

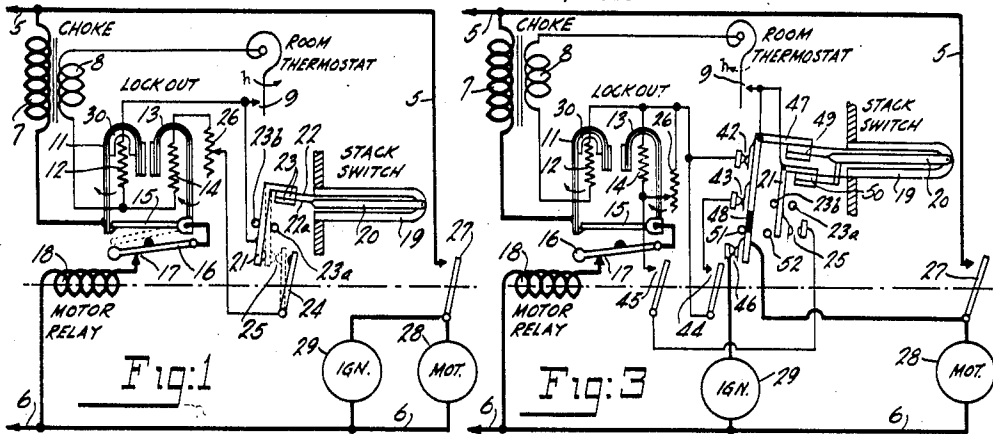
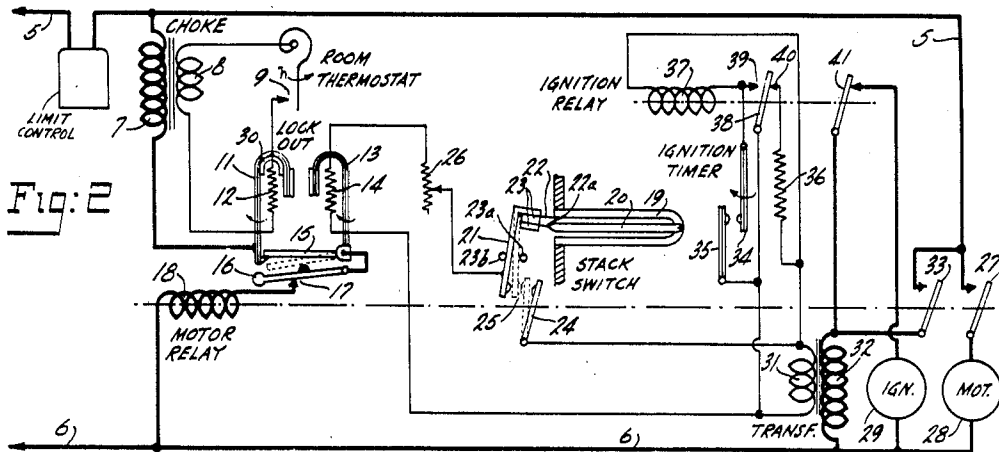
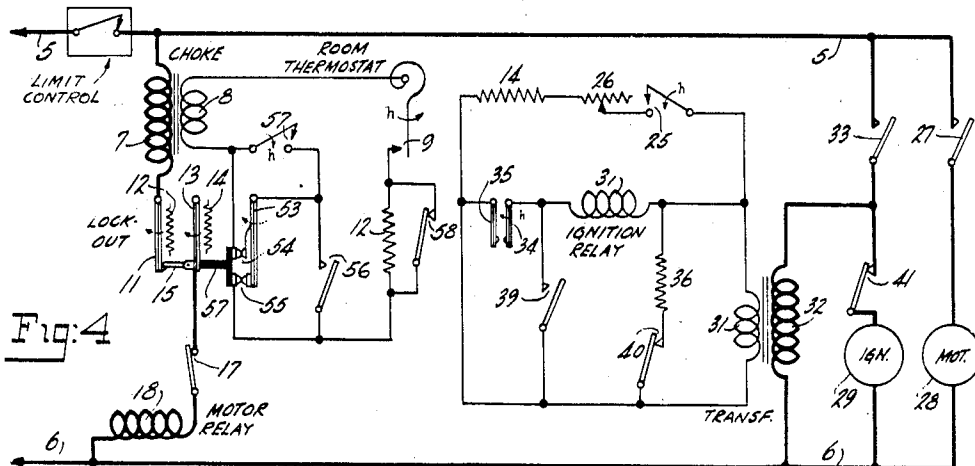
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BURNER CONTROL SYSTEM

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BURNER CONTROL SYSTEM

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30 Claims. (Cl. 158—28)

This invention relates in general to control systems and more particularly to oil burner control systems.

In oil burner control systems it is customary to provide some means which will, in case of ignition failure or flame failure, shut the oil burner down until such means has been manually reset. Such means is generally referred to as a safety switch, and usually consists of a switch, a bi-metal actuator, and an electric heater. If the electric heater is permitted to remain energized for too long a period, the actuator opens the switch and it thereafter remains open until manually reset. Such a safety switch is often referred to as a lockout switch. Usually the safety switch heater is energized upon starting the oil burner, and then after combustion has been established the heater is deenergized, by either opening the heater circuit or shunting it by providing a short circuit around the heater. The means for deenergizing the safety switch heater is usually responsive to combustion conditions. Such means is generally referred to as a combustion responsive switch or stack switch. The line voltage circuit for the oil burner motor is usually controlled by means of a relay having its coil in either another line voltage circuit, or in a low voltage circuit. The safety switch heater is usually connected in series with the motor or in series with the relay coil in order that the oil burner cannot operate without energizing the safety switch heater. Generally, electrical ignition is used for oil burners and if the ignition is left on during the entire period of operation it is referred to as constant ignition, whereas if the ignition is discontinued after combustion has been established, it is referred to as intermittent ignition. In intermittent ignition systems, it is customary to turn the ignition off by a stack switch, after combustion has been established. Customarily some additional means is provided which will shut the burner down in the event that the heating medium reaches an excessive pressure or temperature. Such means is usually called a limit control.

The primary object of this invention is to provide new and improved control systems for controlling the operation of automatic fuel burners and more particularly oil burners.

Another object of this invention is to provide a new and improved timing arrangement for the ignition period on intermittent ignition oil burners.

Another object of this invention is to provide a new and improved safety switch arrangement

which will avoid the necessity of deenergizing the safety switch heater after combustion is established.

Another object of this invention is to provide an improved oil burner control circuit which will give safe operation without having to connect the safety switch heater in series with either the motor or the relay coil.

Another object of this invention is to provide a simplified oil burner control system in which the ignition period is timed and which will return the ignition upon recycling after power failure.

Other objects and advantages reside in certain novel features of construction, circuit arrangement, and operation of the various parts and elements which will be hereinafter more fully described in the specification and particularly pointed out in the appended claims and of which a preferred embodiment is illustrated in the accompanying sheet of drawings forming a part thereof.

In the drawing:

Fig. 1 is a schematic diagram of a circuit incorporating various novel features of the invention as applied to a constant ignition oil burner system;

Fig. 2 is a schematic diagram of a circuit incorporating various novel features of the invention as applied to an intermittent ignition oil burner system in which the ignition period is timed;

Fig. 3 is a schematic diagram of a circuit incorporating various novel features of the invention as applied to an intermittent ignition oil burner system providing for delay between successive motor energizations measured by combustion temperature;

Fig. 4 is a schematic diagram of a circuit like that shown in Fig. 2 with additional means for providing a timed delay between successive motor energizations.

General description

Referring particularly to the circuit diagram shown in Fig. 1 alternating current is fed to the circuit over a pair of line wires comprising a supply or hot wire 5 and a return or ground wire 6. A choke or reactance coil is disclosed which has one side of its line voltage primary winding 7 connected to the hot line 5 and one side of its low voltage secondary winding 8 connected to a room thermostat as shown. This choke is so constructed that when the circuit of the low voltage secondary winding 8 is open it offers a high

impedance to the passage of alternating current through the line voltage primary winding. The closing of contacts 9 of the room thermostat in response to a drop in room temperature energizes the secondary winding 8 of the choke coil and thereby permits an increased flow of current through the primary winding 7.

A manual reset lockout or thermal safety switch is provided comprising a time delay or first actuator in the form of a U-shaped bimetal element 11 supported at one end. For affecting a movement of the free end of bimetal element 11 a first electric heater 12 is arranged in close proximity thereto and connected in the circuit of the low voltage choke winding 8. A compensating or second actuator in the form of a U-shaped bimetal element 13 is arranged in a similar manner to the first bimetal element 11 and is provided with a second heater 14 for moving its free end. The bimetal elements 11 and 13 are arranged to compensate each other for ambient temperature changes. A latch member 15 which serves as a switch is pivoted to the free end of the second bimetal 13 and has normal latching engagement with the free end of the first bimetal element 11. The arrangement is such that should the first heater 12 effect a warping action of its bimetal element 11 for a predetermined period of time before the second heater 14 can effect a similar movement of its associated bimetal element 13 in the same direction, the latch 15 would be released and dropped down by spring action. For resetting the latch 15 a reset lever 16 is provided, the resetting movement of which opens contacts 17. For a more detailed disclosure of the safety switch mechanism, reference may be had to the Lindemann Patent 2,216,748, issued October 8, 1940.

A motor relay coil 18 is connected in series with choke primary 7 across the line wires 5 and 6. Resetting contacts 17 and the latch 15, are connected in series with the choke primary 7 and relay coil 18. The motor relay coil 18 controls a number of switch contacts and circuits as will be pointed out. Since a large proportion of the supply voltage from the main line 5 and 6 is normally dropped across the primary winding 7 of the choke coil, when the choke secondary 8 is open, the remaining portion of the supply voltage is not enough to cause sufficient current to flow through the motor relay coil 18 to cause it to operate its contact springs.

A stack or combustion responsive means is provided having a relatively high expansible thermal element 19 and a relatively low expansible element 20 both connected together at one of their ends. The elements are located in the combustion chamber or stack of a furnace and upon a rise in stack temperature due to the establishment of combustion conditions, the thermal elements effect an inward movement of a switching arm 21 about a spring hinge 22 through the medium of a spring blade 22a which slides between friction blocks 23 secured to arm 21. The switching arm 21 is provided with hot and cold stops 23a and 23b respectively, for limiting its motion and fixing the position where the slip friction mechanism is brought into use. This permits unlimited movement of the thermal element, but limited movement of the switch arm 21. Also, by this arrangement, the switch arm 21 is operated by an initial movement of the thermal elements in either direction. When the motor relay coil 18 is energized it moves a contact spring 24 towards switch arm 21 and a closure of

switch contacts 25 as indicated in dotted lines, results upon the establishment of combustion. Conversely, upon a drop in stack temperature, the thermal elements effect an outward movement of switch arm 21 to open the contacts 25. These contacts 25 control the circuit and the heater 14. It is thought that the general arrangement of a slip friction combustion responsive switch is well known and if the above explanation is insufficient for a clear understanding of the same, reference may be had to a co-pending application of William Christenson, Serial No. 236,818, filed October 24, 1938. Connected in the circuit between the second heater 14 and switch contacts 25 is an adjustable calibrating resistance 26 for calibrating the heating effect of the second heater 14 upon the second bimetal element 13 to vary its effect with respect to the first bimetal 11. The motor relay coil 18 also controls the closure of motor relay contacts 27 which are in the circuit of a fuel motor 28 and ignition means 29.

Starting operation

In the practical operation of the circuit arrangement shown in Fig. 1 assume that the elements are all in their normal inactive condition. A starting circuit for the system is established when the room thermostat calls for heat in response to a drop in room temperature and closes its contacts 9. A control circuit path is thereby established extending through the secondary low voltage winding 8 of the choke coil, electric resistance heater 12 and through the thermostat contacts 9. The heater 12 begins to heat up the bimetal element 11 to cause it to slowly warp and move in a direction tending to release latch 15. The closure of the above circuit closes the choke secondary circuit 8 through the impedance of the bimetal heater 12 and hence causes a decrease in the impedance of the choke primary 7. As a result an increased flow of current passes over the circuit from the hot line 5, through primary winding 7 of the choke coil, bimetal element 11, latch 15, bimetal element 13, reset lever 16, resetting contacts 17, and the winding 18 of the motor relay to the grounded side 6 of the line thus energizing the motor relay. The motor relay coil moves the contact spring 24 toward closed contact position. The motor relay contacts 27 close a circuit to the fuel motor 28 and the ignition means 29 connecting them directly to line conductors 5 and 6 and thereby causing the operation of the burner.

When combustion conditions are established by the burner the thermal elements 19 and 20 of the combustion responsive switch cause movement of the switch arm 21 in a direction to establish a closure of switch contacts 25. After closure of the switch contacts 25 the switch arm 21 continues to move deflecting contact spring 24 until the stop 23a is reached. Upon arriving at this point the slip friction connection 23 begins to slip allowing further expansion of the thermal elements without further movement of the switch arm 21. The closure of the switch contacts 25 establishes a circuit path extending from the secondary choke winding 8, thermostat contacts 9, switch contacts 25, calibrating resistance 26, second electric heater 14 and back to the secondary choke winding 8. The second heater 14 is thereby energized to effect a warping action of the free end of second bimetal element 13 in the same direction as that in which the first bimetal element 11 is being warped by the first

heater 12. From the foregoing operations it is seen that after combustion conditions are successfully established in the burner both heaters are continuously energized to cause their associated bimetal elements to move together in the same direction, thereby maintaining the latch 15 in latched position as long as the burner is operating satisfactorily. From the above, it is seen that the first heater 12 is under control of the thermostat contacts 9 while the second heater 14 is controlled by both the thermostat contacts 9 and the stack switch contacts 25. Since the second heater 14 is energized subsequently to the first heater 12 in the normal operation of the system, the second bimetal 13, after being energized, must move at the same rate or faster than the first bimetal 11 in order to keep pace with it and must assume a definite ultimate position relative to the first bimetal 11 in order to keep the latch 15 engaged.

Normal shut down operation

When the burner has raised the temperature of the room in which the thermostat is located sufficiently to satisfy the same, the thermostat opens its contacts 9. This interrupts the circuit path through the secondary winding 8 of the choke coil and the heaters 12 and 14. The choking effect of the secondary winding 8 is effective in preventing the continued flow of sufficient current through the primary winding 7 to maintain the motor relay energized, and as a result it releases its armature and opens the motor relay contacts 25 and 27. The opening of the motor relay contacts 27 disconnects the fuel motor 28 and ignition means 29 and thereby terminates the operation of the burner. Shortly after the operation of the burner is terminated, the stack thermal elements 19 and 20 and the safety switch actuators 11 and 13 cool and move to their cold positions.

Ignition failure operation

In the event that combustion is not established by the burner within a predetermined time interval, due to the absence of fuel, failure of ignition, or other reasons, the thermal elements of the combustion responsive or stack switch will not be effective to actuate the switch arm 21 and establish a closure of the contacts 25. In this case, the second heater 14 is not energized and the first heater 12 continues to effect the warping action of its bimetal element 11 until a time lapse of 90 seconds, for example, whereupon the latch 15 is caused to be released or tripped. Latch 15 disconnects the energizing circuit of the motor relay which thereby opens the motor relay contacts 27, interrupting the current to the fuel motor 28 and ignition 29 to discontinue the burner operation. The first bimetal element 11 is provided with a mass element 30 of high heat capacity which assists in reliably giving the required time delay. The 90 second timing period is sufficiently long to insure the establishment of combustion conditions by the burner if it is possible to do so, but is short enough to prevent the charging of the combustion chamber with an explosive or dangerous amount of unignited fuel. The burner cannot reoperate until the reset lever 16 is manually raised to again place the latch 15 into latching engagement with bimetal element 11, after it has cooled. During the raising of reset lever 16 contacts 17 are opened to prevent the operation of the burner motor in the event that the reset lever is manually held

in such a position so as to maintain the circuit through the latch 15 and hence maintain operation of the burner without having the safety switch effective.

Flame failure operation

Should it occur that there is a flame failure due to absence of fuel or for other reasons, during the normal running operation of the burner, the stack switch thermal elements will begin to cool off as a result of the decrease in stack temperatures. The switch arm 21 is consequently caused to swing outward upon the initial drop in temperature and open the stack switch contacts 25. As a result the circuit for the second heater 14 is disconnected, permitting the associated bimetal element 13 to quickly cool and warp back toward its cold position. The latch 15 is thereby caused to be tripped from the bimetal element 11 which is still being heated. The release of latch 15 interrupts the operation of the burner as has been explained, and also disconnects the primary winding 7 of the choke coil so that current no longer passes through the secondary winding 8 and the heater 12. The cause of the flame failure is then determined and corrected after which the reset lever 16 is operated to restore the system to normal operation.

Power failure operation

In case of power failure the motor relay disconnects the burner and both heaters cool off together. Upon resumption of power the burner immediately starts up again.

From a consideration of the above description of the operation of the system, it will be apparent that any abnormal failure of combustion or ignition, either during starting or running operations of the burner will result in a quick shut down of the entire system, thereby insuring a high degree of safety. One of the important features of the invention for providing this protection resides in the lockout safety switch and its operation and arrangement in the system as has been explained. The bimetal heaters 12 and 14 are so coordinated in the circuit arrangement so that if either heater fails to function or burns out the system will shut down safely. Another important feature of the system concerns the novel use of a choke or reactance coil in the particular circuit arrangement with the safety switch and relay coil as has been pointed out. The advantages residing in the use of the choke coil include the placing of the relay coil in the line voltage circuit while the heaters 12 and 14 are included in an independent low voltage circuit. Placing the relay coil in the circuit of the primary choke winding prevents the armature from sticking in the operating position because of residual magnetism. Since a small amount of alternating current is always flowing through this circuit, the magnetic force between the relay core and armature passes through zero twice every cycle and prevents any continual attraction between them which might cause sticking. The motor relay is also preferably arranged so as to open its contacts should there be any substantial drop in the operating voltage of the line circuit.

Intermittent ignition control—Fig. 2

Figure 2 incorporates the particular features and operating characteristics of the circuit arrangement of Fig. 1 with the addition of special means for controlling the intermittent ignition means for the burner. A transformer is provided

having a low voltage secondary winding 31 for supplying current to the heater 14 through the stack switch and motor relay contacts 25, and a primary winding 32 which is adapted to be connected to the line wires 5 and 6 by the motor relay contacts 33. The means for timing the intermittent ignition means comprises a bimetallic warp switch 34 having a controlling contact on its free movable end and a heater element 36 for effecting the warping action of the switch 34. A compensating bimetal element 35 carries a contact on its free end opposite the contact on bimetal 34. Cooperating with the warp switch is an ignition relay 37 having a contact arm 38 adapted to engage either a normally open or front contact 39 or a normally closed or back contact 40. Another contact spring 41 is provided for disconnecting and deenergizing the ignition means when the ignition relay is energized.

Upon a call for heat by the room thermostat, heater 12, relay coil 18 and the motor 28 are all energized as explained in connection with Fig. 1. The additional contacts 33 operated by the relay 18 controls the energization of ignition 29 and the primary winding 32 of the transformer.

If combustion is successfully established, the stack switch is rendered effective to actuate its switch arm 21 in the manner previously pointed out, in reference to Fig. 1, and closes the contacts 25. The closure of contacts 25 completes a circuit for the heater 14 from the secondary 31 of the transformer so that the bimetal switch 13 is caused to warp and maintain a relative relation with the bimetal element 11 to prevent the latch 15 from being released.

An ignition timing circuit is completed upon closure of contacts 33 and extends from one side of the low voltage secondary winding 31 of the transformer through the warp switch heater 36, ignition relay back contacts 40, and contact spring 38 to the other side of the transformer winding. The energization of heater 36 causes bimetal switch 34 to warp in a direction to close contact with compensating element 35, which it does after a time interval of 60 seconds, for example. Upon the closure of the contacts the ignition relay coil 37 is energized through the bimetal elements 34 and 35 from the secondary transformer winding 31 and operates to close the ignition relay contacts 39 and to open the ignition relay contacts 40 and 41. At the ignition relay contacts 41 the operating circuit for the ignition means 29 is disconnected from the line without disconnecting the transformer primary winding 32, and further ignition in the burner is maintained by the flame in the combustion chamber. As a further result of the operation of the ignition relay, the ignition relay back contacts 40 disconnect the heater 36 from its energizing circuit so that the bimetal element 34 begins to cool off and move toward the cool position. Ignition relay contacts 39 close a locking or holding circuit for the ignition relay coil 37 independent of its initial energizing circuit through the bimetal contacts 35. From this point on until operation of the burner is interrupted the holding circuit for the ignition relay coil 37 passes through the ignition relay contacts 39 and the secondary transformer winding 31. From the foregoing description, it will be apparent that the time of operation of the ignition timer determines the period during which the ignition means 29 is in operation and that when this time period has expired the ignition relay is energized to cut off the ignition means. The warp switch

timer after performing its function merely returns to its normal cold position. It should also be observed that whereas the heater 12 is energized from the secondary winding 8 of the choke coil, the heater 14 receives its energizing current from the secondary winding 31 of the transformer, so that the two circuits are independent of one another.

The ignition timer is designed so as to provide for a rapid deflection of the bimetal element 34 in the cold direction when heater 36 is deenergized making it impossible with any normal installation to extinguish the flame in the combustion chamber and then restart the fuel motor without obtaining electric ignition, in the event the thermostat is manipulated back and forth. The bimetal switch is so designed that the switch closes when the bimetal 34 is at a relatively high temperature. As soon as the switch closes the heater for the bimetal 34 is deenergized and the blade cools at a rapid rate because of its elevated temperature and opens the switch very shortly after it closes. The length of time that the contacts can remain closed is made less than the normal length of time the flame persists in the fire box so that ignition is always available and may be obtained from either the persisting flame or from the electrical igniting means depending upon the time and the duration of the circuit interruption.

The various operations of the control upon combustion failure after starting, combustion failure after running, and normal shut down, are identical with those described for the constant ignition circuit arrangement as shown in Fig. 1. The ignition controlling means functions as an independent unit after each successive energization of the motor relay as has been described.

Intermittent ignition control with recycling

Figure 3 incorporates the general features and operating characteristics of the circuit arrangement of Fig. 1 with the addition of special means for controlling the ignition of the fuel burner and means for restarting the fuel burning means after a delay or purge timing period following an automatic shut down due to combustion failure. A choke is provided having a high voltage primary 7 and a low voltage secondary 8 for supplying power to the heaters 12 and 14 and to the relay coil 18 as in Fig. 1. On the low voltage side of the choke, the first heater 12 may be energized through any of the following circuit combinations depending upon the time in the control cycle: through thermostat contacts 9 and stack contacts 42, through thermostat contacts 9, contacts 43 and relay contacts 44, or through thermostat contacts 9, stack contacts 25, relay contacts 45 and the second heater 14, in parallel with its calibrating resistor 26. The burner motor 28 is energized through motor relay contacts 27 from supply lines 5 and 6. The ignition means 29 is energized through motor relay contacts 27 and stack switch contacts 46 from lines 5 and 6. Two stack switch arms, 21 and 47, motivate stack contacts 25 and 42-43-46 respectively, as a result of the relative motion between stack switch elements 19 and 20 transmitted through two separate slip friction connections 49 and 50. These separate switch arms control their associated contacts in a particular sequential manner as will be pointed out. "Cold" and "hot" stops 51 and 52, and 23b and 23a limit the motion of switch arms 47 and 21 respectively. The stack switch mechanism is equipped with the two sep-

arate slip friction mechanisms 49 and 50 similar to the one shown in Fig. 1 for the purpose of giving relatively long delay or purging time between successive burner operations.

Assume that the system has been inactive and that the thermostat closes its contacts 9 in response to a drop in room temperature to initiate operation of the burner. A circuit through the first heater 12 and the stack contacts 42 on the low voltage side 8 of the choke is established, changing the impedance of the high voltage side 7 and causing the motor relay to operate. This causes relay contacts 27, 44 and 45 to close, starting the motor of the fuel burning means 28 through motor relay contacts 27 and energizing the ignition means 29 through motor relay contacts 27 and stack contacts 46. Also the heat generated by the first heater 12 causes the bimetal 11 to slowly deflect. As a result of starting the burner, combustion is normally obtained and the stack temperature rises, causing the thermal responsive members 19 and 20 to move the switch arms 21 and 47 in a counter-clockwise direction. For a time the spring loaded stack contacts 42, 43 and 46 follow the stack switch arms. However, after a small amount of motion, stack contacts 42 which served as starting means, open, but the circuit which they controlled is maintained by the stack contacts 43 and the relay contacts 44. After a certain additional amount of motion of the stack switch arms, the stack contacts 25 close and establish a "running" circuit around the series combination of stack contacts 43 and motor relay contacts 44, through the motor relay contacts 45. When the temperature of the stack elements has risen a predetermined amount, depending upon the ignition time desired, the stack contacts 46 open the circuit to the ignition means 29. It is to be understood that the stack contacts 46 are shown in diagrammatic form only. As is well known in the prior art, they may be made snap acting, comprise a mercury switch, sequence acting and used with a separate relay, or any such other means may be employed to control the ignition circuit indirectly, such means being actuated by the switch arm 47. At the time of the disengagement of stack contacts 46, shortly before, or shortly after, depending upon the setting, but after the time of closure of contacts 25, stack contacts 43 open the shunt circuit around the second heater 14 and resistor 26 and by so doing place the second heater 14 and resistor 26 in series with the first heater 12 through motor relay contacts 45 and stack contacts 25. By this action heat is generated in the second heater 14 causing the second bimetal element 13 to deflect toward the first bimetal 11, and the heat being generated by the first heater 12 is slightly reduced causing the first bimetal 11 to change its rate of travel. By proper proportioning of the resistor size of the first and second heaters 12 and 14 and the mass associated with them, as has been previously explained, the two bimetal elements 11 and 13 are caused to deflect at the proper rate and to the ultimate proper position so as to maintain the correct relative distance between them in order to keep the latch 15 engaged.

When the temperature of the stack elements has risen a certain amount, which might be selected to be more or less or the same as that selected for the operation of stack contacts 43, and is dependent upon the adjustment of the control, the switch arm 21 reaches the "hot" stop

23a and the slip friction mechanism 50 is brought into operation upon further deflection of the stack elements. When the temperature of the stack elements has risen an amount somewhat more than that selected for the disengagement of stack contacts 43 and 46, or that selected for the engagement of the switch arm 21 with its "hot" stop 23a, the switch arm 47 reaches its "hot" stop 52 and upon further increase in stack temperature its slip friction element 49 is brought into operation.

After this sequence of events has transpired the control and burner are in the running position and will continue to operate with the elements positioned as stated unless the room thermostat ceases to call for heat, the power fails or there is a flame failure.

If, however, upon the starting of the fuel motor 28, as stated above, combustion is not established, a different sequence of functions ensues. Since, under these conditions, there is no stack temperature rise, the switch arms 21 and 47 are not actuated by the stack elements 19 and 20 and remain in their cold position. The circuit through the second heater 14 consequently remains open at stack contacts 25 and bimetal element 13 is not deflected. The first heater 12, however, is energized and causes the first bimetal 11 to slowly deflect. After a predetermined time interval, for example, 90 seconds, depending upon the adjustment of the control, the first bimetal 11 warps sufficiently to the left to disengage the latch 15 so that it drops down thereby opening the motor relay circuit. The motor relay restores its armature to the open position, opening the motor relay contacts 27 and shutting down the fuel feeding means 28. The control then remains inoperative until the latch 15 is manually reset.

Assume now that normal conditions are prevailing and that the fuel burning means has been satisfactorily operating for some time in answer to the thermostat's call for heat. Now, if the thermostat ceases to call for heat the control will shut down the burner in a normal manner. The thermostat contacts 9 are opened and the motor relay releases its armature because of the action of the choke as has been described. This opens the motor relay contacts 27, stopping the fuel motor 28 and as a result combustion ceases. The first and second bimetals 11 and 13 cool because of lack of heater excitation and the stack switch arms 21 and 47 return to their "cold" positions against stops 23b and 51 respectively, because of the drop in stack temperature. After the cold stops are reached the slip friction mechanisms 49 and 50 are brought into operation allowing the stack elements to continue to operate without deflecting the switch arms 21 and 47. The control will remain with the elements so positioned until the thermostat again calls for heat.

In case the control device has gone through the starting sequence previously described and has reached the normal running position and then combustion ceases for any reason other than power failure, a different sequence of functions takes place. When the stack temperature drops a predetermined amount depending upon the control setting, the stack contacts 25 are opened by means of the switch arm 21 operated by the stack elements 19 and 20. Immediately, the motor relay releases its armature, thereby opening its contacts 27 and stopping the fuel motor 28 by reason of the change of impedance

of the choke. As the stack temperature continues to drop the switch arm 21 reaches its cold stop 23b and upon further motion of the stack elements 19 and 20 the slip friction mechanism 50 is brought into operation. Upon further temperature drop the stack contacts 43 and 46 close and later stack contact 42 closes. Stack contacts 42 complete the starting circuit through first heater 12 and thermostat contacts 9 and as a result the motor relay operates, resulting in starting the burner in the normal manner as before. It will be noted that the burner has been shut down for the length of time required for the stack contacts 42 to close after the stack contacts 25 have opened. This time interval allows unburned fuel if present in the combustion chamber, sufficient time to escape and renders the conditions safe to attempt to restart the burner. If combustion is obtained the control device will go through the sequence of events previously described for a normal start and ultimately will reach the normal running position. If, however, combustion is not reestablished the control will shut down the fuel burning means by means of the lockout switch latch 15.

As another condition of operation, assume the control device has gone through its normal starting sequence and has satisfactorily reached the normal running position. Assume also that now there is a power failure of short duration. The motor relay will immediately release its armature thereby opening its contacts 44, 45 and 27. When power is again restored there will be no control action because the control circuit will be open at contacts 45 and the burner will not restart since in the short duration of power failure the stack switch has not cooled sufficiently to return to its cold position to close the starting contacts 42. As the temperature of the stack continues to drop the stack contacts 25 will open and the stack contacts 43-46 and 42 will close. When stack contacts 42 close, a circuit for the choke secondary is provided through the first heater 12 and the control restarts in the normal manner.

Intermittent ignition control with recycling

Figure 4 illustrates another intermittent ignition circuit in schematic form. This circuit combines the recycling feature of Fig. 3 with the timed ignition feature of Fig. 2 with the addition of means for causing a definite delay between successive motor energizations.

A third bimetal element 53 is provided which is arranged to operate in compensative relation with the two lockout bimetal members 11 and 13, previously described. That is, the arrangement is such that the free ends of the two bimetal elements 13 and 53 are disposed to deflect equal amounts in response to changes in ambient temperature alone. This insures that the device will operate substantially independent of ambient temperature. Two pairs of successively engaging starting contacts 54 and 55 are provided, which open or close dependent upon the relative position of the bimetal members 53 and 13, and when operating in collaboration with a pair of motor relay contacts 56, and a pair of stack contacts 57 effect the means for safely attempting restarting the fuel burning means after a combustion failure. Also by means of the cooperative action of the above mentioned bimetal starting contacts 54 with the stack switch contacts 57, 75

quick shutdown after combustion failure is realized.

The motor relay is adjusted so that it will not operate if energized at a voltage less than a predetermined amount. Motor relay back contacts 58 are provided to shunt the heater 12 to also prevent operation of the safety lockout switch under these subnormal voltage conditions.

Assume that the system has been inactive and that the thermostat closes its contacts 9 in response to a drop in room temperature to initiate operation of the burner. A circuit is thereby established through the relay contacts 58, the safety switch starting contacts 54 and 55, and the low side of the choke 8. This circuit changes the impedance of the high side 7 of the choke, causing the motor relay 18 to operate. The motor relay causes motor relay contacts 27, 33 and 56 to close and relay contacts 58 to open and results in starting the fuel motor 28 through motor relay contacts 27 and the ignition means 29 through motor relay contacts 33 and ignition relay back contacts 41. Also, at this time, the transformer 32 is energized through the motor relay contacts 33, and the first heater 12 is excited as a result of the opening of the motor relay shunt contacts 58 over a circuit including motor relay contacts 56 and starting contacts 54. The ignition relay 37 and the second heater 14 together with their associate controlling devices function exactly as described under the operation of Fig. 2. The modification of this circuit concerns itself entirely with the operation of the motor relay 18.

When second heater 14 causes second bimetal 13 to deflect as has been described, safety switch starting contacts 55 and 54 open in succession, but before the time of opening of safety switch starting contacts 54, stack contacts 57 will have closed, since they are adjusted to close at approximately the same time as stack contacts 25, and a closed circuit is established from the secondary 8 of the choke through stack contacts 57, motor relay contacts 56, thermostat contacts 9 and first heater 12, independent of contacts 54 and 55. After the first and second bimetal members 11 and 13 assume their ultimate position, as described under the operation of Fig. 2, there is no further contact action unless the stack temperature drops, the room thermostat opens its contacts, the power fails, or some element of the control fails.

If, however, upon the starting of the fuel burning means, combustion is not established, second heater 14 will not be energized and the safety switch will lock out as a result of the action of bimetal element 11 as has been described.

Assume that normal conditions are prevailing and that the fuel burning means has been satisfactorily operating for some time in answer to the thermostat's call for heat. Now, if the thermostat ceases to call for heat the control will shut down the burner in the normal manner. The first and second bimetal elements 11 and 13 cool, closing safety switch starting contacts 54 and 55, and the stack switch actuates, opening stack contacts 25 and 57. The control will remain with the elements so positioned until the thermostat again calls for heat.

In case the control device has gone through the starting sequence described above and has reached the normal running position and then combustion ceases for any reason other than

power failure, a different sequence of events takes place. When the stack temperature drops a predetermined amount depending upon the control setting, the stack contacts 57 open, effecting a choke reaction which causes the motor relay to release its armature and to consequently shut down the fuel burning means. As a result of this action the first and second bimetal elements 11 and 13 cool and the safety switch starting contacts 54 and 55 close consecutively after some time. The safety switch starting contacts 55 complete the choke secondary circuit through the room thermostat contacts 9, motor relay contacts 58, and the safety switch starting contacts 55-54, and cause the motor relay 18 to operate as a consequence of the choke reaction. This results in a new attempt to start the fuel burning means in the normal manner as has been described. The "holding" circuit formed by the motor relay contacts 56 around the safety switch starting contacts 55 prevents relay chattering and provides a means to render the safety switch starting contacts 54 inoperative in the starting circuit until after the safety switch starting contacts 55 have been made.

It will be noted that after a combustion failure, the burner remains shut down the length of time required for the safety switch contacts 55 to close after the stack switch contacts 57 have opened. This allows any combustible mixture which may have accumulated in the combustion chamber ample time to escape from the combustion chamber and renders conditions safe to attempt to restart the burner.

As another condition of operation, assume the control device has gone through its normal starting sequence and has satisfactorily reached the normal running position. Assume also that now there is a power failure of short duration. The motor relay 18 will immediately release its armature. When power is restored the motor relay will not operate since the maintaining circuit through relay contacts 56 has opened due to the action of the relay 18, and the safety switch starting contact 55 is open due to the action of the second bimetal element 13. The control will stand by until the safety switch starting contacts 55 are made and then will attempt to start the burner in the normal manner as described.

A limit control is also shown wired in the circuit in Figs. 2 and 4, but it is understood that such a limit control can also be used in the systems shown in Figs. 1 and 3, for the purpose of shutting the system down in the event of excessive pressure, temperature, low water, etc.

While the features of the invention have been illustrated and described in only a few of their practical applications, it will be understood that other applications thereof may be apparent to those skilled in the art, and it is, therefore, desired that the invention be not limited to the particular disclosure of applicant, but only by the scope of the appended claims.

The words "concurrently energized" when used herein and in the appended claims is construed to mean energizing one or more elements coincidentally or simultaneously with and during the entire time of energization of another element.

What is claimed is:

1. A burner control system comprising means for feeding fuel to the burner, a manual reset thermal safety switch having an actuating element and a compensating element for controlling the operation of the fuel feeding means, a heater adjacent the actuating element and energized

during the entire operation of the fuel feeding means for opening the safety switch, a second heater adjacent the compensating element, and means operative to energize said second heater after the establishment of combustion for maintaining the safety switch closed, said compensating element arranged to compensate the actuating element for ambient temperature changes.

2. A burner control system comprising means for feeding fuel to the burner, a manual reset thermal safety switch having an actuating element and a compensating element for controlling the operation of the fuel feeding means, said compensating element being arranged to compensate the actuating element for ambient temperature changes, a heater adjacent the actuating element and energized during the entire operation of the fuel feeding means for opening the safety switch, a second heater adjacent the compensating element and means operative to connect said second heater in parallel with the first heater after the establishment of combustion for maintaining the safety switch closed.

3. A burner control system comprising a means for feeding fuel to the burner, a manual reset thermal safety switch having an actuating element and a compensating element for controlling the operation of the fuel feeding means, said compensating element being arranged to compensate the actuating element for ambient temperature changes, a heater adjacent the actuating element and energized during the entire operation of the fuel feeding means for opening the safety switch, a second heater adjacent the compensating element and means operative to connect said second heater in series with the first heater after the establishment of combustion for maintaining the safety switch closed.

4. A fuel burning system of the class described comprising, means for feeding fuel to a burner, means for promoting combustion, a manual reset safety switch for controlling the operation of the fuel feeding means including a first and second U-shaped bimetal actuator each having a short and a long leg, each actuator being supported by the short leg and arranged to permit free deflection of the long leg, said first and second actuators being arranged with their short legs disposed in spaced parallel relation and their long legs extending parallel to each other and in the same direction, a catch on the end of the long leg of the first actuator, a latch hinged at one end to the end of the long leg of the second actuator and arranged to extend between the two actuators and rest on said catch, a heater adjacent the first actuator and energized during the entire operation of the fuel feeding means for moving the first actuator to release the latch, a heater adjacent the second actuator, means operative to energize said second heater while combustion exists to move the second actuator and prevent the latch being released, said first and second actuators disposed to move in unison to maintain the distance between the ends of their long legs less than a predetermined amount when both heaters are energized, said latch and said catch comprising a pair of contacts for electrically controlling the system and to render the system inoperative in the event said latch is released, means for manually resetting the latch, and a second set of contacts for additionally controlling the system operated by the resetting means and open during the resetting operation.

5. A fuel burning system of the class described comprising, means for feeding fuel to a burner,

means for promoting combustion, a manual reset safety switch for controlling the operation of the fuel feeding means including a first and second bimetal actuator, each actuator being supported at one end and arranged to permit free deflection of the other end; said first and second actuators being arranged parallel to each other, a catch actuated by the free end of one of the actuators, a latch actuated by the free end of the other actuator and arranged to engage said catch, a heater adjacent the first actuator for moving the first actuator to release the latch, condition responsive means for energizing the fuel feeding means and the heater for the first actuator, a heater adjacent the second actuator for moving the second actuator and preventing the latch being released, combustion responsive means for energizing the heater for the second actuator during the existence of combustion, said first and second actuators disposed to move in unison to maintain a predetermined relationship between their free ends when both heaters are energized or deenergized, a pair of contacts operated upon release of the latch to render the system inoperative, and means for manually resetting the latch.

6. A fuel burning system of the class described comprising, means for feeding fuel to a burner, means for promoting combustion, a manual reset safety switch for controlling the operation of the fuel feeding means including first and second bimetal actuators, a heater for moving the first actuator to open the switch, condition responsive means for concurrently energizing the fuel feeding means and the heater for the first actuator, a heater for moving the second actuator to prevent the safety switch from opening, combustion responsive means for energizing the heater for the second actuator during the existence of combustion, said first and second actuators disposed to move in unison to maintain the safety switch closed when both heaters are energized or deenergized, means for manually resetting the safety switch, and a second switch opened during the resetting operation for additionally controlling the system.

7. A burner control system comprising a motor for controlling fuel feed, a line voltage circuit for the motor, a relay having a high voltage coil for controlling the motor circuit, a choke having its primary in series with the relay coil for controlling the energization of the relay coil, said choke having a low voltage secondary, and a control circuit including the secondary of the choke whereby the relay is controlled by opening and closing the low voltage control circuit, a manual reset safety switch for additionally controlling the operation of the relay including a first and second U-shaped bimetal actuator each having a short and a long leg, each actuator being supported by the short leg and arranged to permit free deflection of the long leg, said first and second actuators being arranged with their short legs disposed in spaced parallel relation and their long legs extending parallel to each other and in the same direction, a catch on the end of the long leg of the first actuator, a latch hinged at one end to the end of the long leg of the second actuator and arranged to extend between the two actuators and rest on said catch, a heater adjacent the first actuator and energized during the entire operation of the fuel feeding means for moving the first actuator to release the latch, a heater adjacent the second actuator, means operative to energize said second heater while combustion exists to move the sec-

ond actuator and prevent the latch being released, said first and second actuators disposed to move in unison to maintain the distance between the ends of their long legs less than a predetermined amount when both heaters are energized, said latch and said catch comprising a pair of contacts for electrically controlling the system and to render the system inoperative in the event said latch is released, means for normally resetting the latch and a second set of contacts operated by the resetting means and open during the resetting operation for additionally controlling the system.

8. A burner control system comprising, a motor for controlling fuel feed, a line voltage circuit for the motor, a relay having a high voltage coil for controlling the motor circuit, a choke having its primary in series with the relay coil for controlling the energization of the relay coil, said choke having a low voltage secondary, a control circuit including the secondary of the choke whereby the relay is controlled by opening and closing the low voltage control circuit, a manual reset safety switch for additionally controlling the operation of the relay including first and second bimetal actuators, each actuator being supported at one end and arranged to permit free deflection of the other end, said first and second actuators being arranged parallel to each other, a catch of the free end of one of the actuators, a latch hinged at one end to the free end of the other actuator and arranged to extend between the two actuators and rest on said catch, a heater adjacent the first actuator for moving the first actuator to release the latch, condition responsive means for concurrently energizing the fuel feeding means and the heater for the first actuator, a heater adjacent the second actuator for moving the second actuator and preventing the latch being released, combustion responsive means, a switch jointly operated by said relay and said combustion responsive means for energizing the heater for the second actuator during the existence of combustion, said first and second actuators disposed to move in unison to maintain the distance between their free ends less than a predetermined amount when both heaters are energized or deenergized, a pair of contacts operated by the latch to render the system inoperative in the event said latch is released, means for manually resetting the latch, and a second set of contacts operated by the resetting means and open during the resetting operation for additionally controlling the system.

9. In a combustion control system, a fuel feeding motor, an electric circuit for the motor, a relay for controlling the motor circuit, an electric circuit for the relay, condition responsive means for controlling the relay, a transformer having a primary and a secondary, said primary connected in series with the relay whereby the transformer magnetizing current flows through the relay at all times, a lockout switch in the relay circuit, a bimetal time delay actuator for the lockout switch, a heater for moving the actuator to open the lockout switch, said condition responsive means and said heater connected in series with said secondary whereby said heater and relay are concurrently energized, a second bimetal actuator for the lockout switch arranged to compensate the first actuator for ambient temperature changes, a heater for moving the second actuator for maintaining the lockout switch closed, a circuit for the second actuator heater, combustion responsive means, a switch in said

last mentioned circuit controlled by the joint action of said relay and said combustion responsive means for energizing the second actuator heater during the existence of combustion, a reset switch controlling the energization of the relay, and manual means for resetting the lockout switch and opening said reset switch during the resetting operation.

10. In a combustion control system, a fuel feeding motor, an electric circuit for the motor, a relay for controlling the motor circuit, an electric circuit for the relay, a lockout switch controlling the motor, a bimetal time delay actuator for the lockout switch, a heater for moving the actuator to open the lockout switch, means including condition responsive means for controlling the relay and energizing said heater when the motor is in operation, a second bimetal actuator for the lockout switch arranged to compensate the first actuator for ambient temperature changes, a heater for moving the second actuator for maintaining the lockout switch closed, a circuit for the second actuator heater, combustion responsive means for energizing the second actuator heater during the existence of combustion, a reset switch controlling the energization of the relay, and manual means for resetting the lockout switch and opening said reset switch during the resetting operation.

11. In a control system for a fuel burner, the combination of, a thermal safety switch having an actuating element and a compensating element for controlling the operation of the burner, said compensating element being arranged to compensate the actuating element for ambient temperature changes, first heating means for the actuating element and adapted when energized to cause movement of said actuating element in a direction to open the safety switch, a second heating means for the compensating element and adapted when energized to cause said compensating element to counteract the effect of said first heating means, means including a device responsive to the demand for heat from the burner for placing the same into and out of operation, a circuit extending through said responsive device, said first heating means being interposed in said circuit, an energizing circuit for said second heating means, a switch for controlling said second heating means, and means responsive to the presence of combustion for causing actuation of said switch in a manner to energize said second heating means.

12. In a control system for a fuel burner, the combination of, a thermal safety switch having an actuating element and a compensating element for controlling the operation of the burner, said compensating element being arranged to compensate the actuating element for ambient temperature changes, first heating means for the actuating element and adapted when energized to cause movement of said actuating element in a direction to open the safety switch, a second heating means for the compensating element and adapted when energized to cause said compensating element to counteract the effect of said first heating means, means including a device responsive to the demand for heat from the burner for placing the same into and out of operation, a circuit extending through said responsive device, both of said heating means being connected in parallel relationship in said circuit and in series with said responsive device, a switch connected in series with only said second heating

means, and means responsive to the presence of combustion for causing said switch to close, thereby energizing the second heating means.

13. In a control system for a fuel burner, the combination of, a thermal safety switch having an actuating element and a compensating element for controlling the operation of the burner, said compensating element being arranged to compensate the actuating element for ambient temperature changes, first heating means for the actuating element and adapted when energized to cause movement of said actuating element in a direction to open the safety switch, a second heating means for the compensating element and adapted when energized to cause said compensating element to counteract the effect of said first heating means, means including a device responsive to the demand for heat from the burner for placing the same into and out of operation, said first heating means being connected to a source of power in series with said responsive device, an energizing circuit for said second heating means, a switch for shunting said second heating means, and means responsive to the presence of combustion for causing said switch to open, thereby energizing said second heating means.

14. In a control system for a fuel burner, the combination of, a thermal safety switch having an actuating element and a compensating element for controlling the operation of the burner, said compensating element being arranged to compensate the actuating element for ambient temperature changes, first heating means for the actuating element, second heating means for the compensating element, said heating means when energized having substantially equal effects upon their respective elements whereby when both heating means are energized the safety switch remains closed, the safety switch opening under the action of said elements only when one of said heating means is energized without the other being energized, control means responsive to the demand for heat from the burner for placing the burner into and out of operation, a combustion responsive means, and circuit means controlled by said control means and said combustion responsive means for energizing and deenergizing said heating means, said circuit means being arranged to cause heating of one only of said elements when the burner is in operation prior to response by said combustion responsive means to presence of combustion, while causing both of said heating means to be placed in the same condition after response to combustion whereby the safety switch remains closed.

15. In a control system for a fuel burner, the combination of, a thermal safety switch having an actuating element and a compensating element for controlling the operation of the burner, said compensating element being arranged to compensate the actuating element for ambient temperature changes, first heating means for the actuating element and adapted when energized to cause movement of said actuating element in a direction to open the safety switch, a second heating means for the compensating element and adapted when energized to cause said compensating element to counteract the effect of said first heating means, a relay for controlling said burner, said relay having a control circuit, a device responsive to the demand for heat for controlling said control circuit, said first heating means also being interposed in said con-

trol circuit whereby it is energized with said relay, an energizing circuit for said second heating means, said last mentioned circuit being controlled by said relay, a control device for controlling said second heating means conjointly with the relay, and means responsive to the presence of combustion for causing actuation of said control device in a manner to energize said second heating means.

16. In a control system for a fuel burner, the combination of, a thermal safety switch having an actuating element and a compensating element for controlling the operation of the burner, said compensating element being arranged to compensate the actuating element for ambient temperature changes, first heating means for the actuating element and adapted when energized to cause movement of said actuating element in a direction to open the safety switch, a second heating means for the compensating element and adapted when energized to cause said compensating element to counteract the effect of said first heating means, a relay for controlling said burner, said relay being connected across a source of power, a choke including a primary and secondary coil, the primary coil being connected in series with said relay, a switching device responsive to the demand for heat from the burner, a circuit for the secondary of said choke and including said switching device and first heating means connected in series, a circuit for the second heating means controlled by said relay, and combustion responsive means for controlling said last mentioned circuit conjointly with said relay, said combustion responsive means causing energization of said heating means upon presence of combustion.

17. In a control system for a fuel burner, the combination of, a thermal safety switch having an actuating element and a compensating element for controlling the operation of the burner, said compensating element being arranged to compensate the actuating element for ambient temperature changes, first heating means for the actuating element and adapted when energized to cause movement of said actuating element in a direction to open the safety switch, a second heating means for the compensating element and adapted when energized to cause said compensating element to counteract the effect of said first heating means, first and second switches, means for actuating said switches in sequence after the burner is placed into operation, a relay for controlling the burner, a device responsive to the demand for heat, a starting circuit for the relay extending through said responsive device and the first switch, a holding circuit closed by the relay and extending through said second switch, an energizing circuit for the second heating means, said energizing circuit being controlled by said relay, and means responsive to presence of combustion for also controlling said last mentioned energizing circuit.

18. In a control system for a fuel burner, the combination of, a thermal safety switch for controlling the operation of the burner, a heating means for said safety switch, first and second normally closed switches, means for opening said switches in sequence after the burner is started, a relay for controlling the burner, a device responsive to the demand for heat, a starting circuit for the relay extending through said responsive device and first switch, a holding circuit for the relay controlled by the relay and extending

through said second switch, and means responsive to the presence of combustion for controlling said heating means.

19. In a control system for a fuel burner, the combination of, a thermal safety switch for controlling the operation of the burner, a heating means for said safety switch, first and second normally closed switches, means actuated by a rise in temperature caused by heat from the burner for opening said first switch upon a predetermined rise in temperature and for opening said second switch upon a predetermined further rise in temperature, a relay for controlling the burner, a device responsive to the demand for heat, a starting circuit for the relay extending through said responsive device and first switch, a holding circuit for the relay controlled by the relay and extending through said second switch, and means responsive to the presence of combustion for controlling said heating means.

20. In a control system for a fuel burner, the combination of, a safety switch mechanism in control relationship with the burner, said switch mechanism being biased to open position and including a pair of members, one member adapted to hold the other member in latching engagement or to release the same upon relative movement between said members, the switch mechanism being closed when the members are in latching engagement and open when the members are released by such relative movement, a manual reset means associated with one of said members for replacing said members in latching engagement when released, a bimetal blade adapted upon rise in temperature to cause movement of one of said members relative to the other in a direction to cause release of said members and opening of the switch mechanism, said switch mechanism also including a bimetallic portion adapted to compensate for changes in ambient temperature, an electric heater for said bimetal blade, means for placing said fuel burner into operation and for energizing said electric heater to maintain said bimetal blade continuously heated while the burner is in operation, and means actuated by presence of combustion for causing movement of a portion of the switch mechanism in a direction compensating for the movement of said bimetal blade caused by energization of the heater, whereby relative movement between the members is stopped for causing said members to remain in latching engagement.

21. In a control system for a fuel burner, the combination of, a safety switch mechanism in control relationship with the burner, said switch mechanism being biased to open position and including a pair of members, one member adapted to hold the other member in latching engagement or to release the same upon relative movement between said members, the switch mechanism being closed when the members are in latching engagement and open when the members are released by such relative movement, a manual reset means associated with one of said members for replacing said members in latching engagement when released, means including a bimetal blade adapted upon a predetermined rise in temperature to cause sufficient movement of one of said members relative to the other in a direction to release said members and open the switch mechanism, an electric heater for said bimetal blade, means for placing said fuel burner into operation and for energizing said electric heater irrespective of combustion to provide said prede-

terminated rise in temperature of said bimetal blade regardless of whether or not combustion takes place, and means actuated by presence of combustion for preventing relative movement between said members caused by heating of the bimetal blade, whereby the members remain in latching engagement for maintaining the switch mechanism closed.

22. In a control system for a fuel burner, the combination of a switching mechanism for controlling the burner and including a switch, a time delay actuator operative a predetermined time after starting thereof to actuate said switch for stopping the burner, means operative upon demand for heat for starting said burner and actuator, means including a thermostatic device for preventing actuation of said switch by said time delay actuator, said switching mechanism also including means for compensating for the effect of ambient temperature changes upon the switching mechanism, a heater for said thermostatic device, a switch for controlling the heater, and means responsive to the presence of combustion for controlling said last mentioned switch in a manner to cause said thermostatic device to prevent actuation of said first mentioned switch by said time delay actuator.

23. In a control system for a fuel burner, the combination of, a switching mechanism for controlling the burner and including a switch, first and second movable control members for said switch and adapted to cause movement of said switch to burner stopping position upon a predetermined difference in movement between said control members, a time delay actuator for moving the first control member and operative a predetermined time after starting thereof to move said first control member sufficiently to stop the burner, means operative upon demand for heat from the burner to start the burner and actuator, means including a thermostatic device for moving said second control member, a heater for said thermostatic device, and means responsive to the presence of combustion for controlling said heater in a manner to cause said thermostatic device to move the second control member in a direction preventing movement of said switch to burner stopping position.

24. In a control system for an electric motor driven fuel burner, the combination of, a switch for placing the burner out of operation, a time delay device having electric means separate from said motor and adapted a period of time after actuation thereof to actuate said switch for stopping the motor, means including a shiftable member for mechanically preventing or permitting such actuation of the switch by the time delay device, means including an electric power consuming device for shifting said shiftable member between its positions, means including control means responsive to the demand for heat from the burner for actuating the time delay device and supplying electrical energy to the electric motor, and combustion responsive switching means actuated in accordance with combustion for controlling said electric power consuming device in a manner preventing such actuation of said switch by said time delay device when combustion is present.

25. In a control system for a fuel burner, the combination of, a safety switch mechanism in control relationship with the burner, said switch mechanism being biased to open position and including a pair of members, one member adapted

to hold the other member in latching engagement or to release the same upon relative movement between said members, the switch mechanism being closed when the members are in latching engagement and open when the members are released by such relative movement, a manual reset means associated with one of said members for replacing said members in latching engagement when released, means including a bimetal blade and a compensating bimetal portion therefor compensating for changes in ambient temperature, said last mentioned means being adapted upon a rise in temperature of said bimetal blade a predetermined amount above ambient temperature to cause movement of one of said members relative to the other sufficient to release said members and open the switch mechanism, an electric heater for said bimetal blade, means for placing said fuel burner into operation and for energizing said electric heater to heat said bimetal blade at least said predetermined amount irrespective of combustion whenever the burner is placed into operation, and means actuated by presence of combustion for preventing relative movement between said members caused by heating of the bimetal blade, whereby the members remain in latching engagement for maintaining the switch mechanism closed.

26. In a control system for a fuel burner, the combination of, a thermal safety switch having an actuating element and a compensating element for controlling the burner, said compensating element being arranged to compensate the actuating element for ambient temperature changes, heater means for the actuating element and adapted to cause movement of the actuating element for moving the safety switch to lockout position, heater means for the compensating element and adapted to cause the compensating element to prevent movement of the safety switch to lockout position, means responsive to the demand for heat from the burner for placing the same into and out of operation, means for rendering the actuator element heater means effective to cause movement of the safety switch to lock-out position irrespective of combustion when the burner is in operation, and combustion responsive means for controlling the compensator heater means and effective upon presence of combustion to prevent movement of the safety switch to lockout position.

27. In a control system for a fuel burner, the combination of, a safety switch mechanism in control relationship with the burner, said switch mechanism being biased to open position and including a pair of members, one member adapted to hold the other member in latching engagement or to release the same upon relative movement between said members, the switch mechanism being closed when the members are in latching engagement and open when the members are released by such relative movement, means including a thermostatic element and having a first position wherein the members are in latching engagement and a second position in which the members may be released, an electric heater for said thermostatic element for causing said means to move between its positions, control means for controlling the burner to start and stop the same and including a switch for said electric heater for causing movement of said first mentioned means from its first position to its second position when the burner is started and for maintaining said first mentioned means in its second position while the burner is in op-

eration irrespective of combustion, and means actuated by presence of combustion for preventing movement of the safety switch mechanism to open position.

28. In a control system for a fuel burner, the combination of, a thermal safety switch having an actuating element and a compensating element for controlling the burner, said compensating element being arranged to compensate the actuating element for ambient temperature changes, electric heater means for substantially heating both of said elements, means for starting and stopping the burner and controlling said electric heater means in a manner tending to cause movement of the safety switch to lockout position, and means responsive to combustion for controlling said electric heater means in a manner to prevent such movement of the safety switch to lockout position.

29. In a control system for a fuel burner, the combination of, a switch influencing the operation of the burner, means including a first thermostatic element for actuating said switch, a first electric heater for the first thermostatic element, a second thermostatic element cooperating with said first thermostatic element in controlling said switch, a second electric heater for the second thermostatic element, said second thermostatic element acting to counteract the effect on said switch caused by the first thermostatic element, means for placing the burner into opera-

tion and varying the supply of electrical energy to one of said heaters, and means normally actuated a period of time after starting of a portion of the burner for varying the supply of electrical energy to the other of said heaters.

30. In a control system for an electric motor driven fuel burner, the combination of, a switch for placing the burner out of operation, a first thermostatic element adapted upon heating thereof to actuate said switch for stopping the motor, electric heating means for heating said first thermostatic element, means including a shiftable member for mechanically preventing or permitting such actuation of the switch by the first thermostatic element, means including a second thermostatic element for shifting said shiftable member between its positions, electric heating means for said second thermostatic element, means including control means responsive to the demand for heat from the burner for energizing the electric heating means of the first thermostatic element upon demand for heat and causing electrical energy to be supplied to the electric motor, and combustion responsive switching means actuated in accordance with combustion for controlling the electric heating means of the second thermostatic element in a manner preventing such actuation of said switch by said first thermostatic element when combustion is present.

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