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2,338,786

FUEL BURNER CONTROL SYSTEM

Filed June 16, 1941

2 Sheets-Sheet 1

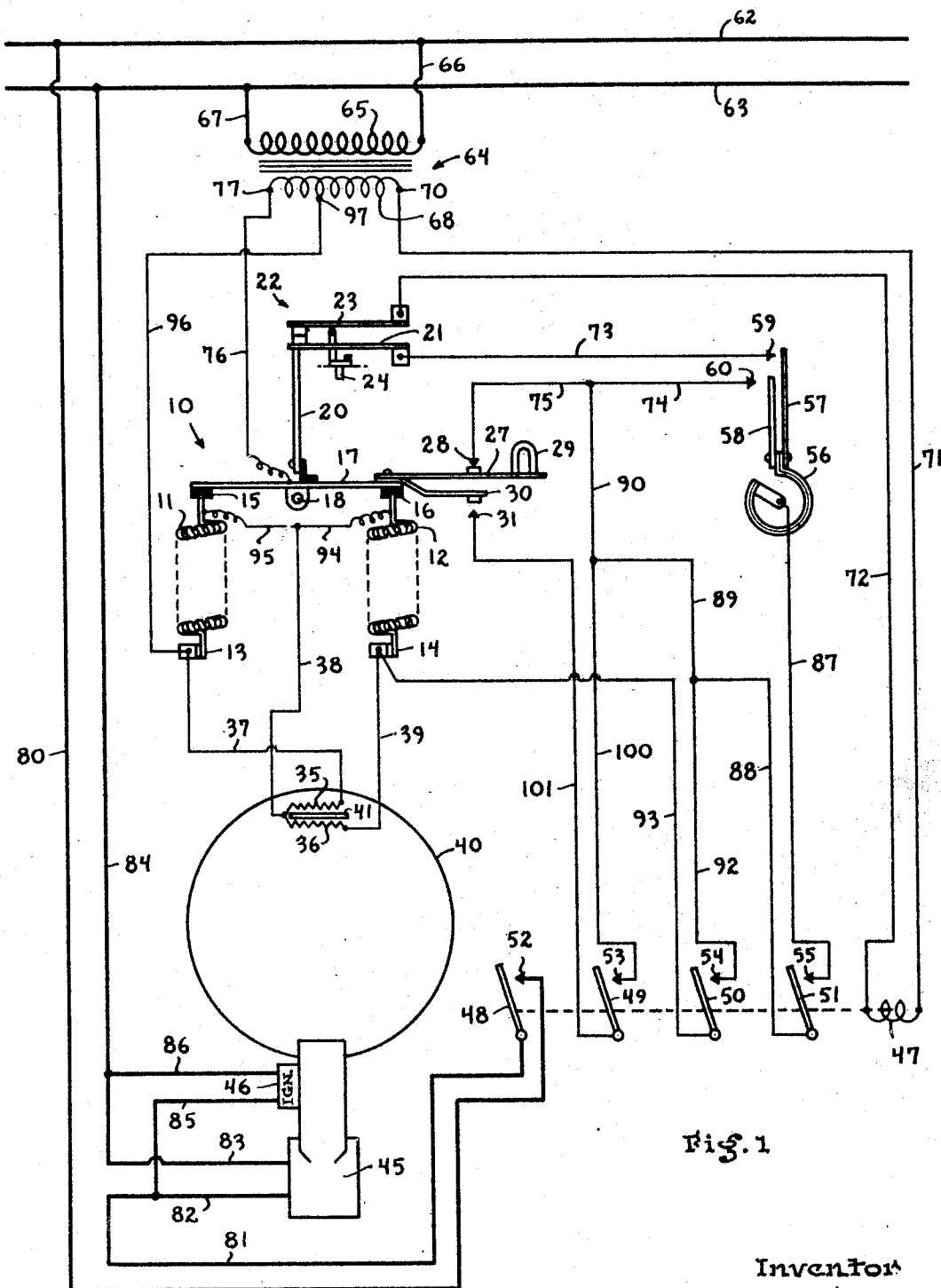


Fig. 1

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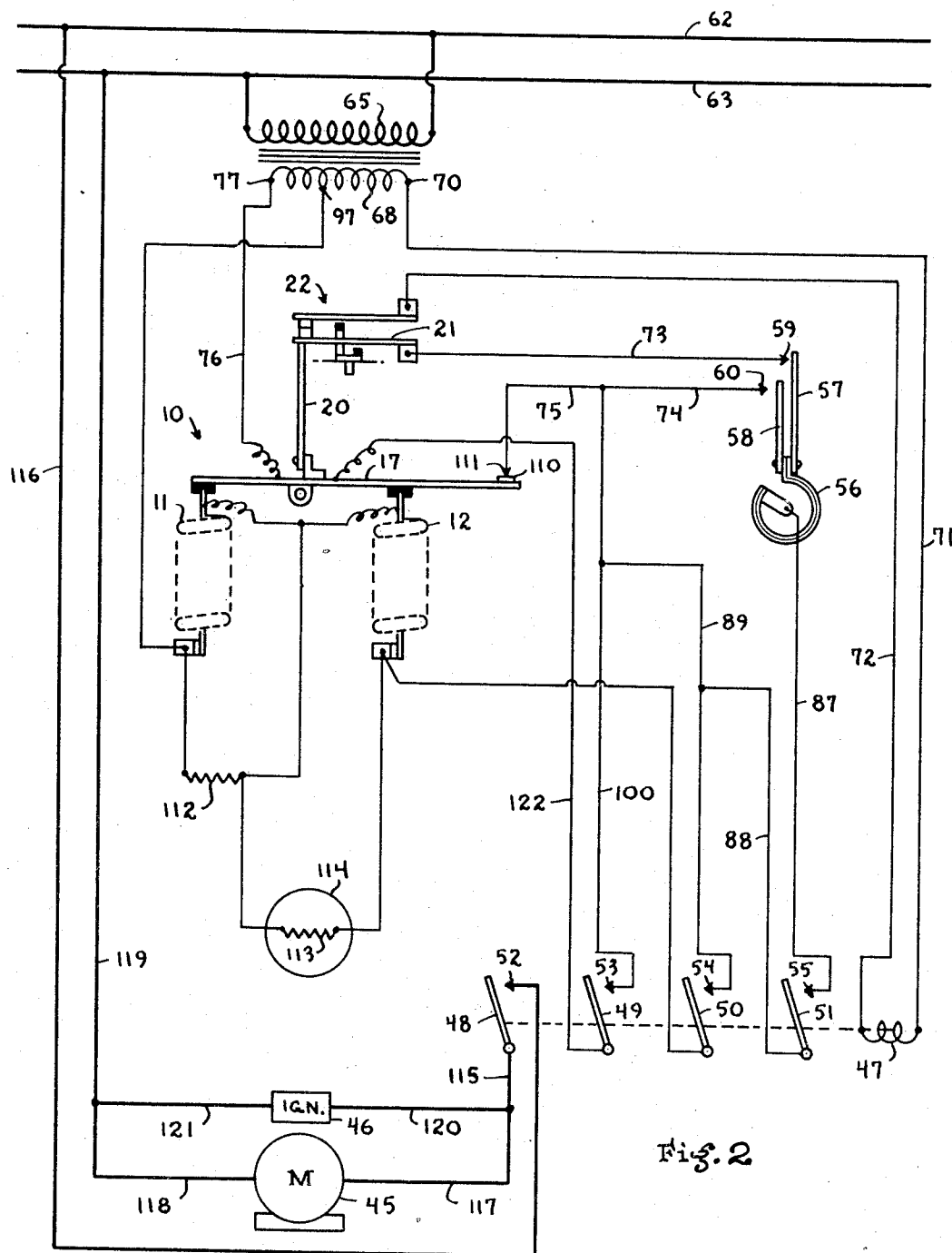
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2 Sheets-Sheet 2



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FUEL BURNER CONTROL SYSTEM

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13 Claims. (Cl. 158—28)

This invention relates to fuel burner control systems of the type requiring a timer for shutting the system down in the event that combustion is not established within a predetermined period of time following a call for heat. These systems obviously require some device which will stop the running of this time period after combustion has been established.

One of the main objects of the present invention is to provide a thermal timer for accomplishing the desired result, this timer moving, when energized, in a direction to deenergize the fuel delivery device as long as combustion has not been established, but to reverse its direction of movement upon the establishment of combustion, the direction of movement of said thermal timer being controlled by a combustion responsive resistance as long as said timer is energized.

A further object is to utilize this thermal timer for controlling the starting circuit and therefore time the scavenger period between successive energizations of the fuel delivery device. It is also contemplated that this timer may be used for controlling the running circuit so that the system will recycle in the event of a flame failure.

A still further object is to provide a thermal timer which is compensated both for variations in ambient temperature and also for variations in line voltage. The thermal elements forming the thermal timer are preferably in the form of double helices.

Although this invention will be described in connection with an oil burner control system, it will readily be apparent that it may be adapted for the control of systems involving other types of fuel.

The above and other objects will become more apparent as the following specification is read in the light of the accompanying drawings, in which:

Figure 1 is a diagrammatic representation of an oil burner control system incorporating my invention, and

Figure 2 is a diagrammatic representation of a slightly modified system.

Referring now to Figure 1, the reference numeral 10 indicates generally a thermal timer including two heat motors 11 and 12. Each of these heat motors comprises a double helix bimetal thermostatic element such as is disclosed in the patent to Parsons 2,121,259. Inasmuch as the strip of bimetal from which these heat motors are made is of a relatively great length, they may be satisfactorily heated merely by passing

current through them, thus eliminating the necessity of a separate electric heater.

The thermal elements 11 and 12 are mounted at one end on the brackets 13 and 14, respectively, and at the upper ends carry insulating members 15 and 16, respectively, which in turn engage opposite ends of a lever 17 which is pivotally mounted as shown at 18. When the two thermal elements 11 and 12 are at substantially the same temperature, they will tend to assume the same length with the result that the lever 17 will occupy a horizontal position as shown in Figure 1. If the current flow through element 11 should become greater than the current flow through element 12, element 11 will increase in temperature and contract and rotate the lever 17 in a counter-clockwise direction, whereas if the element 12 should be the more highly heated the opposite is true and the lever 17 will be rotated in a clockwise direction.

Arm 20 is insulantly carried by the lever 17 and when the lever is in its horizontal position, arm 20 is adapted to engage beneath the resilient blade 21 of a biased open safety switch indicated generally at 22. The upper blade 23 of the safety switch is in closed circuit position with respect to the blade 21 when blade 21 is held by the arm 20, as shown in the drawings. When the lever 17 rotates counterclockwise a predetermined amount, the arm 20 moves from beneath the blade 21 which then moves downwardly due to its bias and opens the safety switch 22. The reference numeral 24 indicates a manual reset of the trip-free type for resetting the safety switch 22 to closed position once it has been opened. The specific construction of this type of switch is old in the art and forms no part of the present invention.

The right-hand end of the lever 17, as seen in Figure 1, carries a resilient blade 27 which, when the lever 17 is in horizontal position, is in engagement with the stationary contact 28 and also in a strong part of the field of the permanent magnet 29. Lever 17 carries a second contact arm 30 which is adapted to cooperate with the stationary contact 31. When the lever 17 moves in a clockwise direction, contact arm 30 will engage the stationary contact 31 before the permanent magnet 29 will permit the resilient blade 27 to snap to open circuit position. Therefore the switches 27, 28 and 30, 31 overlap as the lever 17 moves in a clockwise direction. On movement of the lever 17 in the opposite direction, contacts 30 and 31 will separate before the blade 27 moves close enough to the magnet 29 to

cause it to snap it into engagement with the stationary contact 28. Therefore, the switches do not overlap when the lever 17 moves in a counter-clockwise direction. This type of switching action is shown in my Patent No. 2,223,796.

When the two thermal elements 11 and 12 are energized by an electric current flowing through them, the relative amount of current flowing through each one of them is controlled by means of two resistances 35 and 36. The resistance 35 is connected in parallel with the thermal element 11 by means of the conductors 37, 38 and 95 and the resistance element 36 is connected in parallel with the thermal element 12 by means of conductors 94, 38 and 39. Both of the resistances 35 and 36 may be mounted directly in the combustion chamber of a furnace indicated at 40. The element 36 is located so as to respond directly to the radiant heat of combustion, whereas the element 35 responds only to the ambient temperature in the combustion chamber and is shielded from direct heat radiation from the flame by some such means as the shield 41. The result of this arrangement is that in the absence of combustion the two resistance elements 35 and 36 will be at substantially the same temperature, but when combustion is established the temperature of the element 36 will be considerably higher than that of element 35 due to its absorption of radiant heat energy from the flame. The resistance of these two elements when they are at the same temperature is unequal, element 36 having a lower value than 35 so that in the absence of combustion the thermal element 11 will draw a larger current and hence will be more highly energized than the thermal element 12. Upon the establishment of combustion, the resistance value of the element 36 will increase above that of element 35, at which time the thermal element 12 will draw the higher current and therefore be more highly energized than the thermal element 11.

In as much as these two thermal elements 11 and 12 oppose each other it will be clear that changes in ambient temperature will have no effect upon the lever 17. Moreover, as current flows through both elements simultaneously, variations in line voltage will affect them both alike and will not have any tendency to move lever 17.

This system is provided with the usual oil burner motor 45 and ignition device 46 for producing combustion within the furnace 40. They are under the control of the electromagnetic relay which has a winding 47. This relay controls a plurality of switch arms 48, 49, 50, and 51 which when the relay winding 47 is energized are moved to engage the stationary contacts 52, 53, 54, and 55, respectively.

The main control is effected by the usual room thermostat, which in this instance is shown as comprising a bimetal coil 56 fixed at one end and carrying at its free end a pair of switch blades 57 and 58, which when the temperature decreases to a predetermined value engage the stationary contacts 59 and 60, respectively. The stationary contacts are so arranged that the blade 57 will first engage contact 59 and then at a slightly lower temperature the blade 58 will engage contact 60. The power for operating the system is derived from two line wires 62 and 63. A step-down transformer 64 is provided with a primary winding 65 connected at one end to the line wire 62 by means of conductor 66 and con-

nected at the other end to line wire 63 by the conductor 67. The transformer 64 is provided with the usual secondary winding 68 for supplying low voltage power to the control system.

Operation

In Figure 1 the parts are shown in the position which they will occupy when the room thermostat is satisfied. At this time no current will flow through the two thermal elements 11 and 12 inasmuch as the circuit thereto is open at the switch blade 50. These elements have reached substantially equal temperatures and therefore the lever 17 is in horizontal position at which time resilient blade 27 engages the starting contact 28. The oil burner 45 and the ignition device 46 are deenergized and therefore the temperature in the room in which the thermostat 56 is located will begin to fall. The switch blade 57 will first engage the stationary contact 59 but this will establish no circuit at this time due to the fact that the switch arm 51 is out of engagement with the contact 55. On a further decrease in room temperature, the switch blade 58 will engage stationary contact 60 and establish the following circuit: from one side 70 of the secondary winding 68 through conductor 71, relay winding 47, conductor 72, safety switch 22, conductor 73, contact 59, switch blades 57 and 58, contact 60, conductors 74 and 75, contact 28, switch blade 27, lever 17, and conductor 76 back to the other side 77 of the secondary winding 68. This circuit energizes the relay winding 47 which causes the switch blades 48, 49, 50, and 51 to engage their respective stationary contacts. Engagement of the switch blade 48 with the stationary contact 52 establishes a circuit from line wire 62 through conductor 80, contact 52, switch blade 48, conductors 81 and 82, burner motor 45, and conductors 83 and 84 back to line wire 63. The ignition device 46 is connected in parallel with the burner motor 45 by means of the conductors 85 and 86.

Engagement of the switch arm 51 with contact 55 sets up a holding circuit for the relay winding 47 which is independent of the switch blade 58 and contact 60. This circuit may be traced from the end 70 of the secondary 68, conductor 71, relay winding 47, conductor 72, safety switch 22, conductor 73, contact 59, switch blade 57, thermostat 56, conductor 87, contact 55, switch arm 51, conductors 88, 89, 90 and 75, contact 28, switch blade 27, lever 17, and conductor 76 back to the end 77 to secondary winding 68. Therefore at this time the switch blade 58 may separate from the contact 60 and have no effect on the relay winding 47 which will remain energized until the first-to-close switch blade 57 separates from the contact 59.

Closure of the switch blade 50 with the stationary contact 54 sets up a circuit for the thermal elements 11 and 12, as well as the resistances 35 and 36. This circuit may be traced from the end 77 of the transformer secondary 68 through conductor 76, lever 17, switch blade 27, contact 28, conductors 75, 90, 89, and 92, contact 54, switch arm 50, conductor 93, thermal element 12, conductors 94 and 95, thermal element 11, and conductor 96 back to the tap 97 on the secondary winding 68. The tap 97 is used in this case because it is not desired to have the full secondary voltage applied across the thermal elements 11 and 12. The above circuit causes a current flow through the thermal elements 11 and 12 which will result in their becoming heated

due to the resistance of the bimetal of which they are composed. As set forth above, the relative values of current flowing through these elements is determined by the values of resistance of the two resistance elements 35 and 36 which are connected in parallel with the thermal elements 11 and 12, respectively. Inasmuch as the temperature of the two resistances 35 and 36 will be the same on an original call for heat when there is no combustion present in the furnace, the resistance value of the element 36 will be lower than that of the element 35 causing the thermal element 11 to be more highly energized than the thermal element 12. This will cause a contraction of the thermal element 11 and a slow movement of the lever 17 in a counter-clockwise direction.

If combustion is not established within a predetermined period of time, the continued movement of lever 17 in a counter-clockwise direction will cause the arm 20 to move from beneath the resilient blade 21 and the safety switch 22 will therefore open due to its bias. This will deenergize the relay winding 47 and all of the switch arms 48, 49, 50, and 51 will drop out, thereby deenergizing the burner motor 45, ignition device 46, and breaking the circuit through the thermal elements 11 and 12. It will be noted that the safety switch 22 cannot be reset automatically but must be manually reset by the member 24.

In the event that combustion is established before the safety switch has been opened, the temperature of the resistance element 36 will increase to a value higher than that of the element 35, and at this time the thermal element 12 will become more highly energized than the thermal element 11. This will cause the lever 17 to start rotating in a clockwise direction. It will move past its original horizontal or starting position and will continue until it moves the switch blade 30 into engagement with the contact 31 and later will snap the resilient switch blade 27 out of engagement with contact 28. The relay winding 47 will now be held in by means of a circuit extending from the end 70 of the secondary winding 68 through conductor 71, relay winding 47, conductor 72, safety switch 22, conductor 73, contact 59, switch blade 57, thermostat 56, conductor 87, contact 55, switch arm 51, conductors 88, 89 and 100, contact 53, switch arm 49, conductor 101, contact 31, switch blade 30, lever 17, and conductor 76 back to the end 77 of the secondary winding 68. This is the running condition of the system.

When the temperature in the room increases, the thermostat 56 will cause the switch blade 57 to separate from the stationary contact 59, thereby deenergizing the relay winding 47 and dropping out the switch arms 48, 49, 50 and 51. This will result in the immediate deenergization of the oil burner motor 45 and the ignition device 46 and will also break the circuit through the thermal elements 11 and 12. They will therefore return to the same temperature and move the lever 17 back to its horizontal position, as shown in Figure 1. It will be noted that the relay winding cannot be reenergized until the lever 17 recloses the switch blade 27 and stationary contact 28. It is this action which times the scavenger period.

A power failure while the system is in running condition will deenergize the relay winding 47 and, as set forth above, this winding cannot be reenergized until the lever 17 has returned to

horizontal position. This will prevent the burner motor from being brought back on before the combustion chamber has been purged of unburned vapors.

In the event of a flame failure during the running of the system, the temperature of the element 36 will rapidly decrease and become equal to that of the element 35, at which time the thermal element 11 will become more highly energized than the thermal element 12. This will cause the lever 17 to rotate in a counter-clockwise direction and disengage the switch blade 30 from stationary contact 31. This will break the circuit through the relay winding 47 and deenergize the burner motor and ignition as well as the circuit through the thermal elements 11 and 12. As set forth above, the system cannot be reenergized until the lever 17 returns the switch blade 27 into engagement with the stationary contact 28, at which time the combustion chamber will have been purged. The system will then recycle by reenergizing its original starting circuit if the switch blade 58 is engaged with contact 60.

In the modification shown in Figure 2, the thermal timer 10 is exactly the same as in the modification shown in Figure 1, with the exception that the lever 17 directly carries a movable contact 110 which engages stationary contact 111. This is the only movable contact carried by the lever 17 and hence there is no overlap or non-overlap action. The safety switch 22 is exactly the same as is the transformer secondary 68 with its tap 97. Also the thermal element 56 remains the same and the relay winding 47 with its four switch blades 48, 49, 50 and 51. Also, the same burner motor 45 and ignition device 46 may be used.

This modification differs from the modification of Figure 1 in that one of the resistance elements 112 which is connected in parallel with the thermal element 11 has a fixed resistance value and is positioned so as not to be subject to the temperature of combustion. The resistance element 113 connected in parallel with the thermal element 12 has a positive temperature coefficient of resistance and is very sensitive and may be mounted in the stack 114 which carries the products of combustion from the furnace. When there is no combustion present in the furnace, the resistance element 112 has a higher resistance value than the element 113 and these resistances may be so chosen that when they are near the same temperature the wattage consumed in thermal element 11 is approximately 50% greater than that consumed in the element 12. This always results in the rotation of the lever 17 in a counter-clockwise direction. Upon the establishment of combustion the temperature of the element 113 will increase and at a temperature of about 400° may increase to such a value that the wattage consumed in the thermal element 12 will now be approximately 50% greater than that consumed in the thermal element 11 with the result that the lever 17 will now rotate in a clockwise direction.

Operation

The parts are shown in Figure 2 in the position which they will occupy when the room thermostat 56 is satisfied and the thermal elements 11 and 12 are at the same temperature value. The lever 17 will therefore be closing the starting switch 110, 111. On a call for heat by the room

thermostat, a circuit will be established from one end 70 of the secondary winding 68 through conductor 71, relay winding 47, conductor 72, safety switch 22, conductor 73, contact 59, switch blade 57, switch blade 58, contact 60, conductors 74 and 75, contact 111, movable contact 110, lever 17, and conductor 76 back to the other side 77 of the secondary winding. The above circuit will energize the relay winding 47 and result in the switch arms 48, 49, 50, and 51 moving into engagement with their respective stationary contacts 52, 53, 54, and 55. Engagement of switch arm 48 with contact 52 will result in the energization of the burner motor 45 by means of a circuit extending from line wire 62 through conductor 116, contact 52, switch arm 48, conductors 115 and 117, burner motor 45, and conductors 118 and 119 back to line wire 63. The ignition device 46 is connected in parallel with the burner motor 45 by means of conductors 120 and 121. Engagement of switch arm 51 with contact 55 will close a holding circuit for relay winding 47 which is independent of switch blade 58 and contact 60 in the same manner as described in connection with Figure 1. Engagement of switch blade 50 with contact 54 will close the circuit through the thermal elements 11 and 12 in the same manner as that traced in connection with Figure 1. Engagement of contact arm 49 with contact 53 will set up the following holding circuit for the relay winding 47: from the end 70 of the secondary winding 68, conductor 71, relay winding 47, conductor 72, safety switch 22, conductor 73, contact 59, switch blade 57, thermostat 56, conductor 87, contact 55, switch arm 51, conductors 88, 89 and 100, contact 53, switch blade 49, conductor 122 directly to lever 17 and conductor 76 back to the other side 77 of the secondary winding 68. It will be noted that this holding circuit is set up immediately the relay winding 47 is energized and maintains this energization independently of the contacts 110 and 111.

The thermal timer 10 functions in exactly the same manner as it does in connection with Figure 1 to open the safety switch in the event that combustion is not established within a predetermined time. If combustion is established, however, the resistance value of the element 113 increases to such an extent that the thermal timer reverses its movement and moves past its starting position, separating the contacts 110 and 111. In the event of a normal shut-down by the thermostat 56 or a shut-down due to power failure, the relay winding 47 will be deenergized and cannot be reenergized again until the thermal timer 10 recloses its contacts 110 and 111. The thermal timer therefore times the scavenger period following a normal shut-down or a shut-down from power failure.

In the case of a flame failure, the resistance value of the element 113 will decrease due to a rapid decrease in temperature in the stack and the thermal element 11 will become the more highly energized, causing a rotation of the lever 17 in a counter-clockwise direction. The relay winding 47 will remain energized in this case until the lever 17 has rotated far enough to move the arm 20 from beneath the switch blade 21 of the safety switch 22 and permit this switch to open. This results in the deenergization of the relay winding 47 and hence takes all power off of the system. The system remains effectively locked out until the safety switch is normally reset and

hence there is no recycle in this case as there is in Figure 1 which has the contacts 30 and 31 for deenergizing the relay winding 47 immediately following a flame failure.

It will be appreciated that the specific arrangement of the two elements 35 and 36 may be used in connection with the non-recycling system shown in Figure 2, and likewise the fixed resistance 112 and the stack mounted resistance 113 of Figure 2 may be used equally well with the recycling system shown in Figure 1.

It will be seen therefore that I have designed a system in which a single thermal timer controlled by combustion operates a safety switch as well as a starting switch and a running switch for controlling a system which recycles on flame failure and that the running switch may be eliminated if it is desired to provide a system which does not recycle on flame failure.

There will undoubtedly be many changes and modifications of the above two systems which will occur to those who are skilled in the art, and I therefore desire to be limited by the scope of the appended claims and not by the specific embodiments disclosed.

I claim as my invention:

1. A fuel burner control system comprising in combination, electrical means which, when energized, delivers fuel to a combustion chamber, a normally deenergized timer having a starting position, a main switch for energizing said electrical means and at substantially the same time energizing said timer for movement in a direction to deenergize said electrical means after a predetermined period of time, means responsive to combustion for controlling the energization of said timer, providing it has not already deenergized said electrical means, to reverse its direction of movement and move to a position on the other side of its starting position, and means operative after the establishment of combustion for preventing the reenergization of said electrical means, once it has been deenergized, until said timer returns to its starting position.

2. A fuel burner control system comprising in combination, electrical means which, when energized, delivers fuel to a combustion chamber, a normally deenergized timer having a starting position, a safety switch, a main switch, an energizing circuit for said electrical means including said main switch and said safety switch, means operative upon closure of said main switch to cause energization of said timer, and combustion responsive means controlling the energization of said timer to control the direction of movement of said timer during the time said timer is energized to cause movement of said timer in a direction to open said safety switch in the absence of combustion and in the opposite direction in the presence of combustion, said timer returning to its starting position upon deenergization.

3. A fuel burner control system comprising in combination, electrical means which, when energized, delivers fuel to a combustion chamber, a normally deenergized timer having a starting position, a safety switch, a starting switch, a main switch, a starting circuit for said electrical means comprising said safety switch, starting switch, and main switch in series, a holding circuit for said electrical means comprising said safety switch and main switch but independent of said starting switch, said timer closing said starting switch when in starting position, said main

switch, when closed, causing the energization of said timer, combustion responsive means controlling the direction of movement of said timer during the time it is energized, said combustion responsive means causing said timer to move in a direction to open said safety switch in the absence of combustion and in the reverse direction to a position on the other side of said starting position in the presence of combustion, said timer opening said starting switch as it moves to the said other side of its starting position.

4. A fuel burner control system comprising in combination, electrical means which, when energized, delivers fuel to a combustion chamber, a normally deenergized timer having a starting position, a safety switch, a starting switch, a main switch, a starting circuit for said electrical means comprising said safety switch, starting switch, and main switch in series, a holding circuit for said electrical means comprising said safety switch and main switch but independent of said starting switch, said timer closing said starting switch when in starting position, said main switch, when closed, causing the energization of said timer, combustion responsive means controlling the direction of movement of said timer during the time it is energized, said combustion responsive means causing said timer to move in a direction to open said safety switch in the absence of combustion and in the reverse direction to a position on the other side of said starting position in the presence of combustion, a holding switch in said holding circuit, said timer first closing said holding switch and then opening said starting switch as it moves past said starting position as a result of the establishment of combustion, and first opening said holding switch and then closing said starting switch as it moves back toward its starting position, whereby said control system will recycle in the event of a failure of combustion after combustion has once been established.

5. A fuel burner control system comprising in combination, electrical means which, when energized, delivers fuel to a combustion chamber, a normally deenergized timer having a starting position, a safety switch, a starting switch, a main switch, a starting circuit for said electrical means comprising said safety switch, starting switch, and main switch in series, a holding circuit for said electrical means comprising said safety switch and main switch but independent of said starting switch, said timer closing said starting switch when in starting position, said main switch, when closed, causing the energization of said timer, combustion responsive means controlling the direction of movement of said timer during the time it is energized, said combustion responsive means causing said timer to move in a direction to open said safety switch in the absence of combustion and in the reverse direction to a position on the other side of said starting position in the presence of combustion, said timer opening said starting switch as it moves to the said other side of its starting position, said holding circuit being independent of said timer except that said timer will move in its original direction upon a failure of combustion and open said safety switch.

6. A fuel burner control system comprising in combination, a fuel delivery device, an electric relay which, when energized, renders said device operative to deliver fuel, a timer which occupies a starting position when deenergized, a safety switch, a main switch, an energizing circuit for

said relay including said main switch and safety switch, a switch closed by said relay for energizing said timer, and combustion responsive means in control of said timer during the time that it is energized, said combustion responsive means causing said timer to move in a direction to open said safety switch in the absence of combustion, but to reverse its movement and move to a position on the other side of its first position upon the establishment of combustion.

7. A fuel burner control system comprising in combination, a fuel delivery device, an electric relay which, when energized, renders said device operative to deliver fuel, a timer which occupies a starting position when deenergized, a safety switch, a main switch, a starting switch which is closed when said timer is in its starting position, an energizing circuit for said relay including said main switch, safety switch, and starting switch in series, a holding switch, a holding circuit for said relay including said holding switch, main switch, and safety switch for holding in said relay independently of said starting switch, a switch closed by said relay for energizing said timer, and combustion responsive means in control of said timer during the time that it is energized, said combustion responsive means causing said timer to move in a direction to open said safety switch in the absence of combustion, but to reverse its movement and move to a position on the other side of its first position upon the establishment of combustion, said timer opening said starting switch as it moves past its starting position as a result of the establishment of combustion.

8. A fuel burner control system comprising in combination, a balanced thermal relay comprising a pair of heat motors, electrical means controlling the delivery of fuel to a combustion chamber, a main switch, closure of said main switch causing the substantially simultaneous energization of said electrical means and said thermal relay, and means comprising a combustion responsive resistance connected in circuit with said heat motors for controlling their relative energization, said resistance, in the absence of combustion, causing one of said heat motors to be more highly energized than the other resulting in a deenergization of said electrical means by said thermal relay after a predetermined time interval, said resistance, in the presence of combustion, rendering said other heat motor more highly energized, thus preventing deenergization of said electrical means if it has not already been deenergized.

9. A fuel burner control system comprising in combination, a balanced thermal relay comprising a pair of heat motors, which include electric heaters, electrical means controlling the delivery of fuel to a combustion chamber, a first resistance connected in parallel with one of said heaters, a second combustion responsive resistance connected in parallel with the other heater, said two parallel arrangements being connected in series, a main switch, closure of said main switch causing the energization of said electrical means and the establishment of a circuit through said electric heaters and resistances, said resistances being so chosen that in the absence of combustion one of said heat motors is more highly energized than the other causing said thermal relay to deenergize said electrical means after a predetermined time interval, said second resistance changing in value in response to the establishment of combustion to cause said other

heat motor to become more highly energized whereby said thermal relay moves in the opposite direction.

10. A fuel burner control system comprising in combination, a balanced thermal relay comprising a pair of heat motors, which include electric heaters, electrical means controlling the delivery of fuel to a combustion chamber, a first resistance connected in parallel with one of said heaters, a second resistance connected in parallel with the other of said heaters, said two parallel arrangements being connected in series, both of said resistances being subject to the heat of combustion but only one of them being subject to the radiant heat of combustion, the resistance value of said one resistance being lower than the other when they are both at the same temperature and higher than the other in the presence of combustion, a main switch, closure of said main switch causing the energization of said electrical means and the establishment of a circuit through said electric heaters and resistances, one of said heat motors being more highly energized than the other on starting to cause the thermal relay to move in a direction to deenergize said electrical means after the elapse of a predetermined time, said one resistance increasing in value upon the establishment of combustion to cause the other heat motor to be more highly energized whereby said thermal relay reverses its direction of movement.

11. A fuel burner control system comprising in combination, a balanced thermal relay comprising a pair of heat motors, which include electric heaters, electrical means controlling the delivery of fuel to a combustion chamber, a first resistance connected in parallel with one of said heaters, a second resistance connected in parallel with the other of said heaters, said two parallel arrangements being connected in series, said first resistance being substantially fixed and unaffected by the temperature of combustion, said second resistance being positioned to respond to the temperature of combustion, a main switch, closure of said main switch causing the energization of said electrical means and the establishment of a circuit through said heaters and resistances, the resistance values of said resistances being so chosen that when they are near the same temperature one of said heaters is in the neighborhood of 50% more highly energized than the other causing said thermal relay to move in a direction to deenergize said electrical means, but upon the establishment of combustion the resistance value of said second resistance increases until said other heater is in the neighborhood of 50% more highly energized than said one, whereupon said thermal relay reverses the direction of its movement.

12. A fuel burner control system comprising in combination, electrical means controlling the delivery of fuel to a combustion chamber, a main controlling switch, a balanced thermal timer comprising a pair of electrothermal elements, said thermal timer assuming a starting position when deenergized, a starting switch associated with said timer and closed thereby when said timer is in its starting position, a second switch associated with said timer, means for causing energization of said electrothermal elements and said fuel controlling means upon closure of both said main controlling switch and said starting switch, said timer being operative upon continued energization of said electrothermal elements to terminate energization of said fuel controlling means, combustion responsive means controlling said thermal timer and operative upon the establishment of combustion prior to the termination of the energization of the fuel controlling means to cause said timer to close said second switch and open said starting switch, and means operative upon closure of said second switch by said timer to maintain energization of said fuel controlling means despite opening of said starting switch.

13. A fuel burner control system comprising in combination, electrical means controlling the delivery of fuel to a combustion chamber, a main controlling switch, a balanced thermal timer comprising a pair of electrothermal elements, said thermal timer assuming a starting position when deenergized, a starting switch associated with said timer and closed thereby when said timer is in its starting position, a second switch associated with said timer, means for causing energization of said electrothermal elements and said fuel controlling means upon closure of both said main controlling switch and said starting switch, said timer being operative upon continued energization of said electrothermal elements to terminate energization of said fuel controlling means, combustion responsive means controlling said thermal timer and operative upon the establishment of combustion prior to the termination of the energization of the fuel controlling means to cause said timer to close said second switch and open said starting switch, and means operative upon closure of said second switch by said timer to maintain energization of said fuel controlling means despite opening of said starting switch, said thermal timer being operative upon the cessation of combustion to first open said second switch to interrupt energization of said fuel controlling means and after an interval of time to reclose said starting switch.

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