March 6, 1951 R. PRATT 2,544,511

SAFETY HEAT CONTROL SYSTEM

Filed Sept. 30, 1944 2 Sheets-Sheet 1

Fig. 1.

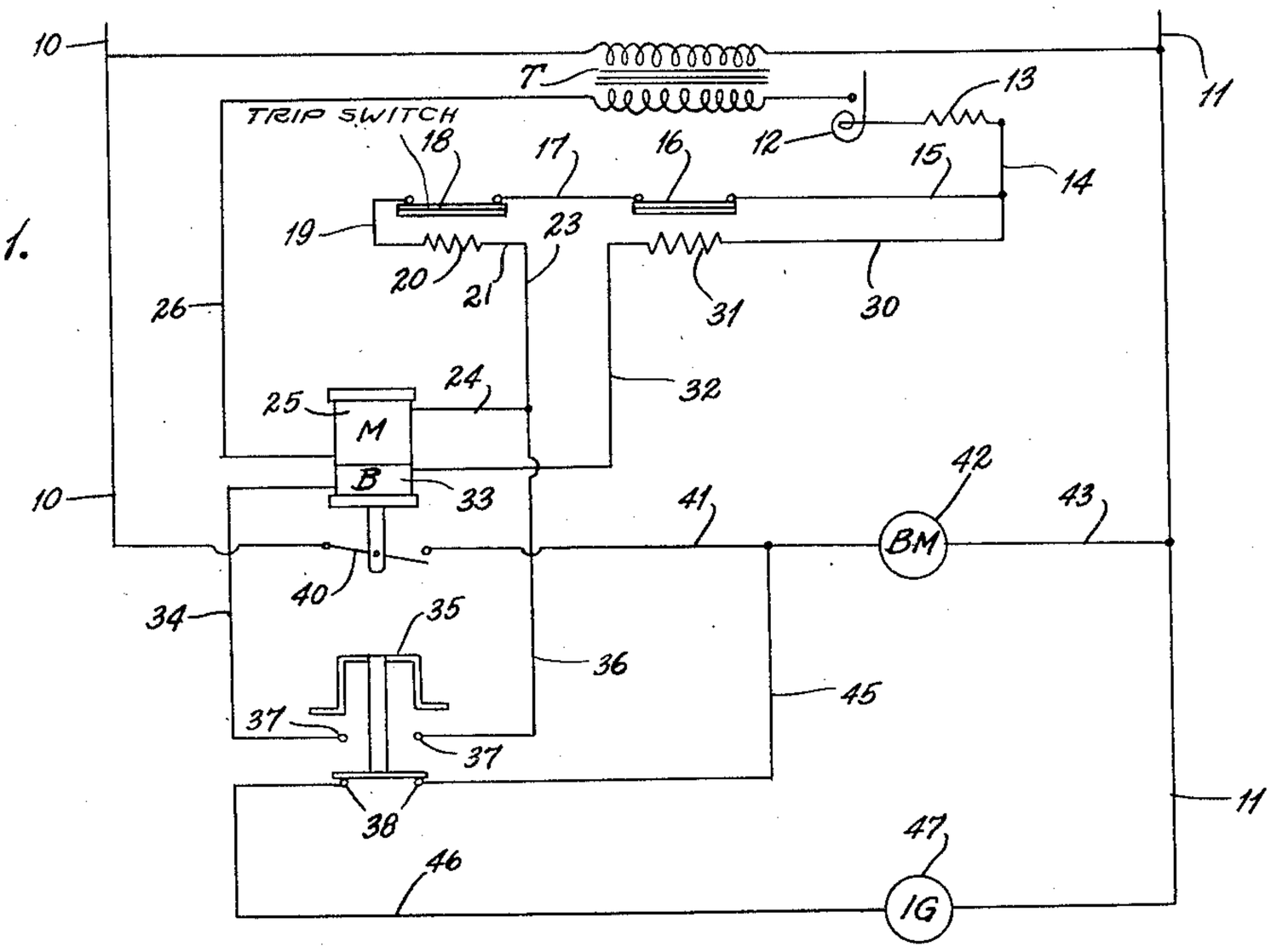

Fig. 2.

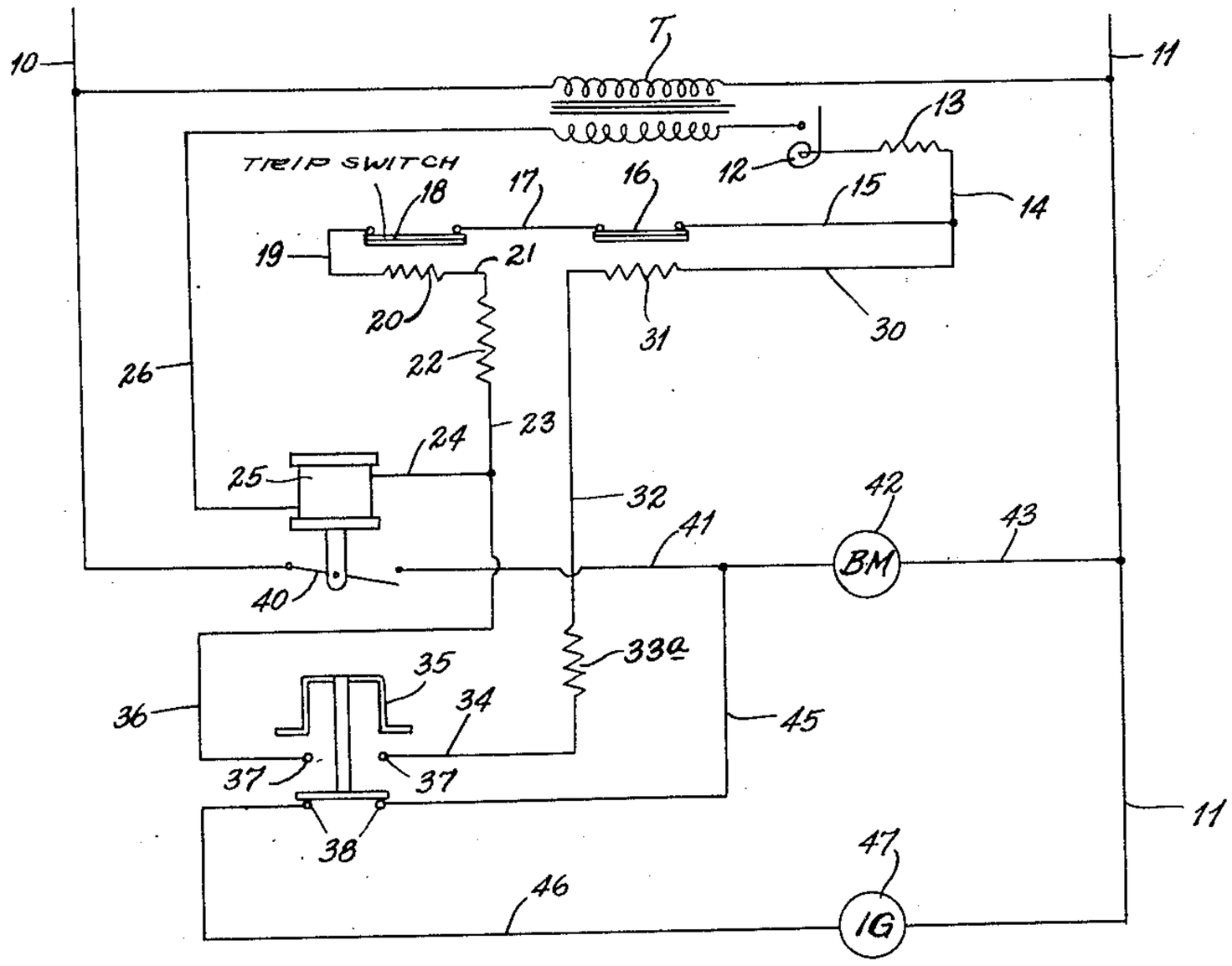

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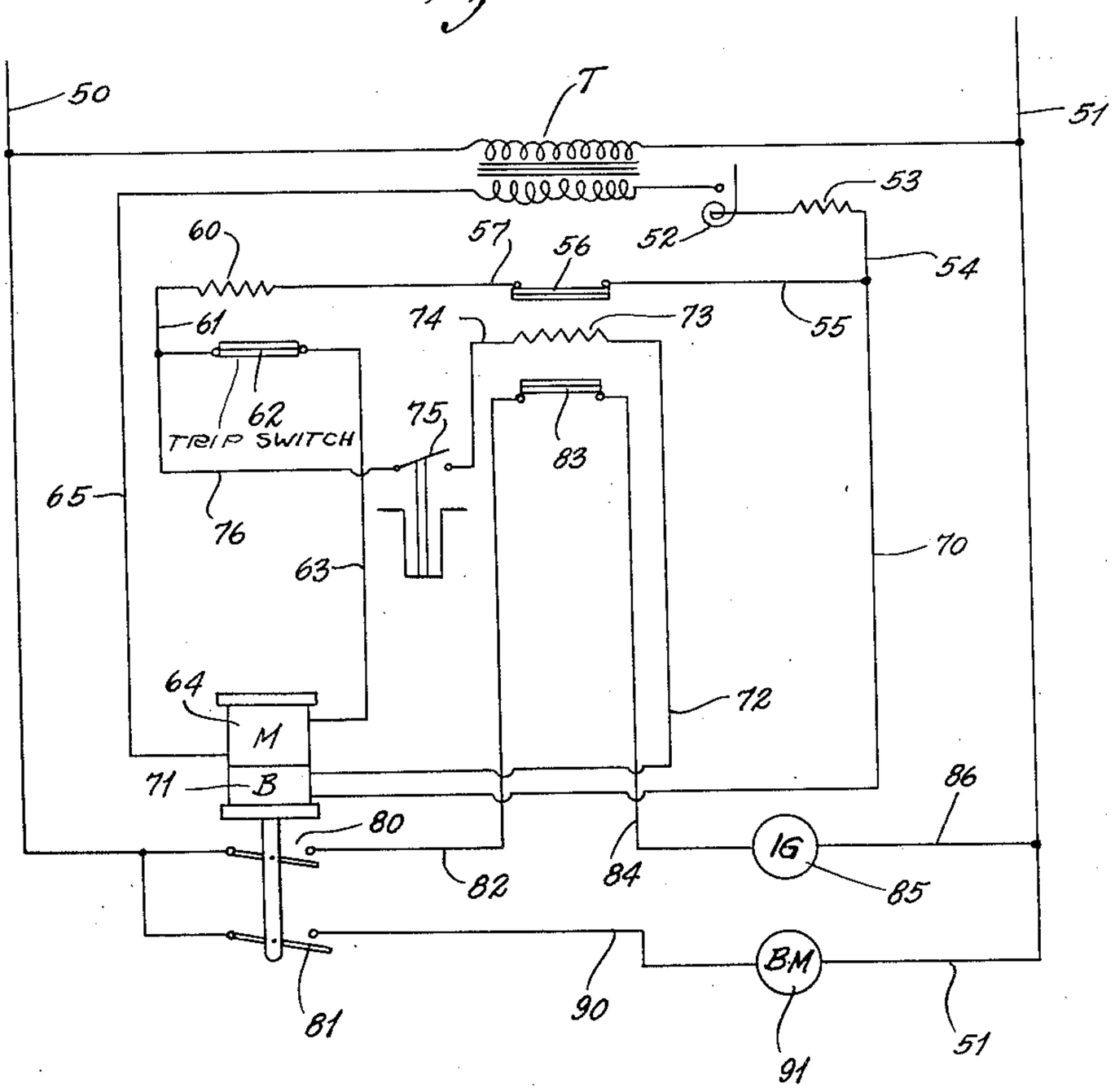
Fig. 3.



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SAFETY HEAT CONTROL SYSTEM

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Application September 30, 1944, Serial No. 556,516

15 Claims. (Cl. 158—28)

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The present invention relates to a heat control device. It is especially adapted to the control of burners requiring ignition, but it will be evident that in some aspects it will be applicable to other heat control or refrigeration control.

An object of the invention is to provide a control that is simple and inexpensive, yet safe. More particularly, it is an object to provide a control with a limited starting period followed by a running period, only if combustion occurs, and with safety features including a scavenging period, the whole being attained through the use of delayed action relays.

A further object is to provide a control of the foregoing kind in which momentary power failure with no igniter in operation cannot result in an immediate restart of the burner, but restart is required to await completion of a scavenging period.

A specific object is to provide a control having a timed starting circuit, a running circuit, and means in the running circuit to open the starting circuit and hold it open for a period after the running circuit opens.

A further object is to provide in a control of the foregoing kind an ignition means that is cut out upon combustion, or, particularly, with ignition means that is cut out only after a safety means has been made operative to prevent operation of the fuel supply means, upon extinguishment of flame concurrent with an instantaneous power failure. More specifically, it is an object to provide a means operated by establishment of a running circuit to effect opening of the starting circuit, and opening of an ignition circuit no sooner than the opening of the starting circuit.

In the drawings:

Fig. 1 is a schematic view of one type of such control;

Fig. 2 is a schematic view of a second type of such control; and

Fig. 3 is a schematic view of a third and most desirable type of such control.

Referring to Fig. 1, electric power lines are shown at 10 and 11. These are bridged by the primary of a transformer T. The control circuit is operated principally off the secondary or low voltage side of the transformer. It includes a room or similar space thermostat 12 having, if desired, an anticipating heater 13. The anticipating heater is connected by lines 14 and 15 through the bimetal switch 16 of the heat relay; thence is connected by a line 17 to the bimetal

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switch 18 of a second heat relay. From the switch 18, a line 19 leads through the heating coil 20 that opens the second heat relay switch 18 after the heater 20 has been energized a predetermined period of time. The heater 20 is connected by lines 23 and 24 through a main relay coil 25. From this coil, a line 26 leads back into the secondary of the transformer T.

A running circuit around the second heat relay switch 13 is provided by a line 30 connected to the line 14 and leading into a heater 31 for the first heat relay switch 16. From the heater 31, a line 32 leads through a bucking relay coil 33 associated with the main relay coil 25. From the bucking relay coil 33, a line 34 leads through one set of contacts 37 of a combustion safety switch 35. From the combustion safety switch, a line 36 is connected back to the line 24. The combustion switch is one that closes the contacts 37 only when combustion exists, and alternately closes the contacts 38 only when the burner is cold.

The main magnetic relay operates a switch 40, one side of which is connected to the main power line 10. On the other side of the switch a line 41 leads through the burner device 42, which is, in turn, connected by a line 43 to the other power line 11. The burner device is, typically, a power driven mechanism supplying fuel, or air, or both, to a furnace.

A line 45 is connected to the line 41 and leads to cold contacts 38 on the combustion safety switch 35. These contacts are in series, by means of a line 46, with the igniter 47 that is, in turn, connected to the power line 11.

The room thermostat 12 is disposed in the room or other space the temperature of which is to be controlled. The burner motor or burner device 42 represents an electrical burner operating means supplying fuel, or air, or both, that requires a short period during which combustion ordinarily occurs. The heat-responsive elements of the combustion safety switch 35 are located at some point so as to be quickly responsive to the presence or absence of combustion in the furnace.

Operation of Fig. 1

When the room thermostat 12 closes its switch in response to a demand for heat, the circuit is closed from the secondary of the transformer through the thermostat 12, the anticipating heater 13 (if used), the line 14, the line 15, the switch 16, the line 17, the switch 18, the line 19, the relay heater 20, the line 21, the line 23,

the line **24**, the main relay coil **25**, and the line **26** back to the secondary.

When the coil **25** is thus put in circuit and energized, it pulls up the switch **40**, closing the lines **10** and **41** so that the burner device is put in operation across the lines **10** and **11**. At the same time, and as long as the combustion safety switch **35** is cold, the igniter **47** is put in circuit, by the line **41**, through the line **45**, the combustion safety switch contacts **38**, and the line **46**. With both the burner motor and the igniter in operation, the former supplying the proper fuel mixture, ignition will normally take place.

During this phase of the cycle, the relay heater **20** is generating heat for the bimetal switch blade **18**. After a predetermined lapse of time, sufficient heat will be applied to the bimetal **18** to cause it to open. This period of time is fixed at greater than the normal time for combustion to occur in the furnace.

When combustion occurs, the combustion safety switch **35** responds, shifting its switch to open the ignition circuit contacts **38** and to close the running circuit contacts **37**. This latter effects a circuit around the heater **20** of the second heat relay as follows: The line **14**, the line **30**, the heater **31** of the first heat relay, the line **32**, the bucking coil **33**, the line **34**, the combustion safety switch **35**, the line **36** to the line **24**, whence the circuit completes itself through the main relay coil **25**.

The foregoing circuit not only shunts the second heat relay heater **20**, but also energizes the first heat relay heater **31** and the bucking coil **33**. Preferably the design is such that when the running circuit is closed, the current through the second heater **20** is reduced so that the time to open the heat relay **18** is increased.

The application of current to the heater **31** causes it to generate heat and apply it to the bimetal switch **16**. After a short period, the switch **16** is opened, and it is held open during the remainder of the running period so long as the combustion safety switch is in its hot position.

The bucking coil **33** is of insufficient strength to cause the relay **25** to open the switch **40**, but it is of sufficient strength to prevent the main coil **25** from pulling the relay closed when both coils are in series, that is with the starting circuit open and the running circuit closed.

In the normal cycle, the running period continues until the room thermostat **12** opens, deenergizing both coils **25** and **33**, and opening the switch **40**. It is impossible, however, to complete the starting circuit immediately thereafter because the bimetal **16** must cool before the relay **25** can be reenergized and close the switch **40**. Even if there is a reclosing of the room thermostat after combustion ceases, but before the combustion safety switch cools, the burner motor will not start because the switch **40** remains open. Although the running circuit might thus reclose, both the bucking coil and the main coil are energized in series, with the result that insufficient magnetic pull is generated to draw in the switch **40**. The result of such false start is to apply further heat to the bimetal **16** from the coil **31**, until the combustion safety switch **35** cools and opens due to the absence of combustion. As it does cool and shifts to its lower position in the drawing, the running circuit through the contacts **37** is broken, and, as soon as the switch **16** closes, the starting circuit will again be ready for restart under control of the room thermostat.

In the event that power fails momentarily during a starting period before the stack switch **35** has heated, the main relay will drop out but may reclose again upon restoration of power, to continue the starting cycle.

If power fails momentarily during a running period, the relay will drop out, stopping the burner motor, which is at this time operating without the operation of the igniter. This condition is apt to cause flame failure so that a restart of the burner motor without the igniter would be dangerous. However, such restart is prevented upon restoration of power because the main coil circuit is open at the switch **16**, in which condition, with both coils **25** and **33** in series, the relay has insufficient power to pull the switch **40** closed. Therefore, upon such momentary power failure during the running period, the burner motor will remain out of operation until the combustion safety switch cools to break the running circuit, and to reestablish the starting circuit.

If, through any circumstance, the starting circuit through the switches **16** and **18** remains energized, as where combustion does not occur, the heater **20** will continue to generate heat, and finally will open the switch **18**, which switch is one requiring manual reset.

If, for any reason, there is a failure of the running circuit, as when combustion fails after an operation has been effected, the result will simply be a temporary shut-down, because the switch contacts **37** will open, and the starting circuit will be opened at the switch **16**. This switch **16** will remain open for a scavenging period until the heater **31** cools, and a new start can commence. If flame failure occurs before the switch **16** has opened, the starting circuit will be reopened shortly by the reestablished heating of the heater **20**, which will open the switch **18**.

The modification of Fig. 2

In Fig. 2, a similar result is obtained by the use of a resistor in place of the bucking coil. It will be seen that the resistor **33***a* is substituted for the bucking coil **33**, and that otherwise the circuits are the same. When the combustion safety switch **35** heats, it establishes a running circuit around the starting circuit through the switches **16** and **18**, the heater **20** and the resistor **22**. The resistor **33***a* in the running circuit cuts down the current through the main coil **25** to such a point that the coil **25** may hold the switch **40** closed but cannot reclose the relay in the event it drops out when the starting circuit is open.

The modification of Fig. 3

The preferred form of the invention is shown in Fig. 3 and includes additional safety features. In it, the two power lines are shown at **50** and **51**. The transformer primary is connected across them. In the secondary circuit, there is a room thermostat **52** which can have an anticipating heater **53**, from which there leads a line **54**. This is connected with a line **55** leading to a first bimetal switch **56**. The line **57** leads from the switch **56** to a heater **60**. From this heater, a line **61** leads through a bimetal switch **62**. A line **63** leads from the switch **62** into the main coil **64** of the main relay, the other end of which is connected by a line **65** back to the secondary.

In this case, a running circuit comprises a line **70** connected to the line **54**. The line **70** is connected with a bucking coil **71** on the relay. A line **72** leads from the bucking coil through a heater **73**, from which a line **74** leads into the

combustion safety switch 75 connected by a line 76 to the switch 62.

The main relay in this case controls two switches 80 and 81, both of which are connected to the main power line 50. The switch 80 is also connected by a line 82 through a bimetal switch 83 associated with the heater 73. A line 84 connects the switch 83 to the igniter device 85, which is, in turn, connected by a line 86 with the other power line 51.

The switch 81 connects the line 50 through a line 90 with the burner device 91, which, in turn, is connected to the line 51.

In this control, the heater 73 acts upon both of the bimetal switches 56 and 83. When this heater is hot, it opens both switches simultaneously. The heater 60 is the warp switch timer, and opens the bimetal switch 62 after a predetermined interval of time.

Operation of Fig. 3

When the room thermostat 52 closes upon a demand for heat, a circuit is completed from the secondary through the thermostat 52, the anticipating heater 53 (if used), the line 54, the line 55, the now closed switch 56, the line 57, the heater 60, the line 61, the now closed heater switch 62, the line 63, the main relay coil 64, and the line 65 back to the secondary.

When the main coil 64 is energized, it closes the switches 80 and 81. Closure of the switch 80 puts the igniter device 85 in circuit through the presently closed bimetal switch 83. Closure of the switch 81 puts the burner device directly across the lines. Thereupon, fuel is supplied and ignited.

Combustion causes the combustion safety switch 75 to close after a brief interval. This closes the running circuit around the timing switch of the heater 60 through the line 70, the bucking coil 71, the line 72, the heater 73, the line 74, the heated and closed combustion safety switch 75, the line 76, and thence through the switch 62 and the main coil 64.

The resistances in the starting circuit and running circuit are substantially equal so that when both circuits are closed the current in the starting circuit is somewhat reduced, thereby increasing the time required for the heater 60 to open the switch 62. In normal operation, when both starting and running circuits are closed, the heater 73 in the running circuit will open the switches 56 and 83 before the heater 60 opens the switch 62.

The opening of the switches 56 and 83 opens the starting and ignition circuits, leaving the main coil and bucking coil in series. As in connection with the control shown in Fig. 1, energization of the bucking coil produces insufficient force in opposition to the main coil 64 to throw out the relay, but it will prevent its being drawn in from an open position.

When the switch 56 opens, the starting circuit is opened and the heater 60 completely deenergized. Furthermore, as before, the heater 73 remains hot throughout the running period and acts to prevent an immediate recycle should the room thermostat open and reclose during the running period.

In the event of momentary power failure during a starting phase, before the running circuit is closed, restoration of power will reestablish the starting period.

Momentary power failure, or any other failure resulting in flame failure, during the interval between closing of the running circuit and opening of the starting circuit at the switch 56, will be harmless, as restoration of power will occur with the igniter in circuit. A lock-out may occur if the switch 62 opens before a reignition can take place, but this is a safe condition, and only a manual reset is required to restart the mechanism. Manual reset cannot be effective until the heater 60 cools, so that scavenging is provided.

Momentary power failure, or other failure resulting in flame failure during the running period, is the same as opening the running circuit at the room thermostat. The bucking coil is in series, so that the switch 80 is held open until the switch 56 cools and recloses.

In all of these controls, inadvertent opening or vibrating of the room thermostat acts like a power failure. A snap-action thermostat is preferred.

The control in Fig. 3 will lock out if the timing switch heater 60 is held in circuit an excessive period of time through failure of combustion or if the switch 56 fails to open. The circuit through the bucking coil is also broken and the entire mechanism is maintained in a state of complete deenergization until manually reset.

What is claimed is:

1. In a control for use with a burner operating device and a power source, the combination of a relay comprising a coil and a relay switch, the relay switch being normally in a first position, but displaceable into a second position by energization of the coil, the relay requiring more coil energy to displace the switch than to hold the switch in displaced position, said coil having two terminal connections, and developing magnetic power greater than the displacement-resisting load of the switch, whereby the coil is capable of displacing the relay switch to second position when a predetermined potential is applied to said terminals, power reducing means having terminal connections at its ends, said power reducing means being adapted to reduce the magnetic power of the coil to below that required to overcome the displacement-resisting load of the switch but above the lesser load tending to return the switch to its first position, a control switch device having a control switch and electrically energizable means to open the switch when the said means is energized and to permit the switch to close when said means is deenergized, and an additional switch; a closing circuit branch including the control switch and the coil in series; a holding circuit branch including the control switch energizable means, the power reducing means, the additional switch and the coil; the latter being in series with the other components of the holding circuit branch whereby the coil may be energized to close the relay switch when the closing circuit branch is energized, the coil may be held energized when the holding circuit branch is energized, and the closing circuit branch may be opened by energization of the holding circuit branch to leave the coil energized at reduced magnetic power.

2. In a control for use with a burner operating device and a power source, the combination of a relay comprising a coil and a relay switch, the relay switch being normally in a first position, but displaceable into a second position by energization of the coil, the relay requiring more coil energy to displace the switch than to hold the switch in displaced position, said coil having two terminal connections, and developing magnetic power greater than the displacement-resist-

ing load of the switch, whereby the coil is capable of displacing the relay switch to second position when a predetermined potential is applied to said terminals, power reducing means having terminal connections at its ends, said power reducing means being adapted to reduce the magnetic power of the coil to below that required to overcome the displacement-resisting load of the switch but above the lesser load tending to return the switch to its first position, a control switch device having a control switch and electrically energizable means to open the switch when the said means is energized and to permit the switch to close when said means is denergized, and an additional switch; a closing circuit branch including the control switch and the coil in series, a holding circuit branch including the control switch energizable means, the power reducing means, the additional switch and the coil; the latter being in series with the other components of the holding circuit branch whereby the coil may be energized to close the relay switch when the closing circuit branch is energized, the coil may be held energized when the holding circuit branch is energized, and the closing circuit branch may be opened by energization of the holding circuit branch to leave the coil energized at reduced magnetic power, the additional switch comprising a combustion-responsive switch that is automatically closed when subjected to combustion temperatures and opened when not subjected to combustion temperatures.

3. In a control for use with a burner operating device and a power source, the combination of a relay comprising a coil and a relay switch, the relay switch being normally in a first position, but displaceable into a second position by energization of the coil, the relay requiring more coil energy to displace the switch than to hold the switch in displaced position, said coil having two terminal connections, and developing magnetic power greater than the displacement-resisting load of the switch, whereby the coil is capable of displacing the relay switch to second position when a predetermined potential is applied to said terminals, power reducing means having terminal connections at its ends, said power reducing means being adapted to reduce the magnetic power of the coil to below that required to overcome the displacement-resisting load of the switch but above the lesser load tending to return the switch to its first position, a control switch device having a control switch and electrically energizable means to open the switch when the said means is energized and to permit the switch to close when said means is deenergized, and an additional switch; a closing circuit branch including the control switch and the coil in series, a holding circuit branch including the control switch energizable means, the power reducing means, the additional switch and the coil; the latter being in series with the other components of the holding circuit branch whereby the coil may be energized to close the relay switch when the closing circuit branch is energized, the coil may be held energized when the holding circuit branch is energized, and the closing circuit branch may be opened by energization of the holding circuit branch to leave the coil energized at reduced magnetic power, the control switch device comprising a time-delay relay in which the control switch does not reclose until after lapse of a time interval, upon deenergization of its energizable means.

4. In a control for use with a burner operating device and a power source, the combination of a relay comprising a coil and a relay switch, the relay switch being normally in a first position, but displaceable into a second position by energization of the coil, the relay requiring more coil energy to displace the switch than to hold the switch in displaced position, said coil having two terminal connections, and developing magnetic power greater than the displacement-resisting load of the switch, whereby the coil is capable of displacing the relay switch to second position when a predetermined potential is applied to said terminals, power reducing means having terminal connections at its ends, said power reducing means being adapted to reduce the magnetic power of the coil to below that required to overcome the displacement-resisting load of the switch but above the lesser load tending to return the switch to its first position, a control switch device having a control switch and electrically energizable means to open the switch when the said means is energized and to permit the switch to close when said means is deenergized, and an additional switch; a closing circuit branch including the control switch and the coil in series; a holding circuit branch including the control switch energizable means, the power reducing means, the additional switch and the coil, the latter being in series with the other components of the holding circuit branch; whereby the coil may be energized to close the relay switch when the closing circuit branch is energized, the coil may be held energized when the holding circuit branch is energized, and the closing circuit branch may be opened by energization of the holding circuit branch to leave the coil energized at reduced magnetic power, the additional switch comprising a combustion-responsive switch that is automatically closed when subjected to combustion temperatures and opened when not subjected to combustion temperatures, and a space thermostat switch connected in series with both the closing circuit branch and the holding circuit branch.

5. In a control for use with a burner operating device and a burner, a power source, a space thermostat, and a combustion responsive switch having hot contacts closed in response to combustion, the combination of a relay coil and a relay switch operated by the coil for actuating the burner operating device, a time delay switch and a time delay operating means adapted to open the switch after an interval of energization thereof, said time delay switch and its operating means and the relay coil being connected together in a starting circuit branch; electrically energizable power reducing means to reduce the magnetic power of the relay coil to a value below that required to operate the switch but above that required to hold it operated, said power reducing means being connected with the relay coil to form a running circuit branch, said running circuit branch thus being partially interconnected with the starting circuit branch but excluding said time delay operating means; said starting circuit branch and running circuit branch being adapted for connection through the space thermostat, and the running circuit branch being adapted for connection through the hot contacts of the combustion switch to be energized when combustion exists, mechanism for rendering the starting circuit branch ineffective, including means to open the starting circuit branch and operating means for the opening means, said opening means being connected in the starting

circuit branch and the operating means being connected in the running circuit branch, said running circuit branch, when energized alone, rendering the relay coil incapable of operating the relay switch but capable of holding it operated.

6. In a control for use with a burner operating device and a burner, a power source, a space thermostat, and a combustion responsive switch having hot contacts closed in response to combustion, the combination of a relay coil and a relay switch operated by the coil for actuating the burner operating device, a time delay switch and a time delay operating means adapted to open the switch after an interval of energization thereof, said time delay switch and its operating means and the relay coil being connected together in a starting circuit branch; a power reducing means to reduce the power of the relay coil to a value below that required to operate the switch but above that required to hold it operated, said power reducing means being connected with the relay coil to form a running circuit branch, said running circuit branch thus being partially interconnected with the starting circuit branch but excluding said time delay operating means; said starting circuit branch and running circuit branch being adapted for connection through the space thermostat, and the runing circuit branch being adapted for connection through the hot contacts of the combustion switch to be energized when combustion exists, mechanism for rendering the starting circuit branch ineffective, including means to open the starting circuit branch and operating means for the opening means, said opening means being connected in the starting circuit branch and the operating means being connected in the running circuit branch, said mechanism for rendering the starting circuit ineffective being constructed to delay reclosing of the opening means for a period after deenergization of the running circuit branch.

7. In a control for use with a burner operating device and an igniter, the combination of a relay coil and a switch operated thereby to effect operation of the burner operating device, a starting circuit branch for the relay, and a running circuit branch for the relay, said starting circuit branch having a control switch therein displaceable for rendering the starting circuit branch ineffective, an igniter switch for controlling the igniter, and displaceable for rendering the igniter ineffective, and a switch operating means in the running circuit branch adapted to displace both the control switch and the igniter switch when the running circuit branch is energized.

8. In a control for use with a burner operating device and an igniter, the combination of a relay coil and a switch operated thereby to effect operation of the burner operating device, a starting circuit branch for the relay, and a running circuit branch for the relay, said starting circuit branch having a control switch therein displaceable for rendering the starting circuit branch ineffective, an igniter switch for controlling the igniter, and displaceable for rendering the igniter ineffective, switch operating means in the running circuit branch adapted to displace both the control switch and the igniter switch when the running circuit branch is energized, and time delay means in the starting circuit branch for rendering the same ineffective to operate the relay after a predetermined period of energization thereof.

9. In a control for use with a burner operating device and an igniter, the combination of a relay coil and a switch operated thereby to effect operation of the burner operating device, a starting circuit branch for the relay, and a running circuit branch for the relay, said starting circuit branch having a control switch therein displaceable for rendering the starting circuit branch ineffective, an igniter switch for controlling the igniter, and displaceable for rendering the igniter ineffective, switch operating means in the running circuit branch adapted to displace both the control switch and the igniter switch when the running circuit branch is energized, and a combustion responsive switch in the running circuit branch, and adapted to prevent energization thereof in absence of combustion.

10. In a control for use with a burner operating device and an igniter, a relay coil and a relay switch operated thereby, the switch being adapted to be connected with the burner operating device, a time delay switch and operating means to open the switch after a predetermined time, an igniter switch, adapted when opened to render the igniter ineffective, a control switch, energizable means to open both the control switch and the igniter switch, a power reducing coil, terminal connections for connection with the combustion responsive switch, the control switch, the time delay switch, the time delay operating means and the first coil being connected in series to form a starting circuit means through which the relay coil may be energized and the relay switch operated, the energizable means, the power reducing coil, the relay coil, and the combustion responsive switch terminal connections being connected in series to form a running circuit means through which the relay coil may be held energized, the igniter switch opened and the control switch opened to render the starting circuit means ineffective, the power reducing coil being capable of reducing the power of the relay coil to between that required to operate the switch and that required to hold it operated when the running circuit means is energized.

11. In a control for use with a burner operating device and an igniter, a relay coil and a relay switch operated thereby, the switch being adapted to be connected with the burner operating device, a time delay switch and operating means to open the switch after a predetermined time, an igniter switch, adapted when opened to render the igniter ineffective, a control switch, energizable means to open both the control switch and the igniter switch, a power reducing coil, terminal connections for connection with the combustion responsive switch, the control switch, the time delay switch, the time delay switch operating means and the coil being connected in series to form a starting circuit means through which the relay coil may be energized and the relay switch operated, the energizable means, the power reducing coil, the relay coil, and the combustion responsive switch terminal connections being connected in series to form a running circuit means through which the relay coil may be held energized, the igniter switch opened and the control switch opened to render the starting circuit means ineffective, the power reducing coil being capable of reducing the power of the relay coil to between that required to operate the switch and that required to hold it operated when the running circuit means is energized, said energizable means comprising a heater, and the control switch including a heat responsive means, whereby when the running circuit means is deenergized, the

control switch may not reclose until it has undergone an interval of cooling.

12. In a control mechanism, a relay having a coil, and an actuating device operated to operative position upon energization of the coil, a timing device including a switch and time-delay operating means energizable to open the switch, a starting circuit branch for the relay coil, the branch interconnecting the timing device switch and the time-delay operating means with the relay coil, whereby upon energization of the branch the relay coil is energized, but the coil is subject to deenergization upon lapse of a predetermined interval by the timing device, energy-reducing means to render the coil incapable of operating its actuated device to operative position, but not to render the coil incapable of holding the device in said position, means to open the starting circuit branch including a switch in said branch, and energizable means to operate the switch, and a running circuit branch for the relay coil interconnecting the energy-reducing means and the energizable means of the switch to open the starting circuit branch with the relay coil.

13. The combination of claim 12, wherein the means to open the starting circuit branch is a time-delay device that maintains its switch in the starting branch open for a period after the energizable means to open the switch is deenergized.

14. In a control mechanism, a relay having a coil adapted to pull in an actuating device, a time delay device including a switch and an electrical operating means therefor, the operating means being energizable to open the switch, and deenergizable to permit closure thereof, a first circuit branch interconnecting the coil and the switch so that the coil may be energized thereby only when the switch is in closed position, means to reduce the magnetic pull of the coil to a point between that to pull in the actuating device and that to hold it in, a second circuit branch interconnecting the coil, the magnetic pull reducing means and the means to operate the switch, said

last-named means and its switch comprising a time-delay device of the type in which the switch is held against movement for a period after deenergization of its operating means, and then is moved.

15. In a control mechanism, a relay having a coil adapted to pull in an actuating device, a switch and an electrical operating means therefor, a first circuit branch interconnecting the coil and the switch so that the coil may be energized thereby only when the switch is in closed position, means to reduce the magnetic pull of the coil to a point between that to pull in the actuating device and that to hold it in, a second circuit branch interconnecting the coil, the magnetic pull reducing means and the means to operate the switch, said switch operating means comprising a heater and its switch including a heat-responsive device, and both together comprising a time-delay device that holds the switch open for a period after deenergization of the heater.

RYDER PRATT.

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