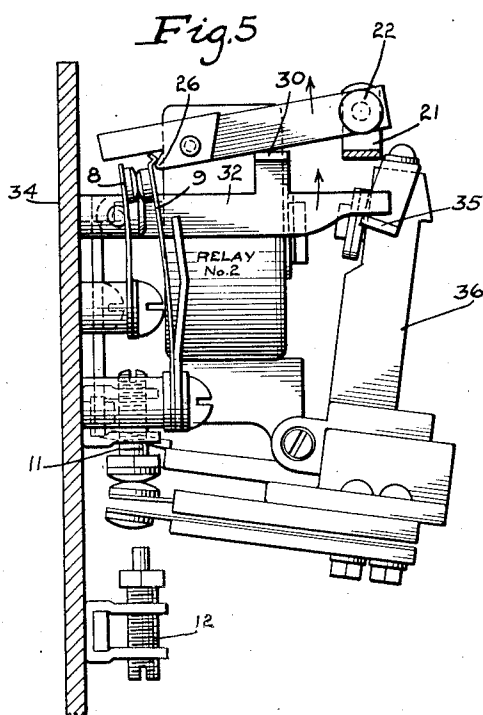
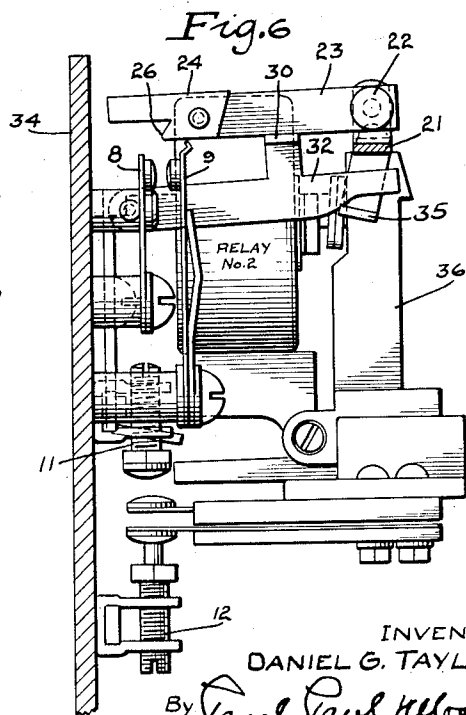
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BURNER CONTROL SYSTEM

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3 Sheets-Sheet 2



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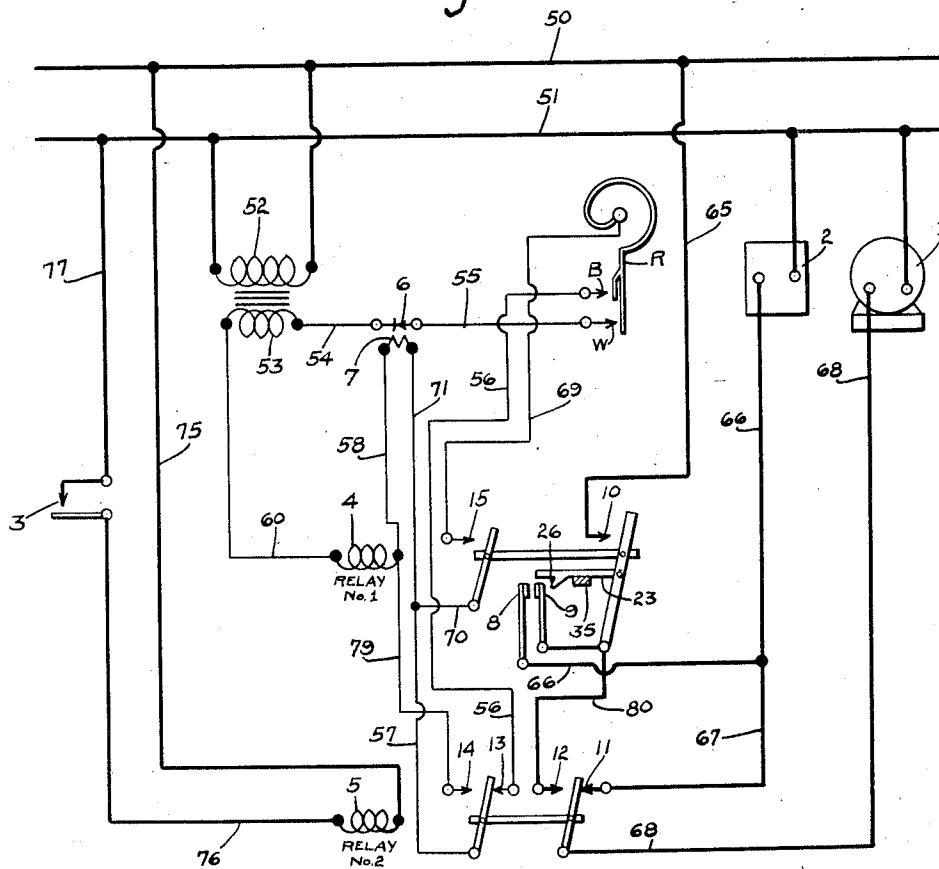
2,064,231

BURNER CONTROL SYSTEM

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3 Sheets-Sheet 3

Fig. 7



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BURNER CONTROL SYSTEM

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Application March 5, 1932, Serial No. 597,084

18 Claims. (Cl. 158—28)

This invention relates generally to systems for controlling heat production. Objects of the invention are: To substantially immediately stop fuel feed following power or flame failure; to prevent immediate resumption of fuel feed and/or ignition on re-energization of the control system following resumption of power, after power failure of a duration inadequate to lower the stack temperature sufficiently to open the contacts of the flame responsive device; to mechanically control an igniter circuit and/or motor circuit switch by means of two relays, first and second, in a manner to cause the switch to be closed when one of the relays assumes one control position and open the switch when the other relay moves to one of its control positions, while the first relay is acting to hold the switch closed; to control igniter energization through a circuit having a contact controlled by the first relay and a switch mechanically controlled by both relays; to control fuel feeder energization also through the same contact of the first relay through the switch mechanically controlled by both relays and through a contact controlled by the second relay; and to maintain fuel feeder energization, after ignition, through the same contact of said first relay and a different contact of the second relay, the circuit in this instance being independent of the mechanically controlled contact.

One of the objects of this invention (to substantially immediately stop fuel feed following flame failure) has been heretofore briefly mentioned and will now be considered in more detail.

For the purpose of this explanation, automatically controlled fuel burning systems may be divided into two classes: First, those systems which, upon occurrence of a flame failure, re-establish ignition in an attempt to re-ignite the fuel; second, those systems which, upon occurrence of a flame failure, prevent the return of ignition and eventually shut down the system by means of some type of safety device. The present invention relates to the second class.

In prior art systems of this general class, upon a flame failure, return of ignition has been prevented and the usual thermal safety switch has been re-energized with the result that the systems continued to operate for a time period equal to the usual trial ignition period, after which the systems were rendered inoperative until manual intervention. In these systems, the burner motors continued to feed unconsumed fuel to the combustion chambers until the systems were completely shut down by op-

eration of the safety device. This resulted in the depositing of a large amount of unburned fuel in the combustion chamber.

By means of the present invention, the burner motor is stopped much more quickly on a failure of flame. Broadly stated, the burner motor is shut down in a shorter time, after a flame failure, than it would be upon an initial failure to establish combustion. Specifically, the motor is shut down at the same time that the timed safety mechanism is set into operation upon the occurrence of a flame failure, with the result that unconsumed fuel is not fed to the combustion pot during the time that is required by the safety mechanism to shut down the system. It will be readily appreciated that this diminishing of the amount of unconsumed fuel that is delivered to the combustion chamber after a flame failure combined with the shutting down of the system until manual intervention, is a distinct improvement in that type of control system which prevents the return of ignition and does not recycle upon a failure in flame.

Features include the detailed arrangement of the circuits, along with the broader ideas of means inherent in the disclosure.

Another feature of the invention relates to the control of a switch by two relays, in a manner to close the switch when one relay moves to one control position, and to open the switch when the other moves to one of its control positions, and to the specific construction of the device for accomplishing these purposes.

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 face view of a relay panel with both relays in open position, and with the ignition switch also open;

Figure 2 is a top plan view of Figure 1 with the parts in the same position;

Figure 3 is a vertical section on line 3—3 of Figure 1 with the parts positioned as in Figure 1;

Figure 4 is a view similar to Figure 3 showing the armature of the first relay moving to closed position, and with the switch partly closed;

Figure 5 is a vertical section on line 5—5 of Figure 1 showing the switch elements and control means therefor positioned as when the first relay is fully closed, and illustrating the relations of the tripping elements before the second relay closes;

Figure 6 is a view on line 6-6 of Figure 1 showing the position of the parts after tripping as the result of closure of the second relay, while the first is closed; and

5 Figure 7 is a diagram illustrating the control system.

The principal elements of this embodiment of the invention are: a switch 3 operable in response to combustion conditions; a fuel controller 1, such as the usual burner motor; an igniter 2 of any preferred type; a room thermostat having elements R-B-W; a safety timer switch including a switch 6 controlled by the usual thermal element, not shown, this element being controlled by the usual heater 7; a first relay indicated No. 1; a second relay indicated No. 2; and a switch 8-9 and means by which it is mechanically controlled by both relays. There is also provided contacts or switches 10, 11, 12, 13, 14 and 15. The circuit connections are referred to numerically more in detail, under the heading "Operation." The main lines are indicated at 50, 51 across which a transformer is arranged, the primary of which is indicated at 52, the secondary at 53.

As before stated, the relays No. 1 and No. 2 have mechanical means which cooperate to control switch 8-9, which is in the ignition circuit and which, in this instance, is also in the motor circuit, energization of these circuits being controlled by relay No. 1 which must be closed before the igniter or motor can be initially energized.

The construction of this mechanical switch control device is a feature of the invention.

The switch 8-9 is controlled by the following described device: The armature 20 of relay No. 1, see Figure 1, has a laterally extending arm 21 to which is pivoted as at 22, an arm 23 of insulating material having a metal tip 24, which is provided on the lower side of its forward portion with a shoulder or detent 26 which is adapted (as relay No. 1 closes) to engage the spring arm 9, and press it into engagement with the spring arm 8 to close the ignition circuit and also the motor circuit.

The arm 23 normally rests upon a lateral projection 30 (see Figures 1 and 3) of an arm 32 pivoted as at 33 to the panel board 34. The forward end of this arm 32 is so disposed and shaped as to cooperate with lateral extension 35 of the armature 36 of relay No. 2, in such manner that when relay No. 2 closes the arm 32 is raised to correspondingly raise the detent arm 23 from its position in Figure 5. Normally, this raising takes place after relay No. 1 has closed the switch. Such raising results in a release of the arm 9 and a final positioning of the parts as shown in Figure 6, in which figure both relays are closed. This release results from the upward movement of the arm 32 and the corresponding upward movement of the arm 23, withdrawing the detent 26 from engagement with the arm 9.

The arrangement is such that in case of power failure, contact 13 opens, on resumption of power, so that the first relay receives an impulse of power far too short in duration to close the relay. This latter condition arises where there is a momentary power failure with the resumption of power before the stack temperature is lowered sufficiently to open switch 3. This is a very important feature of this invention. Adjustment of the relays and/or the contacts controlled thereby is such that starting contact 13 (see Figure 7) is opened to prevent

closure of holding contact 15, and, therefore, although both relays are energized, the first relay is not effective to operate the fuel controller, and the detent is not effective to close the switch 8-9. After this opening (in case the room thermostat is closed), and after the stack switch 3 has opened the device will recycle in the usual manner, and if flame is not produced at the end of a predetermined timed period, the safety switch 6 will open, rendering the entire control inoperative until after inspection and repair, and manual reclosing of the switch 6.

Operation

Figure 7 of the drawings represents the normal position of the parts before a call for heat. At this time, the switch 8-9 is open. On closure of the room thermostat at R-W-B, relay No. 1 is energized through the following circuit: One side of transformer secondary 53, 54, safety switch 6, 55, W, R, B of the room thermostat, 56, closed contact 13 of open relay No. 2, 57, 71, heater 7 of the safety switch 6, 53, coil 4 of relay No. 1, 60 to the opposite side of 53. The holding circuit for relay No. 1 is as follows: 53, 54, 6, 55, W-R, 69, 15, 70, 71, 7, 58, 4, 60 to 53. Closure of relay No. 1 results in closure of switch 8-9. However, on closure of relay No. 1, master contact 10 closes, and the igniter and fuel feeder are simultaneously activated to obtain combustion. The igniter is energized through the following circuit: from the hot line 50, 65, contact 10, switch 8-9, 66, igniter 2, to ground line 51. The motor is energized through the following circuit: hot line 50, 65, 10, 8-9, 66, 67, closed contact 11 of open relay No. 2, 68, motor 1, to ground line 51. Ignition, fuel feeder (or motor) relay No. 1 and safety switch heater are substantially simultaneously energized on closure of the room thermostat, and if ignition is not successful at the end of the predetermined period for which the timer is set, safety switch 6 opens, breaking the circuit of relay No. 1, and the switch 6 is locked in open position in the usual manner, so that further automatic operation of the system is prevented. If flame is not produced, and on opening of relay No. 1, ignition switch 8-9 and master switch 10 are opened.

In case flame is successful within the period for which the safety timer switch is set, relay No. 2 is energized through the following circuit: hot line, 50, 75, coil 5 of relay No. 2, 76, contact 3 of the flame responsive device, 77 to ground line 51. Energization of relay No. 2 opens starting contact 13, and results in the establishment of a holding circuit for relay No. 1 which shunts out the heater 7. The circuit is completed by closure of contact 14, and is as follows: 53, 54, 6, 55, W, R, 69, 15, 70, 57, 14; 79, 4, 60 to 53.

Also on closure of relay No. 2, the starting contact 13 for relay No. 1 is opened, and the motor contact 12 is closed. This contact 12 and master contact 10 then cooperate to maintain a closed motor circuit which is as follows: 50, 65, 10, 80, 12, 68, 1, 51. On closure of relay No. 2, its trip arm 35 moves arm 23, to withdraw the detent 26 and release the arm 9, thus opening the switch 8-9, to de-energize ignition means 2.

An important feature of this invention is that the motor or oil feed is substantially immediately shut down on power failure, with no return of ignition. Suppose that while the burner is operating, that is while the room thermostat and both relays are closed, there is a momentary

power failure, or a power failure of such duration that power is resumed before switch 3 opens. Under these conditions, both relays simultaneously open. On resumption of power, however, only relay No. 2 closes, for the reason that the relay contacts are so related that contact 13 is opened, before relay No. 1 can be sufficiently energized to close its holding contact 15, and, therefore, neither the igniter nor fuel feeder are activated. Presently, due to continued cooling of the stack, the switch 3 opens, de-energizing relay No. 2, and contact 13 is closed. Then (assuming that the room thermostat is closed) relay No. 1 is immediately closed, switches 10, 8-9 and 11 are closed, heater 7 is energized and a trial ignition operation is initiated in the usual manner. A feature is that on momentary power failure, the igniter and fuel controller cannot be activated, until the combustion switch 3 opens.

Although the switch 3 has been referred to as a "stack" switch, it is understood that an equivalent control device may be used, and may be placed at any desired position to properly respond to combustion conditions for the purposes mentioned. For example, it may operate directly in response to flame, in order to obtain a very prompt shut-down of a gun type burner. In other words, any proper form of combustion safety device may be used, and may be positioned where most effective.

The motor is controlled by two parallel circuits, one of which passes through master contact 10 controlled by relay No. 1, as well as through switch 8-9 which is mechanically controlled by both relays, and through contact 11 of open relay No. 2. In other words, this first circuit passes through the mechanically controlled switch 8-9, as well as each of two contacts respectively controlled by the first and second relays. The other motor circuit is independent of the mechanically controlled switch, and passes through the master contact 10 of the first relay which is common to both motor circuits, as well as to the igniter circuit, through the mechanically controlled contact.

One salient feature of this device is that fuel feed is promptly stopped on combustion failure, and that this prompt stopping is dependent on the opening of a stack or equivalent combustion responsive device, which opens promptly after combustion failure. No time switch other than the thermal safety switch is used.

Assume flame failure to occur when the system is operating normally with both relays and the motor energized, and the heater 7 and ignition means 2 de-energized. The resultant lowering of the temperature of combustion causes combustion responsive contact 3 to quickly open. This opening of combustion responsive contact 3 de-energizes coil 5 of relay No. 2. De-energization of relay No. 2 opens contacts 12 and 14 and closes contacts 11 and 13. Opening of contact 14 and closing of contact 13 re-energizes the heater 7 for safety switch 6. Opening of contact 12 de-energizes motor 1. Closing of contact 11 does not maintain energization of motor 1 or re-energize motor 1 and ignition means 2 since switch 8-9 is open, and cannot be re-closed until relay No. 1 is de-energized and subsequently re-energized while relay No. 2 is de-energized as will be apparent from the previous description of the manner in which switch 8-9 is controlled by the conjoint action of relays No. 1 and No. 2. At the end of the predetermined time for which the safety switch is set to operate, switch 6 will

open and render the entire system inoperative until switch 6 is manually reset, preferably accompanied by an inspection and repair of the system if such repair is necessary.

From the foregoing description of the operation of the system of this invention, it will be apparent, that upon the occurrence of a flame failure, the motor is stopped in a shorter time than it would be upon an initial failure to establish combustion and specifically the motor is stopped immediately upon the opening of the combustion contact 3.

A device is, therefore, herein provided wherein the prompt shut-down of fuel feed on flame failure occurs, and wherein the control does not return the ignition following flame failure.

I claim as my invention:

1. In a combustion apparatus, a fuel controller, an igniter, a contact, first and second electrically controllable means and means operable thereby for controlling said contact to close it when the first means is energized, and to open it when the second is energized, and electrical circuits by which, on energization of the first means said fuel controller and igniter are energized through said contact, and by which motor energization is maintained independently of said contact on energization of said second means, and means including a combustion responsive device operative to energize the first electrically controllable means upon a call for heat during the absence of combustion and operative to energize the second electrically controllable means upon the establishment of combustion.

2. A fuel controller and igniter, a room thermostat, first electrically controllable means, second electrically controllable means and means by which it is energized when flame is produced, a contact mechanically controlled by said first mentioned means to be closed when the first is energized and to be opened when the second is energized, igniter and motor circuits controlled by said contact to be energized when the first means is energized, and if the second means is de-energized, an independent motor circuit adapted to be closed when the second means is energized while the first is energized, and an energizing circuit for said first means including therein a starting contact which is closed when the second means is de-energized, and a holding circuit for said first means which is closed on energization of said first means.

3. A fuel controller and igniter, a room thermostat, a first electrically operable means, a second electrically operable means and means by which it is energized when combustion is produced, a contact mechanically controlled by said first mentioned means to be closed when the first is energized and to be opened when the second is energized, igniter and motor circuits controlled by said contact to be energized when the first means is energized, but only if the second means is de-energized, an independent motor circuit which is energized when the second means is energized while the first means is energized, and an energizing circuit for said first means including therein a starting contact which is closed when the second means is de-energized, a holding circuit for said first means which is closed on energization of said first means, the energizing and holding circuits for said first means including therein a safety timer switch and heater therefor, the holding circuit for said first means passing through a second contact which is controlled by said second means to shunt the heater

when said second means is energized in response to combustion.

4. In a combustion apparatus, a fuel controller, an igniter, a contact, first and second electrically controllable means and means operable thereby for controlling said contact to close it when the first means is energized and to open it when the second is energized, and electrical circuits by which on energization of the first means said fuel controller and igniter are energized through said contact and by which motor energization is maintained independently of said contact on energization of the second means, combustion responsive means including a switch, a circuit for the second electrically controllable means controlled by said combustion responsive switch, safety means for timing a trial ignition period including a thermoelectric timer switch arranged to prevent operation of the system when opened and an associated electric heater operative to open the timer switch if energized for a timed period, switching means controlled by said second electrically controllable means and movable to first and second positions upon deenergization and energization of the second electrically controllable means, circuit connections controlled by said switching means when in said first position permitting energization of said first electrically controllable means and heater, and means including circuit connections controlled by said switching means when moved to said second position as a result of the establishment of combustion operative to maintain energization of said first electrically operable means and to operatively deenergize said heater.

5. In a combustion apparatus a fuel controller, an igniter, a contact, first and second electrically controllable means, and means operable thereby for controlling said contact to close it when the first means is energized and to open it when the second is energized, a starting circuit for the fuel controller including therein: a contact controlled by said first means, said first mentioned contact and a first contact controlled by said second means and which is closed when the second means is de-energized; a running circuit for the fuel controller including therein said contact of the first means and a second contact of the second means which is closed only when the second means is energized; a flame responsive switch controlling said second means; control circuits for said electrically controllable means including a starting circuit for the first means which includes a third contact controlled by the second means, which contact is closed when the second means is de-energized; a holding circuit for the first means which is closed on energization of said first means, means for timing an ignition period including a timer switch and heater which are in the starting and holding circuits of the first means, said second means controlling a fourth contact which is closed when said second means is energized in response to combustion to shunt out the heater.

6. In a combustion apparatus, a fuel controller, an igniter, a contact, first and second electrically controllable means and means operable thereby for controlling said contact to close it when the first means is energized and to open it when the second is energized, a starting circuit for the fuel controller including therein: a contact controlled by said first means, said first mentioned contact and a first contact controlled by said second means and which is closed when the second means is de-energized; a run-

ning circuit for the fuel controller including therein said contact of the first means and a second contact of the second means which is closed only when the second means is energized; a flame responsive switch controlling said second means; control circuits for said electrically controllable means including a starting circuit for the first means which includes a third contact controlled by the second means, which contact is closed when the second means is de-energized; a holding circuit for the first means which is closed on energization of said first means, means for timing an ignition period including a timer switch and heater which are in the starting and holding circuits of the first means, said second means controlling a fourth contact which shunts out the heater when said second means is energized in response to combustion, said electrically controllable means being so adjusted that on power failure, and resumption of power before said flame responsive switch opens in response to combustion failure, said third contact of the second means which is in the starting circuit of the first means is opened to prevent re-energization of said first means.

7. In a combustion apparatus, a fuel controller, an igniter, a contact, first and second electrically controllable means and means operable thereby for controlling said contact to close it when the first means is energized and to open it when the second is energized, means for successively energizing said first and second controllable means including a combustion responsive switch controlling said second means, and circuits controlled by said electrically operable means to obtain activation of the igniter and of the fuel controller through said contact on energization of the first means to produce combustion and to de-activate said igniter and to continue fuel controller activation on energization of the second means in response to the establishment of combustion, and to quickly de-activate said fuel controller and stop fuel feed on power failure after successful combustion, the duration of which failure is not sufficient to open said combustion responsive switch as a result of interrupted combustion.

8. A device of the class described including an igniter, a fuel controller, first and second relays, means effective to energize the second relay when flame is produced, a switch which is mechanically controlled by both relays, to be closed whenever the first relay is energized, and to be opened when the second relay is energized, means by which on energization of the first relay the fuel controller and igniter are activated through said mechanically controlled switch, means effective only when the second relay is deenergized to permit energization of the first relay and fuel controller, and means effective only when the second relay is energized to maintain motor energization independently of said mechanically controlled switch.

9. A device of the class described including an igniter, a fuel controller, first and second relays, means effective to energize the second relay in response to flame production, a switch which is mechanically controlled by both relays to be closed whenever the first relay is energized, and to be opened when the second relay is energized, means by which on energization of the first relay the fuel controller and igniter are activated through said mechanically controlled switch, means effective only when the second relay is deenergized to permit energization of

the first relay and fuel controller, means effective only when the second relay is energized to maintain motor energization independently of said mechanically controlled switch, the mechanical elements of said relays being so adjusted, that on power failure for a period insufficient to affect said flame responsive means to open the circuit to the second relay, and on resumption of power, the second relay is reenergized before the means controlled by the second relay when deenergized can act to activate said first relay.

10. A device of the class described including a room thermostat, a thermal safety switch including a heater, an igniter, a motor, first and second relays and a contact mechanically controlled by both to be closed whenever the first relay is energized, and to be opened when the second relay is energized, circuits by which on closure of the room thermostat the first relay is energized through a circuit including therein the thermostat and safety switch, a contact of the second relay which is closed only when that relay is deenergized, and said heater circuits by which on energization of the first relay the motor is activated through a motor contact controlled only by said first relay, said mechanically controlled contact and a motor contact of said second relay which is closed only when the relay is deenergized, and the igniter is activated through the motor contact of the first relay and the mechanically controlled contact, a holding circuit for the first relay including therein the thermostat and heater, means for energizing the second relay when flame is produced, said relay controlling two contacts, one of which is in circuit with the motor contact of the first relay to maintain motor activation independently of the mechanically controlled contact, and the other of which is in a holding circuit for the first relay which does not include said heater.

11. In a system of the class described, an igniter, fuel control means, a first relay, a second relay, a switch and means by which it is controlled by the conjoint action of the relays to be closed when the first relay is energized and to be opened when the second relay is energized, a combustion responsive switch and means by which it controls the second relay to energize it in the presence of and de-energize it in the absence of combustion, a safety switch including a timer heater, a room thermostat, a starting circuit for the first relay energized through the safety switch, room thermostat and heater when the second relay is de-energized, a holding circuit for the first relay energized through the safety switch room thermostat and heater after energization of said first relay, a holding circuit for the first relay which is independent of the heater, and through the safety switch and room thermostat, and energized after closure of the second relay while the first relay is closed, a circuit for the igniter and motor energized when the first relay closes while the second relay is open, and through the relays-controlled switch, and a circuit for the motor energized independently of the relays-controlled switch when the second relay closes while the first relay is closed.

12. In a system of the class described ignition means, fuel control means, a first relay, a second relay, a switch and means by which it is controlled by the conjoint action of the relays to be closed when the first relay is ener-

gized and to be opened when the second relay is energized, a combustion responsive switch and means by which it controls the second relay to energize it in the presence of and deenergize it in the absence of combustion, a safety switch including a timer heater, a room thermostat, means for controlling energization of the first relay through said safety switch and heater on a call for heat by the room thermostat including a circuit and contact therein which is closed when the second relay is deenergized, means for maintaining energization of the first relay including a circuit which is independent of said heater and having therein a contact which is closed on energization of the second relay, means for energizing the ignition and fuel control means through said relays-controlled switch on energization of the first relay, including a fuel control means contact which is closed when the first relay is energized, and means for maintaining fuel control means energization independently of said relays-controlled switch including the fuel control means contact of the first relay and a contact which is closed when the second relay is energized.

13. In a device of the class described, a fuel control means, ignition means and an ignition contact controlling said means, a safety switch including a heater, first and second electrically controllable means, and means operable thereby for controlling said ignition contact to close it and hold it closed when the first means is energized and to cause it to open when the second means is energized, a first contact controlled by the first electrically controllable means to close when that means is energized and vice versa, second third contacts controlled by the second electrically operable means to open the second and close the third when energized and vice versa, fourth and fifth contacts also controlled by said second electrically operable means to open the fourth and close the fifth when energized, a master switch controlled by the first electrically operable means to close when that means is energized and vice versa, a circuit for the fuel control means which passes through the master switch, said ignition switch and said fourth contact, a circuit for the igniter which passes through the master switch and the ignition switch; and a circuit for the fuel control means which passes through said master switch and said fifth contact, a thermostat, a starting circuit for said first electrically operable means which passes through the safety switch, thermostat, said second contact and said heater, a holding circuit for said first means which passes through said safety switch, thermostat, said first contact and heater, a holding circuit for the first relay which passes through said safety switch, thermostat, first contact, and third contact but not through said heater, and means operative on production of combustion to close the second relay, and vice versa.

14. In combination, an electrically controlled igniter, an electrically operable fuel controller, an electro-magnetic coil, a thermal safety switch and a heating element therefor, a main switch, a circuit including said electro-magnetic coil and heating element in series controlled by said main switch, a switch moved to closed position by said relay, a circuit for the igniter and a fuel controller starting circuit including said last-named switch, a combustion responsive switching mechanism including a pair of switches which are closed upon the establish-

ment of combustion, circuit connections controlled by said switches operative to short-circuit said heating element and to establish a maintaining circuit for the fuel controller, and means including a combustion responsive device for interrupting the fuel controller starting circuit and igniter circuit upon the establishment of combustion and arranged to prevent re-establishment of the starting circuit if combustion ceases while said electromagnetic coil is energized, opening of said two combustion responsive switches because of a flame failure while the electro-magnetic coil is energized operates to remove the shunt for the heating element and to discontinue energization of the fuel controller while maintaining the igniter inoperative so that there is no attempt to re-establish combustion and the supply of fuel is discontinued prior to opening of the safety switch.

15. In combination, an electrical igniter, an electrically operable fuel controller, an electrically operable device, a main switch to energize said device upon a call for heat, mechanism controlled by the presence or absence of combustion which is in a first position during the absence of combustion and moves to a second position upon the establishment of combustion, a mechanical switch, means operatively associated with said device, mechanism and mechanical switch to close said mechanical switch upon energization of said device while said mechanism is in its first position by reason of the absence of combustion and for opening said mechanical switch upon movement of said mechanism to said second position as a result of the establishment of combustion while said device is still energized, an energizing circuit for the igniter and a first fuel controller circuit controlled by said mechanical switch, a first fuel controller switch closed by said mechanism when moved to its second position, a second fuel controller circuit independent of said mechanical switch and including said first fuel controller switch, and a second fuel controller switch closed by said device when energized and included in said first-named fuel controller circuit.

16. In combination, an electrical igniter, an electrically operable fuel controller, an electro-magnetic coil, an element moved from a first position to a second position by said electro-magnetic coil upon energization of the same, mechanism controlled by the presence or absence of combustion which is in a first position during the absence of combustion and which is moved to a second position upon the establishment of combustion, a mechanically controlled switch, means controlled by said element and said mechanism operative to close the mechanically controlled switch upon movement of said element to its second position while said mechanism is in its first position and for opening the mechanically controlled switch upon movement of said mechanism to its second position as the result of establishment of combustion while said element is in its second position, a main control switch which energizes said electro-magnetic coil upon a call for heat, energizing circuits for said igniter and fuel con-

troller controlled by said mechanical switch, a fuel controller switch which is closed by said mechanism when moved to its second position as a result of the establishment of combustion, and a second circuit for the fuel controller independent of the mechanical switch controlled by said fuel controller switch.

17. In combination, an electrical igniter, an electrically operable fuel controller, an electro-magnetic coil, an element moved from a first position to a second position by said electro-magnetic coil upon energization of the same, mechanism controlled by combustion conditions which is in a first position during the absence of combustion and is moved to a second position upon the establishment of combustion, a mechanically controlled switch, means controlled by said element and mechanism for closing the mechanically controlled switch upon movement of said element to its second position while said mechanism is in its first position by reason of the absence of combustion and for opening the mechanically controlled switch upon movement of said mechanism to its second position as a result of the establishment of combustion while said element remains in its second position, a main control switch to energize said electro-magnetic coil upon a call for heat and move said element to its second position, a fuel controller switch closed by said element when moved to its second position, energizing circuits for the igniter and fuel controller controlled by the mechanical switch and fuel controller switch in series, a second fuel controller switch closed by said mechanism when moved to its second position as the result of the establishment of combustion, and a second circuit for the fuel controller independent of the mechanical switch controlled by both of said fuel controller switches in series.

18. A system of the class described, comprising, in combination, an electrical igniter, an electrically operable fuel controller, an electro-magnetic coil, means controlled thereby when energized to initiate igniter and fuel controller operation, a safety mechanism comprising a thermal lock-out switch and an electrical heater therefor, a main switch, circuit connections controlled by the main switch for energizing the electro-magnetic coil and electrical heater upon a call for heat, and means associated with said first-named means and including circuit connections and a device responsive to combustion conditions operative to terminate energization of the igniter while maintaining energization of the fuel controller and to operatively de-energize the safety mechanism electrical heater upon the establishment of combustion and to prevent re-energization of the igniter, de-energize the fuel controller and re-energize the electrical heater upon a failure of combustion while said electro-magnetic coil is energized, whereby the supply of fuel is discontinued prior to the time that the complete system is rendered inoperative as a result of re-energization of the safety mechanism electrical heater.

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