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FUEL BURNER CONTROL SYSTEM

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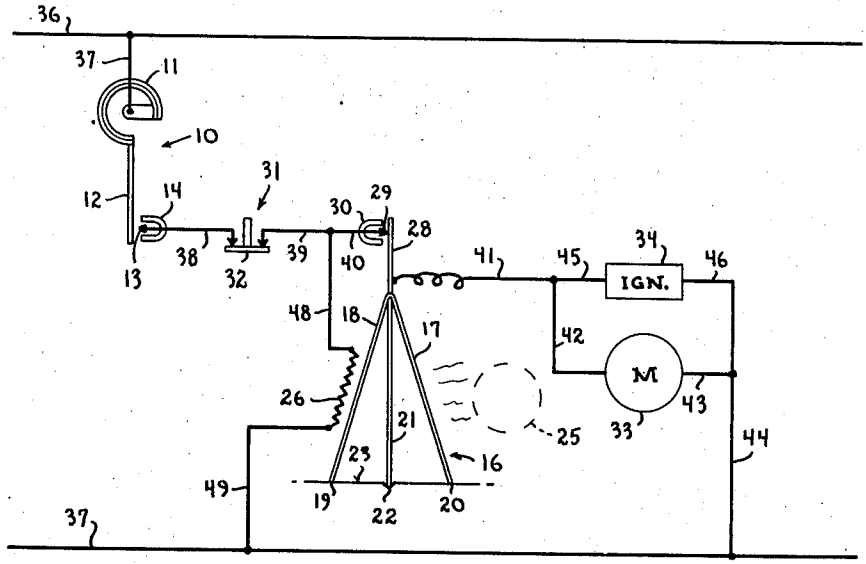

Fig. 1

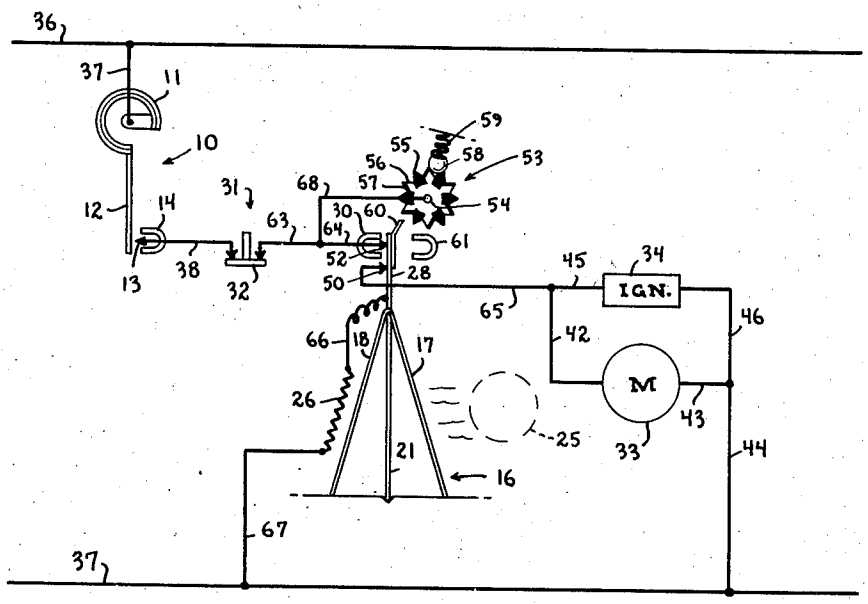

Fig. 2

INVENTOR.
Clifford I. Holmes

BY George D. Fisher
Attorney

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FUEL BURNER CONTROL SYSTEM

Gifford I. Holmes, Minneapolis, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

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10 Claims. (Cl. 158—28)

The present invention is directed broadly to automatic control systems for fluid fuel burners and is more particularly concerned with that type of system which employs an automatic means responding to combustion at the burner for performing various features of safety.

It has long been old in the art in connection with fluid fuel burners, such as oil burners, to provide the control system with a combustion responsive means and a safety switch of some sort, the function of the safety switch being to shut the system down after a predetermined trial ignition period in the event that combustion is not established, and the function of the combustion responsive means being to respond to the establishment of combustion to disable the safety switch so that the system will remain in operation in the event that combustion is successfully established. Such systems require some sort of device, usually a thermal device or a light sensitive device, for responding to the flame at the burner, and a timing device, usually a thermally operative switch utilizing an electric heater for the thermal element.

One of the principal objects of the present invention is to combine the functions of the combustion responsive device and thermal switch into a single thermal element which responds both to the temperature of combustion and also to heat supplied by an electric heater, it being contemplated that this device will shut the system down in the event that combustion is not established within a predetermined time.

A further object of the invention is to make this combustion responsive device in the form of a thermal means having two separate heat responsive portions, one portion being heated by means of an electric heater for moving the thermal means in one direction to shut the system down, and the other portion being positioned to respond to the heat of combustion for maintaining the system in operation as long as combustion continues at the burner, or until the system is shut down by some other means.

A still further object of the invention is to provide the thermal means with a recycling switching mechanism for breaking the circuit to the electric heating means in the event that combustion is not established within a predetermined time and by permitting the thermal means to cool and return to its original position after which the system can again attempt to make a normal start. If the system does not start at this time the recycling switching mechanism will maintain a circuit to the electric heating means to prevent the return of the thermal means thereby shutting the system down permanently until a manual intervention occurs. It is also contemplated that this recycling mechanism may be arranged to provide for any number of attempts to start before the final shutdown occurs, instead of just two as described above.

Still another object of the present invention is to return the thermal means to its original position in the event that combustion has not been established and the system has been shut down by the thermal means, by placing a manual switch in series with the electric heating means so that this heating means may be deenergized to permit the cooling of the thermal means and its return to its original position. This manual means is usually not operated until the trouble which prevented the normal establishment of combustion has been remedied.

These and other objects will readily become apparent as the following specification is read in the light of the accompanying drawing in which

Figure 1 is a diagrammatic representation of an oil burner control system embodying the various features of my invention, and

Figure 2 is a diagrammatic representation of an oil burner control system which is similar to that shown in Figure 1 except that it is provided with the recycling switching mechanism.

Referring now to Figure 1 of the drawing the reference character 10 indicates the primary control which in the present instance is shown in the form of a bimetallic thermostat 11 fixed at one end and carrying a contact blade 12 at the other. The thermostat is so arranged that on a decrease in temperature the contact blade 12 will be brought into engagement with the stationary contact 13. A permanent magnet 14 may be used if desired in order to secure a positive switch action.

The reference character 16 indicates generally a thermally sensitive device in the form of an elongated expansible metal ribbon having a pair of legs or heat sensitive portions 17 and 18. The metal ribbon 16 is fixed at its two ends as indicated at 19 and 20 and is supported at its mid-portion by means of a switch actuating arm 21 which is seated in a pivotal manner at 22 to a supporting member indicated diagrammatically by the line 23. This member 23 is preferably resilient and biased upwardly so that the member 21 in supporting the mid-portion of the ribbon 16 places it under tension. For a more complete showing of this particular device see the copending application of Benjamin Cyr, Serial No. 401,199, filed July 5, 1941, now Patent No. 2,299,533.

The metal ribbon 16 is so positioned that the leg 17 is directed towards the fuel burner indicated by dotted lines at 25 and is thus in a position to absorb the radiant heat caused by combustion of the burner. The leg 18 on the other hand, is protected from direct heat radiation from the burner. An electric heating element 26 is mounted adjacent the leg 18 for heating it.

The arrangement is such that when the electric heating element 26 is energized and combustion is present at the burner the temperature of the two legs 17 and 18 will be substantially the same and the member 21 will assume the position shown in Figure 1. This will also be its position when there is no combustion present in the burner and the electric heating element 26 is deenergized. When the electric heating element 26 is energized and there is no combustion present in the burner however, the temperature of the leg 18 will be greater than that of the leg 17 with the result that the member 21 will be rotated in a clockwise direction because of the thermal expansion of the leg 18 with respect to that of the leg 17.

The member 21 is provided with an extension 28 which cooperates with a stationary contact 29. A permanent magnet 30 may be provided if desired to afford a positive switch action.

The reference numeral 31 indicates a manually operable switch having a switch plate 32 for breaking the circuit. This system is adapted to control the usual burner motor, indicated at 33, for delivering fuel to the burner, and an electric ignition device indicated at 34.

Operation

The parts are shown in Figure 1 in the position that they will occupy when the room thermostat is satisfied, and the temperature of the two legs 17 and 18 of the metal ribbon 16 are at substantially the same temperatures. Under these conditions the burner motor 33 and ignition device 34 will be deenergized due to the fact that the room thermostat 10 is in open circuit position. On a decrease in temperature in the space in which the thermostat 10 is located, the bimetallic element 11 will move the switch blade 12 into engagement with its stationary contact 13. This will result in establishment of a circuit from one line wire 36 through conductor 37, bimetallic element 11, switch blade 12, contact 13, conductor 38, manual switch plate 32, conductors 39 and 40, contact 29, switch arm 28, conductors 41 and 42, burner motor 33 and conductors 43 and 44 back to the other line wire 37. The electric ignition device 34 is connected in parallel with the burner motor 33 by means of the conductors 45 and 46. It will therefore be seen that whenever the burner motor 33 is energized the electric ignition device 34 will also be energized. In other words, this system is what is known as a constant ignition system.

Closure of the thermostatic switch 12, 13 also energizes the electric heating means 26 by means of a circuit extending from the line wire 36 to conductor 37, bimetallic element 11, switch arm 12, contact 13, conductor 38, manual switch plate 32, conductors 39 and 48, electric heating means 26 and conductor 49 back to the other line wire 37.

Thus, on a call for heat by the thermostat 10, the electric heating means 26, burner motor 33 and ignition device 34 will all be simultaneously energized. The energization of the electric heating means 26 will increase the temperature of the leg 18 of the metallic ribbon 16 and this leg will consequently expand and tend to rotate the member 21 in a clockwise direction to separate the extension 28 from the stationary contact 29. After a predetermined interval of time the expansion of the leg 18 will be sufficient to pull the extension 28 away from the permanent magnet 30 with the result that the circuit to the burner motor 33 and ignition device 34 will be opened. This results in the deenergization of the burner motor and ignition device but the circuit to the electric heating means 26 will remain established. Therefore, the metal ribbon 16 will keep the extension 28 out of engagement with contact 29 and the parts will remain in this position. The system is therefore effectively shut down and locked out and will remain so until the circuit to the electric heating means 26 is broken to permit the metal ribbon 16 to cool and return to its original position in which it will close the switch 28, 29.

The manual switch 31 is provided for accomplishing this result. If this switch is opened and kept open until the leg 18 has a chance to cool down and reach substantially the same temperature as the leg 17, the member 21 will be rotated in a clockwise direction and the switch 28, 29 reclosed. Then upon the release of the manual switch 31 the system will again attempt to start by simultaneously energizing electric heater 26, burner motor 33 and ignition device 34 as before.

If combustion is established, the heat of combustion will raise the temperature of the leg 17 before the leg 18 has attained a high enough temperature to cause the arm 28 to separate from the contact 29. Under these circumstances, the two legs 17 and 18 will remain at substantially the same temperature and the switch 28, 29 will remain closed. This is the normal operating condition of the system.

It will be obvious that upon a flame failure the temperature of the leg 17 will decrease and cause the opening of the switch 28, 29 in the same manner as upon an original failure of combustion.

When the thermostat 10 is satisfied following a successful burner operation the circuit to the burner motor and ignition device and also to the electric heating means 26 will be simultaneously broken at 12, 13 so that both the legs 17 and 18 will cool down together and will remain at substantially the same temperature. The system will then be in a condition to restart when the thermostat recloses switch 12, 13.

The system shown in Figure 2 is the same, basically, as the system shown in Figure 1 except that it is provided with a recycling switching mechanism so that the system will not lock out the first time a failure of combustion occurs, but will recycle once and then lock out. Many elements of the two systems are common and these elements have been given the same reference numerals.

In Figure 2 the extension 28 on the member 21 cooperates with a pair of stationary contacts 50 and 52. A wheel indicated at 53 is rotatably mounted at 54. The wheel 53 has a saw tooth circumference formed by a plurality of pointed projections, each alternate projection being formed of insulating material as indicated at 55 whereas the remaining projections have a conducting surface 56 and an insulating surface 57. A ball 58 and spring 59 tend to maintain the wheel 53 in any one of a number of fixed positions depending upon the number of projections with which the wheel is provided. The wheel 53 is adapted to be intermittently rotated by means of a finger 60 which is carried on the projection 28 of the member 21. As the member 21 is rotated in a clockwise direction by means of the metallic ribbon 16, it will engage one of the projections on the wheel 53 and notch it around one position. If the projection which is engaged by the finger 60 is an electrically conducting projection 56 then this finger makes electrical contact between the wheel

53 and the extension 28. If it happens to be one of the insulating projections 55 then no electric contact is made. It will be noted that as the finger 60 is withdrawn from the wheel 53 after having notched it around by means of engagement with an insulating projection 55, then the finger 60 will slide on the insulating surface of the electrically conducting projection 56 and will therefore not make electrical contacts with the wheel 53. The only time that electrical contact will be made will be when the finger 60 drives the wheel by means of engagement with the conducting surface of a projection 56.

The permanent magnet 61 is provided to assure that the member 21 and the extension 28 will move with a snap action from one position to another in order to properly position the wheel 53 in one of its definite positions as determined by the ball 58 and spring 59.

Operation

The parts are shown in Figure 2 in the position they will occupy when the thermostat 10 is satisfied and the two heat responsive legs 17 and 18 of the metal ribbon 16 are at substantially the same temperature. This temperature will be substantially room temperature due to the fact that the burner motor is deenergized and hence there is no combustion in the combustion chamber of the furnace and due also to the fact that the electric heating element 26 is deenergized. On a decrease in temperature in the space in which the thermostat 10 is located the bimetallic element 11 will cause the switch arm 12 to engage its stationary contact 13. This will establish a circuit from one line wire 36 through conductor 37, bimetallic element 11, switch arm 12, stationary contact 13, conductor 38, switch plate 32, conductors 63 and 64, stationary contact 52, extension 28, stationary contact 50, conductors 65 and 42, burner motor 33, and conductors 43 and 44 back to the other line wire 37. The ignition device 34 is connected in parallel with the burner motor 33 by means of the conductors 45 and 46 in the same manner as shown in Figure 1. The above circuit will therefore simultaneously energize the burner motor 33 and the ignition device 34. At the same time, a circuit will be established from line wire 36 through conductor 37, bimetallic element 11, switch arm 12, stationary contact 13, conductor 38, switch plate 32, conductors 63 and 64, stationary contact 52, extension 28, conductor 66, electric heater element 26 and conductor 67 back to the other line wire 37. It will therefore be seen that the electric heating element 26 is energized at the same time as the burner motor 33 and ignition device 34.

If combustion fails to take place, the leg 18 of the metal ribbon 16 will increase in temperature with respect to the leg 17 and after a predetermined period of time the metal ribbon 16 will snap the extension 28 from engagement with contacts 52 and 50 over into engagement with the permanent magnet 61. During this movement of the extension 28, the finger 60 will engage the insulating projection 55 and notch the wheel 53 around one notch. It will be noted that the finger 60 does not make electrical contact with the wheel 53 during this operation due to the fact that it engages only insulating surfaces on the wheel 53. Therefore, at this time, the circuit will be broken to the burner motor 33 and ignition device 34 as well as to the electric heater 26. Therefore, the leg 18 will begin to cool off and after a predetermined period of time the metal ribbon 16 will snap the extension 28 back into engagement with the stationary contacts 52 and 50. This action reestablishes the original circuit to the burner motor 33, ignition device 34, and electrical heating element 26. Therefore, the leg 18 will again begin to heat up and if combustion is not established will again snap the extension 28 into engagement with the permanent magnet 61. At this time, it will be noted, an electrically conducting projection 56 will be engaged by the finger 60 and this will establish an electric circuit extending from the line wire 36 to conductor 37, bimetallic element 11, switch arm 12, stationary contact 13, conductor 38, switch plate 32, conductors 63 and 68, wheel 53, electrically conducting projection 56, finger 60, extension 28, conductors 66, electrically heating element 26 and conductor 67 back to the other line wire 37. Therefore, under these conditions the extension 28 in snapping into engagement with the permanent magnet 61 will break the circuit to the burner motor 33 and electric ignition device 34, and will also break the original energizing circuit for the electric heating element 26, but the finger 60 in cooperating with an electrically conducting portion of the wheel 53 will set up a holding circuit for the electric heating element 26. Therefore, this element will remain energized and the leg 18 will remain heated. The parts will therefore remain in this position until the circuit to the electric heating element 26 is broken by means of the manual switch 31, thus causing the ribbon 16 to snap the extension 28 back into engagement with the two stationary contacts 52 and 50.

It will therefore be seen that this control system will recycle once before it locks out permanently. As in the case of the control system shown in Fig. 1, if combustion is established before the extension 28 is snapped away from its stationary contact, then the leg 17 will be heated up and maintained at substantially the same temperature as the leg 18, thus preventing the metal ribbon 16 from breaking the circuit to the burner motor and ignition device.

If the system is operating normally and a flame failure should occur, the leg 17 will commence to cool while leg 18 will remain heated by the electric heating element 26. Therefore, the ribbon 16 will snap the extension 28 to the right and notch the wheel 53 around one notch. As the finger 60 will engage an insulating projection on the wheel 53 it will break the circuit to the heating element and the ribbon 16 will return the extension 28 into engagement with its two stationary contacts 52 and 50. This will reenergize the circuit to the burner motor 33 and ignition device 34, as well as the electric heating element 26. The system will then attempt a normal start and if combustion is established will remain in running position, but if combustion is not established it will break the circuit to the burner motor and ignition device while maintaining the circuit to the electric heating element 26, thereby effectively locking the system out. Thus, this system will recycle once on a flame failure following a successful establishment of combustion. The time required for the ribbon to cool and return to its original position in each case will always provide for the proper scavenger period.

It will be readily appreciated that the wheel 53 may be designed with any number of insulating projections 53 to provide for any number of trial ignition periods before the system permanently locks out. Various other changes and modifications of this invention will undoubtedly occur to those who are skilled in the art and I therefore

intend to be limited only by the scope of the appended claims and not by the specific embodiments which have been disclosed herein merely for the purposes of illustration.

I claim as my invention:

1. A fluid fuel burner control system comprising in combination, an electric device controlling the delivery of fuel to a burner for combustion, thermal means having a first heat responsive portion, electric heating means for said first portion, first circuit means including said electric heating means, second circuit means including said electric device, switch means controlling both of said circuits, means for energizing both of said circuit means in response to a demand for burner operation, said switch means being moved alternately to open and closed positions by said thermal means, in the absence of combustion, as a result of the alternate energization and deenergization of said electric heating means by said switch means, means actuated by said thermal means for preventing the automatic reclosure of said switch means by said thermal means after at least one such reclosure, and means comprising a second heat responsive portion of said thermal means which is responsive to the heat of combustion for preventing said thermal means from opening said switch means in the event that combustion is established first.

2. A fluid fuel burner control system comprising in combination, an electric device controlling the delivery of fuel to a burner for combustion, thermal means having a first heat responsive portion, electric heating means for said first portion, first circuit means including said electric heating means, second circuit means including said electric device, switch means controlling both of said circuits, means for energizing both of said circuit means in response to a demand for burner operation, said switch means being moved alternately to open and closed positions by said thermal means, in the absence of combustion, as a result of the alternate energization and deenergization of said electric heating means by said switch means, circuit closing means actuated by said thermal means, said circuit closing means being operative at times, and inoperative at times, to close a circuit to said electric heating means which is independent of said switch means for causing said thermal means to maintain said switch means in open position, and means comprising a second heat responsive portion of said thermal means which is responsive to the heat of combustion for preventing said thermal means from opening said switch means in the event that combustion is established first.

3. A fluid fuel burner control system comprising in combination, an electric device controlling the delivery of fuel to a burner for combustion, thermal means having a first heat responsive portion, electric heating means for said first portion, first circuit means including said electric heating means, second circuit means including said electric device, switch means controlling both of said circuits, means for energizing both of said circuit means in response to a demand for burner operation, said switch means being moved alternately to open and closed positions by said thermal means, in the absence of combustion, as a result of the alternate energization and deenergization of said electric heating means by said switch means, means actuated by said thermal means for preventing the automatic reclosure of said switch means by said thermal means after at least one such reclosure, means comprising a second heat responsive portion of said thermal means which is responsive to the heat of combustion for preventing said thermal means from opening said switch means in the event that combustion is established first, and manual means for deenergizing said electric heating means to permit said thermal means to return to its original position and reclose said switch means.

4. A fluid fuel burner control system comprising in combination, an electric device controlling the delivery of fuel to a burner for combustion, thermal means having a first heat responsive portion, electric heating means for said first portion, first circuit means including said electric heating means, second circuit means including said electric device, switch means controlling both of said circuits, means for energizing both of said circuit means in response to a demand for burner operation, said switch means being moved alternately to open and closed positions by said thermal means, in the absence of combustion, as a result of the alternate energization and deenergization of said electric heating means by said switch means, circuit closing means actuated by said thermal means, said circuit closing means being operative at times and inoperative at times, to close a circuit to said electric heating means which is independent of said switch means for causing said thermal means to maintain said switch means in open position, means comprising a second heat responsive portion of said thermal means which is responsive to the heat of combustion for preventing said thermal means from opening said switch means in the event that combustion is established first, and manual means for deenergizing said electric heating means to permit said thermal means to return to its original position and reclose said switch means.

5. A fluid fuel burner control system comprising in combination, an electric device controlling the delivery of fuel to a burner for combustion, thermal means having a first heat responsive portion, electric heating means for said first portion, first circuit means including said electric heating means, second circuit means including said electric device, switch means controlling both of said circuits, means for energizing both of said circuit means in response to a demand for burner operation, said switch means being moved alternately to open and closed positions by said thermal means, in the absence of combustion, as a result of the alternate energization and deenergization of said electric heating means by said switch means, circuit closing means actuated by said thermal means, said circuit closing means cooperating with said thermal means to close a circuit to said electric heating means on each alternate switch opening movement of said thermal means, said last named circuit being independent of said switch means whereby said thermal means maintains said switch means open when said last named circuit is closed, and means comprising a second heat responsive portion of said thermal means which is responsive to the heat of combustion for preventing said thermal means from opening said switch means in the event that combustion is established first.

6. A fluid fuel burner control system comprising in combination, an electric device controlling the delivery of fuel to a burner for combustion, thermal means having a first heat responsive portion, electric heating means for said first portion,

first circuit means including said electric heating means, second circuit means including said electric device, switch means controlling both of said circuits, means for energizing both of said circuit means in response to a demand for burner operation, said switch means being moved alternately to open and closed positions by said thermal means, in the absence of combustion, as a result of the alternate energization and deenergization of said electric heating means by said switch means, circuit closing means actuated by said thermal means, said circuit closing means cooperating with said thermal means to close a circuit to said electric heating means on each alternate switch opening movement of said thermal means, said last named circuit being independent of said switch means whereby said thermal means maintains said switch means open when said last named circuit is closed, means comprising a second heat responsive portion of said thermal means which is responsive to the heat of combustion for preventing said thermal means from opening said switch means in the event that combustion is established first, and manual means for deneergizing said electric heating means to permit said thermal means to return to its original position and reclose said switch means.

7. A unit adapted to be used in the control of a fluid fuel burner comprising in combination, a thermal means having first and second heat responsive portions, said second portion being adapted to be positioned to absorb the heat of combustion of a burner, an electric heating means for said first portion, switch means electrically connected to said electric heating means for energizing and deenergizing the same, means operated by said thermal means for closing said switch means when said two portions are at substantially the same temperature and for opening said switch means and deenergizing said electric heating means when said second portion is at a higher temperature than said first portion, and circuit closing means operated by said thermal means and operative at certain times when said thermal means opens said switching means to close a circuit to said electric heating means which is independent of said switching means whereby said thermal means holds said switching means in open position.

8. A fluid fuel burner control system comprising in combination; a burner; a device for controlling the delivery of fuel to a burner for combustion; a main controller for controlling the operation of said device; a thermal safety controller for controlling operation of said device comprising a pivoted controlling arm, a ribbon of a material expansible with temperature, means for placing said ribbon under tension with an intermediate point thereof engaging said controlling arm so that said controlling arm assumes a position dependent upon the relative expansion of the two portions of the ribbon, and means for heating one portion of said ribbon, the other portion being exposed to the heat of combustion of said burner; said cntrolling arm of said safety controller being movable between a normal position which it assumes when both portions of the ribbon are unheated and in which said fuel flow controlling device can be operated under the control of said main controller and a second position in which such operation is prevented; the portion of said ribbon with which said heating means is associated being effective when heated to cause movement of said controlling arm to said second position unless such movement is prevented by the heating of said other portion through the establishment of combustion; and means under the control of said main controller for rendering said heating means effective.

9. A fluid fuel burner control system comprising in combination; a burner; an electrically operated device for controlling the delivery of fuel to a burner for combustion; a main switch for controlling the operation of said device; a thermal safety controller for controlling operation of said device comprising a switch, a pivoted arm for actuating said switch, a ribbon of a material expansible with temperature, means for placing said ribbon under tension with an intermediate point thereof engaging said controlling arm so that said controlling arm assumes a position dependent upon the relative expansion of the two portions of the ribbon, and an electrical heater for heating one portion of said ribbon, the other portion being exposed to the heat of combustion of said burner; circuit means including said main switch and said switch of said thermal safety controller for causing energization of said device when both of said switches are closed; said switch actuating arm being movable between a normal position which it assumes when both portions of the ribbon are unheated and in which said switch of said safety controller is closed and a second position in which said safety switch is open; the portion of said ribbon with which said electrical heater is associated being effective when heated to cause movement of said switch actuating arm to said second position unless such movement is prevented by the heating of said other portion through the establishment of combustion; and a circuit under the control of said main switch for energizing said electrical heater.

10. In a fluid fuel burner control mechanism, switch means adapted to be connected to a device for controlling the delivery of fuel to a burner for combustion, thermal means for positioning said switch means, said thermal means having a first heat responsive portion which when heated tends to cause said switch means to be opened, electric heating means for said first portion, said heating means being electrically connected to said switch means and adapted to be connected to a main controlling switch and a source of power so as to tend to cause said switch means to move alternately to open and closed positions as a result of energization and deenergization of said electric heating means by said switch means, circuit closing means associated with said thermal means and actuated thereby each time that said thermal means is effective to move said switch means to open position, said circuit closing means cyclically assuming circuit closing and circuit opening positions during the successive movements of said switching means to open position, circuit connections between said circuit closing means, said switch means and said heater, such that during certain opening movements of said switch means, said heater is not deenergized so that it maintains said thermal means heated and said switch means in open position, and means comprising a second heat responsive portion of said thermal means which is adapted to respond to the heat of combustion for preventing said thermal means from opening said switch means in the event that combustion is established first.

GIFFORD I. HOLMES.