May 18, 1943 J. M. WILSON 2,319,360

AUTOMATIC CONTROL SYSTEM FOR FUEL BURNERS

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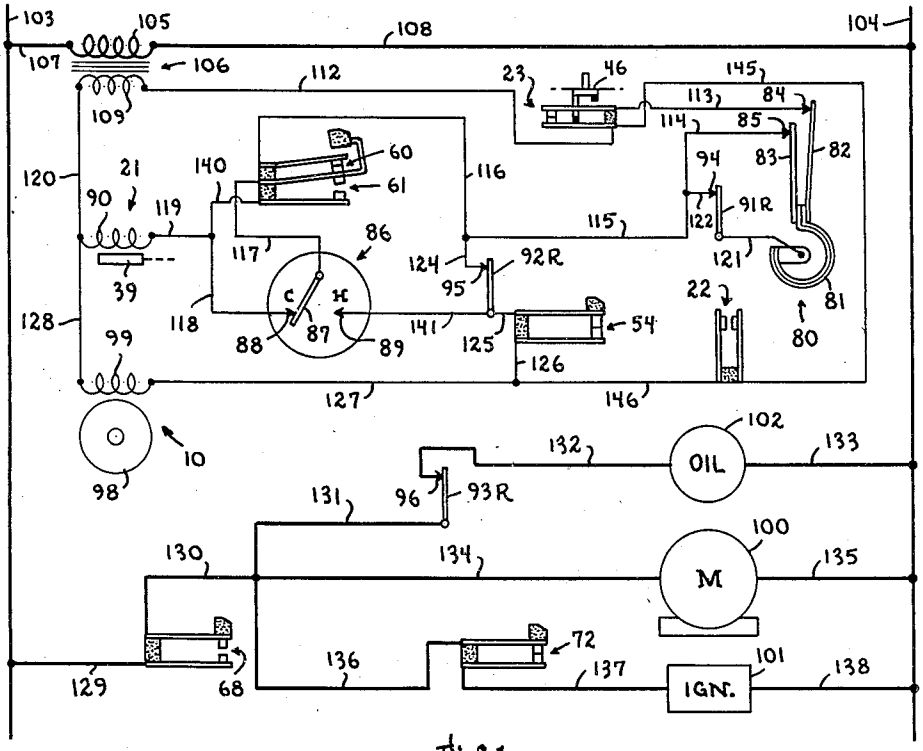

Fig.1

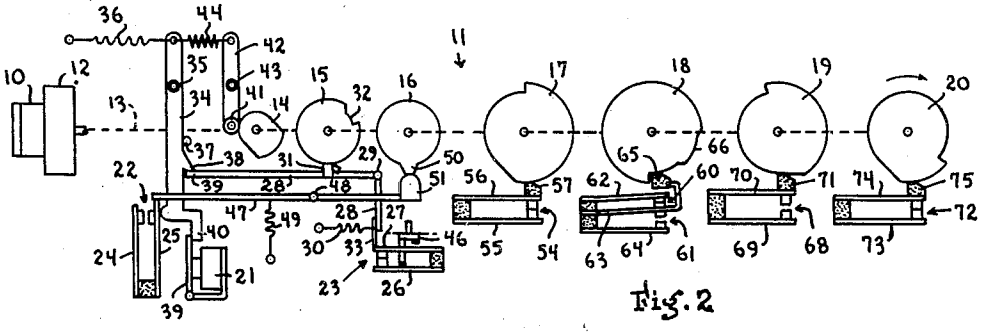

Fig.2

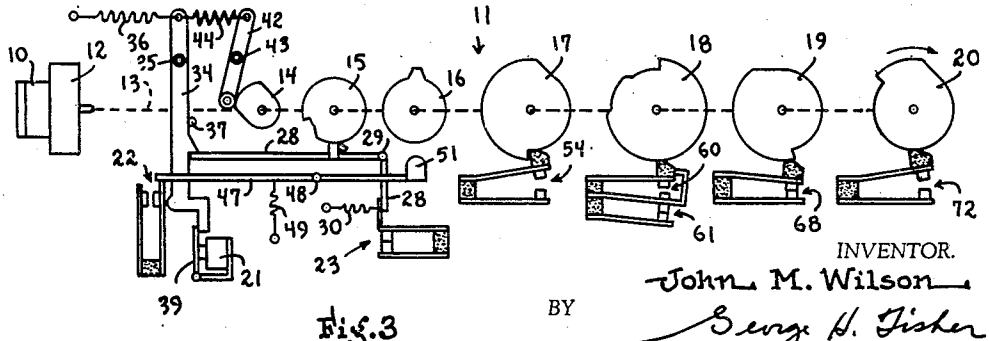

Fig.3

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AUTOMATIC CONTROL SYSTEM FOR FUEL BURNERS

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Application March 5, 1942, Serial No. 433,493

14 Claims. (Cl. 158—28)

This invention relates to an automatic control system for fluid fuel burners in which the system is put through its starting and stopping sequence by means of a control motor.

One of the main objects of this invention is to design a motor operated fuel burner control system which utilizes a minimum number of parts and which is simple in operation thus assuring a low production cost, while incorporating therein all of the necessary features of safety required in fuel burner control systems.

A further object of the invention is to design a control system of the above type in which a control unit in the form of a plurality of cams is operated by a control motor to energize the fuel feeding device and ignition means and then open a safety switch and lock the system out in the event that combustion is not established within the normal trial ignition period. A closed hot combustion switch is provided for preventing the opening of the safety switch in the event that combustion is established first, and the control motor then continues to operate until the control unit reaches a running position at which time it deenergizes the control motor.

Another object of the invention is to provide the system with a return switch so that the control motor will return to its original starting position upon the opening of the safety switch or when the room thermostat or other condition responsive device in control of the system is satisfied.

A still further object of the invention is to control the safety switch and return switch by the conjoint action of the control motor and an electromagnetic relay which is energized as long as there is a demand for burner operation, or upon a failure of ignition. Where the fluid fuel being controlled is oil and an oil valve is used in addition to the usual burner motor, it is also contemplated that the relay may control a switch in series with the oil valve so that this valve will be closed immediately upon the satisfaction of the demand for burner operation whereas the burner motor will remain energized until the control motor can operate the control unit sufficiently to open the switch in series with the burner motor. One of the chief advantages of this operation is that it gives a short blow-out cycle and thus prevents oil dripping into the combustion chamber after the burner motor has been stopped.

A still further object of the invention is to utilize a single operating member for controlling the opening of the safety switch and also for closing and latching the return switch. This operating member is normally biased to a position where it prevents opening of the safety switch and maintains the return switch in open position but is biased to its other position by the control unit when the control unit reaches an intermediate position which corresponds to the end of the trial ignition period and also when the control unit reaches its running position. This is so that the operating member may be biased to close the return switch and release the safety switch for movement to open position in the event that combustion is not established at the end of the trial ignition period and so that this same operating member may close the return switch when the demand for burner operation has been satisfied and the control unit is in its running position. A separate means on the control unit prevents the operating member from opening the safety switch except when the control unit is in the intermediate position corresponding to the end of the trial ignition period.

The invention further contemplates, where intermittent ignition is desired, that the burner motor and ignition device shall be brought on simultaneously when the control motor is started in response to a demand for burner operation and that the ignition device shall be deenergized before the control motor reaches its intermediate position so that the combustion responsive switch will be closed to prevent opening of the safety switch only if combustion has been well established.

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 schematic wiring diagram of the circuit in which my invention is used,

Figure 2 is a more or less diagrammatic showing of my control motor, control unit, and switches operated thereby with the control unit being shown in starting position, and

Figure 3 is a view similar to Figure 2 with the control unit being shown in running position.

This application is directed to the same general type of system as my copending application, Serial No. 433,494 which was filed concurrently herewith.

Referring first to Figure 2 of the drawing, the control motor 10 operates a control unit 11 through the reduction gearing 12. The control unit 11 comprises a rotatable shaft indicated by the dotted line 13, which shaft carries a plurality of cams 14, 15, 16, 17, 18, 19 and 20.

The cams 14 and 15 are adapted to cooperate with the relay 21 in controlling the action of the

return switch 22 and the safety switch 23. The return switch 22 comprises a pair of contact blades 24 and 25 which are biased to open circuit position as shown in Figure 2 of the drawing. The safety switch 23 comprises a pair of resilient contact blades 26 and 27, the blade 27 being biased upwardly to open circuit position. A latch 28 pivoted at 29 normally holds the safety switch 23 latched in closed position as shown in Figure 2, but this latch is continuously biased to its tripped position by means of the spring 30. The latch 28 is provided with an extension 31 which cooperates with the surface of cam 15 so that this cam normally prevents the biasing spring 30 from moving the latch 28 to its tripped position, except when the extension 31 enters into the low part 32 of cam 15.

An operating member 34 is pivotally mounted at 35 and, as shown in Figure 2, is biased by means of the spring 36 into a first position in engagement with the stop pin 37. In this position a latching surface 38 engages the end 39 of the latch 28 to prevent this latch from being moved to its tripped position by means of the spring 30.

The relay 21 is shown as having a pivoted armature 39 which is illustrated in its attracted position in Figure 2. In this position it engages the end 40 of the operating member 34 to maintain the operating member in its first position against the stop pin 37. The surface of cam 14 is adapted to cooperate with a roller 41 on one end of a lever 42 which is pivotally mounted at 43. The other end of the lever 42 carries a spring 44 which connects the lever 42 with one end of the operating member 34. With the low portion of the cam 14 engaging the roller 41, as shown in Figure 2, there is substantially no tension in the spring 44 and therefore the weaker spring 36 is effective to bias the operating member 34 into its first position in engagement with the stop pin 37. When the cam 14 is rotated far enough so that the high portion of the cam engages the roller 41, the lever 42 is rotated in a clockwise direction, tensioning the spring 44. This spring 44 is stronger than spring 36 and therefore its effect, when tensioned, is to overcome the spring 36 and bias the operating member 34 for rotation in a clockwise direction to a second operating position. As long as the relay 21 is energized, its armature 39 prevents the clockwise rotation of the operating member 34 and it remains in the position shown in Figure 2. However, if the relay 21 should be deenergized, such clockwise rotation of the operating member 34 will be permitted.

This clockwise rotation of the operating member 34 removes the latching surface 38 from the end 39 of the latch 28 so that if the extension 31 on this latch is opposite the low point 32 of the cam 15, then the spring 30 is operative to rotate the latch 28 to its tripped position and permit the safety switch 23 to open. The safety switch 23 will then remain open until it is manually closed by the reset member 48.

Clockwise rotation of the operating member 34 under the influence of the spring 44 will additionally cause this member to close the return switch 22 and at the same time a latch member 47 which is pivoted at 48 will drop down under the influence of its biasing spring 49 and latch the return switch 22 in closed position. This will occur whenever the return switch is closed and the return switch will then remain closed until the cam 16 has rotated sufficiently to cause its high point 50 to engage extension 51 on the latch 47 and move this latch to its tripped position, as shown in Figure 2. This will always permit opening of the return switch 22 because when the cam 16 is in position to trip the latch 47, the cam 14 has relieved the tension in the spring 44 and the operating member 34 is therefore biased to its first position against the stop pin 37. It will therefore be seen that the cams 14 and 15 cooperate with the relay 21 to control the safety switch 23, and the cams 14 and 16 cooperate with relay 21 to control the return switch 22.

For the sake of simplifying the drawing, the armature 39 of the relay 21 and the operating member 34 have been shown in such a position that the tension of the spring 44 will tend to move the armature 39 to its deenergized position. Actually, the relay 21 is reversed and a member operated by the armature 39 slips in between the end 40 of the operating member 34 and the relay 21 so that the effect of the spring 44 is to tend to move the armature 39 towards its energized position. In this way it would never be possible for the spring 44 to bring the armature to its deenergized position. The diagrammatic showing, however, is thought to be operable and therefore sufficient to show the operation of the system as a whole.

The control motor switch 54 is shown as comprising a pair of resilient contact blades 55 and 56 which are biased to open position as shown in Figure 3. An insulating member 57 carried by the free end of the resilient blade 56 cooperates with the surface of the cam 17 so that when it engages the high surface of the cam, as shown in Figure 2, switch 54 is closed and when it engages the low surface of the cam, as shown in Figure 3, the switch 54 is opened.

The switches 60 and 61 are shown as comprising the resilient contact blades 62, 63 and 64, the blades 62 and 64 being biased to their straight line positions whereas the blade 63 is shown as being biased to its upper position in Figure 2 in which it engages the blade 62 to close the switch 60. This takes place when the insulating member 65 carried by the free end of the blade 63 is in engagement with the lowest portion of the cam 18. When the cam rotates slightly in its clockwise direction the insulating member 65 is in engagement with the intermediate portion 66 of the cam 18, at which time the blade 63 is moved downwardly until it engages the blade 64, the blade 62 remaining in engagement with blade 63 during this movement. When the highest portion of the cam 18 engages the insulating member 65, the blade 63 is in its lowest position in which the switch 61 is closed and the switch 60 is open. This position is shown in Figure 3.

The burner motor switch 68 comprises a pair of resilient contact blades 69 and 70 which are biased to open circuit position as shown in Figure 2. When the insulating member 71 carried by the blade 70 engages the low portion of the cam 19, switch 68 is in open circuit position as shown in Figure 2, but when the insulating member 71 engages the high portion of the cam 19, switch 68 is closed as shown in Figure 3.

Ignition switch 72 comprises a pair of resilient contact blades 73 and 74 which are biased to open circuit position as shown in Figure 3. When the insulating member 75 carried by the free end of the contact blade 74 engages the high point of cam 20, the switch 72 is closed as shown in Figure 2, and when the insulating member 75 engages the low point of cam 20 switch 72 is open as shown in Figure 3.

The system shown in Figure 1 is intended to

respond to some condition which is indicative of a demand for burner operation. It will be appreciated that this may be any one of a number of different conditions, but for the purposes of illustration the condition chosen is dry bulb temperature. Therefore, a room thermostat 80 is utilized, this thermostat comprising a bimetallic element 81 having a resilient contact blade 82 and a second contact blade 83. On a decrease in temperature, the bimetallic element 81 is adapted to contract and first cause the resilient contact blade 82 to engage the stationary contact 84 and then cause the contact blade 83 to engage the stationary contact 85.

A reference numeral 86 indicates generally any one of a number of well known combustion responsive devices for positioning a contact arm 87 into engagement with a cold contact 88 in the absence of combustion and into engagement with a hot contact 89 in the presence of combustion. It will be understood that this is not intended to be a calibrated switching device but one which will respond to the appearance and disappearance of a flame at the burner. It is not necessary that this switching action overlap in either direction.

The relay 21 is shown as comprising an electric winding 90 and the armature 39 which, when the relay is energized, is adapted to move the relay arms 91R, 92R, and 93R, into engagement with their stationary contacts 94, 95 and 96, respectively. The letter "R" has been used after the reference numerals indicating the relay arms in order to indicate that these arms are actuated by the relay.

The control motor 10 is shown as having a rotor 98 and an energizing winding 99. When a circuit is closed to the winding 99, it will be understood that the control motor 10 is energized to cause rotation of the rotor 98, which, through the reduction gearing 12, rotates the shaft 13 of the control unit 11. The switches 22, 23, 54, 60, 61, 68 and 72 which are controlled by the control unit are shown in Figure 1 in the same positions which they occupy in Figure 2.

This system is provided with the usual oil burner motor 100 and ignition device 101. It is also provided with an electromagnetically operated oil valve 102 which, when deenergized, prevents the flow of oil to the burner.

The electrical power for operating the system is obtained from the two supply lines 103 and 104 to which the primary winding 105 of a step-down transformer 106 is connected by means of conductors 107 and 108. The transformer 106 is provided with a secondary winding 109 which supplies power to the low voltage portion of the system.

Operation

The various elements of the system are shown in the position which they will occupy when the control unit is in its starting position and the temperature in the room being controlled has decreased sufficiently to cause the switch arm 83 to engage its stationary contact 85, this action occurring at a slightly lower temperature than that at which the resilient contact arm 82 engages its stationary contact 84. The closure of the two room thermostat switches results in the establishment of a circuit from one side of the secondary winding 109 through conductor 112, switch 23, conductor 113, contact 84, switch blades 82 and 83, stationary contact 85, conductors 114, 115 and 116, switch 60, conductor 117, switch arm 87, cold contact 88, conductors 118 and 119, winding 90 of the relay 21, and conductor 120 back to the other side of the secondary winding 109. This circuit results in the energization of the relay 21 which then moves the relay arms 91R, 92R, and 93R into engagement with their stationary contacts 94, 95 and 96, as shown in Figure 1 of the drawing. The engagement of the relay arm 91R with its stationary contact 94 establishes the usual holding circuit from one side of the secondary winding 109, through conductor 112, safety switch 23, conductor 113, contact 84, resilient switch blade 82, bimetallic element 81, conductor 121, relay arm 91R, stationary contact 94, conductors 122, 115 and 116, switch 60, conductor 117, switch arm 87, cold contact 88, conductors 118 and 119, relay winding 90, and conductor 120 back to the other side of the secondary winding 109. This holding circuit is therefore independent of the contact blade 83 and stationary contact 85 of the room thermostat 80.

The engagement of the relay arm 92R with its stationary contact 95 sets up a circuit for the control motor 10. This circuit extends from one side of the secondary winding 109 through conductor 112, safety switch 23, conductor 113, contact 84, resilient switch blade 82, bimetallic element 81, conductor 121, relay arm 91R, contact 94, conductors 122, 115 and 124, contact 95, relay arm 92R, conductor 125, switch 54, conductors 126 and 127, energizing winding 99 for the control motor 10, and conductors 128 and 120 back to the other side of the secondary winding 109. Energization of the relay 21 therefore results in the energization of the control motor 10 which immediately starts to rotate the control unit 11 from its starting position in a clockwise direction, as seen in Figures 2 and 3.

As the control unit 11 starts to rotate, the cam 19 will first cause the closure of the switch 68 which will result in the simultaneous energization of the oil valve 102, burner motor 100 and ignition device 101. The oil valve 102 is energized by a circuit extending from the supply line 103 through conductor 129, switch 68, conductors 130 and 131, relay arm 93R, contact 96, conductor 132, oil valve 102, and conductor 133 to the other supply line 104. The burner motor will be energized by a circuit extending from the supply line 103 through conductor 129, switch 68, conductors 130 and 134, burner motor 100, and conductor 135 back to the other supply line 104. The ignition device will be energized from a circuit extending from the supply line 103 through conductor 129, switch 68, conductors 130 and 136, switch 72, conductor 137, ignition device 101, and conductor 138 back to the other supply line 104.

The closure of the above three circuits normally results in the establishment of combustion at the burner. It will be noted that at substantially the same time as the cam 19 closes the switch 68 for energizing the oil valve, burner motor and ignition device, the cam 18 causes its intermediate surface 66 to engage the insulating portion 65 on the blade 63 and therefore causes this blade to move downwardly into engagement with the blade 64 resulting in the closure of the switch 61 while maintaining the switch 60 in closed position. This results in a holding circuit for the relay winding 90 which is independent of the combustion responsive switch arm 87 and the cold contact 88. This circuit extends from one side of the secondary winding 109 through conductor 112, safety switch 23, conductor 113, contact 84, resilient switch blade 82, bimetallic ele-

ment 81, conductor 121, relay arm 91R, contact 94, conductors 122, 115 and 116, switches 60 and 61 in series, conductors 140 and 119, relay winding 90, and conductor 120 back to the other side of the secondary winding 109. Therefore, if combustion is established causing the combustion responsive switch arm 87 to separate from the cold contact 88, the relay winding 90 will nevertheless remain energized and the control motor 10 will continue to operate.

The combustion responsive switch arm 87 in continued response to combustion will continue to move into engagement with the hot contact 89. This sets up a holding circuit for the relay winding 90 which is independent of the switch 60 through which the original energizing circuit for the relay winding 90 passed. The latter holding circuit may be traced from one side of the secondary winding 109 through conductor 112, safety switch 23, conductor 113, contact 84, resilient switch blade 82, bimetallic element 81, conductor 121, relay arm 91R, contact 94, conductors 122, 115 and 124, contact 95, relay arm 92R, conductor 141, hot contact 89, switch arm 87, conductor 117, switch 61, conductors 140 and 119, relay winding 90, and conductor 120 back to the other side of the secondary winding 109.

Continued rotation of the control unit 11 will cause the insulating member 75 of the ignition switch 72 to slip off the high side of the cam 20 thus resulting in the opening of the ignition switch 72. The control unit 11 is now approaching its intermediate position in which it will open the safety switch 23 in the event that combustion has not been established. At this time the cam 16 has rotated so that its high point 50 has released the latch 47 for operation by its biasing spring 49 in the event that the return switch 24 should be closed. The cam 15 has rotated until its low point 32 is opposite the projection 31 on the latch 28 so that this latch may be moved by its biasing spring 30 to open the safety switch 23 in the event that the latch 28 is released by the operating member 34. The cam 14 has rotated sufficiently to rotate the lever 42 and tension the biasing spring 44 to bias the operating member for rotation in a clockwise direction to cause it to release the latch 28 in the event that the relay 21 should be deenergized. At this same time, the cam 18 moves its high side into engagement with the insulating portion 65 on the switch blade 63 so that this switch blade moves downwardly to open the switch 60.

At this time the relay 21 will be deenergized if the combustion responsive switch arm 87 is not in engagement with its hot contact 89 but will remain energized by the holding circuit traced above through the hot contact 89 in the event that combustion has been established.

Let it be assumed first that combustion has not been established at this time and that the combustion responsive switch arm 87 is still in engagement with the cold contact 88. Opening of the switch 60 will therefore break the circuit through the relay winding 90 and the relay 21 will become deenergized and drop out its armature 39. This permits the biasing spring 44 to rotate the operating member 34 in a clockwise direction and release the latch 28, which in turn is rotated by its spring 30 to release the safety switch 23 for movement in open direction. Opening of the safety switch 23 breaks the original circuit to the control motor 10, but this motor is immediately reenergized because at the same time that the operating member 34 permits the opening of the safety switch 23 it closes and latches the return switch 22. This latch is of course the latch 47 which moves downward into latched position by means of its biasing spring 49. Thus the control motor 10 immediately starts operating again.

The ignition 101, it will be remembered, has already been deenergized, and the deenergization of the relay 21 results in the movement of the relay arm 93R to open circuit position which results in the immediate closure of the oil valve 102. The switch 68 is still closed however, and therefore the burner motor 100 continues to operate. The control unit 11 therefore rotates under the influence of the control motor 10 which is now energized by the return switch 22. This energizing circuit extends from one side of the secondary winding 109 through conductors 112, 145, return switch 22, conductors 146, 127, energizing winding 99, and conductors 128 and 120 back to the other side of the secondary winding 109. The control motor 10 will continue to operate until the control unit 11 has returned to its starting position, at which time the high point 50 on the cam 16 trips the latch 47 and permits the return switch 22 to open. In this position of the control unit, the cam 14 is in the position shown in Figure 2 in which it has released the tension of the biasing spring 44 with the result that the operating member 34 is now biased to its position against the stop pin 37 and will not reclose the return switch 22. The control motor will therefore be deenergized with the control unit in the starting position. At this time the cam 15 will have returned the latch 28 to its latched position but the safety switch 23 will remain open until it is manually reset on the resilient latching blade 33 carried by the latch 28. Moreover, the control motor 10 cannot be reenergized until this safety switch 23 is reclosed due to the fact that this switch is in the thermostat circuit and therefore will maintain the circuit to the control motor 10 open even though the room thermostat 30 is closing both of its thermostatic switches in response to a demand for burner operation. When the safety switch 23 is manually set, the parts will be in the position shown in Figures 1 and 2 of the drawing and the system will then go through a normal starting operation.

Let it be assumed now that the control unit 11 is in its intermediate position wherein the cam 14 has tensioned the biasing spring 44, cam 15 has positioned its low point 32 opposite projection 31 on the latch 28, high point 50 of cam 16 has moved to permit action of the latch 47 by its biasing spring 49, switch 68 is closed by cam 19, and ignition switch 72 has been opened by cam 20, and the cam 18 has just opened the switch 60. If at this time combustion has been established the combustion responsive switch arm 87 will be in engagement with its hot contact 89 and the relay 21 will remain energized by means of a circuit extending from one side of the secondary winding 109 through conductor 112, safety switch 23, conductor 113, contact 84, resilient switch blade 82, bimetallic element 81, conductor 121, relay arm 91R, contact 94, conductors 122, 115, and 124, contact 95, relay arm 92R, conductor 141, hot contact 89, combustion responsive switch arm 87, conductor 117, switch 61, conductors 140 and 119, relay winding 90, and conductor 120 back to the other side of the secondary winding 109. The armature 39 of the relay 21 will therefore not release the operating member

34 for movement by the biasing spring 44 with the result that the safety switch 23 will remain closed and the return switch 22 will remain open. The control motor 10 will therefore remain in operation and the control unit 11 will continue to operate until the cam 17 moves its low portion adjacent the insulating member 57 which results in the opening of the switch 54. This breaks the circuit to the control motor 10 and therefore deenergizing it, although the relay 21 will still remain energized by the circuit just traced above. This is the normal running condition of the system in which the oil valve 102 is opened, burner motor 100 energized and the ignition 101 deenergized.

With the control unit 11 in its running position, if the relay 21 is deenergized, either as a result of a failure of the flame at the burner or as a result of the room thermostat opening switch 32, 34, the armature 39 will be released and permit the operating member 34 to rotate in a clockwise direction under the influence of its biasing spring 44. This results in the closure of the return switch 22 and the latching thereof by means of the latch 47. The control motor 10 will therefore be energized and will rotate the control unit 11 back to its starting position, at which time the high point 50 on the cam 16 will trip the return switch to open position. The parts will then have returned to the positions shown in Figures 1 and 2 of the drawing.

It will be noted that the motor control switch 54 always maintains energization of the control motor 10 when it is operating normally until the control unit 11 reaches its running position, at which time the switch 54 opens and stops the motor in this position. The motor then remains deenergized until the return switch 22 is closed as a result of the deenergization of the relay 21.

It will be noted further that whenever the relay 21 is deenergized for any reason the oil valve 102 is immediately closed due to the breaking of the circuit therethrough at the relay arm 93R. The burner motor 100, however, will continue in operation until the cam 19 opens the motor switch 68. This provides for a blow-out cycle.

Various changes and modifications of the invention will undoubtedly occur to those who are skilled in the art, and I therefore wish it to be understood that I intend to be limited by the scope of the appended claims and not by the specific embodiment disclosed which is for the purpose of illustration only.

I claim as my invention:

1. In a motor operated fuel burner control system, a control motor, a control unit operated thereby and having a starting position, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch in control of said device, said first switch being operated by said control unit and open when said control unit is in starting position, a relay in control of said control motor, a circuit for said relay, a condition responsive element for closing said circuit, the resultant movement of said control unit from its starting position causing closure of said first switch, switch means operated by said control unit for deenergizing said control motor when said control unit reaches a running position, a return switch for energizing said control motor independently of said switch means, means controlled by said relay upon deenergization thereof for closing said return switch, and means operated by said control unit when it reaches its starting position for opening said return switch, said first switch being opened by said control unit as it leaves its running position.

2. In a motor operated fuel burner control system, a control motor, a control unit operated thereby and having a starting position, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch in control of said device, said first switch being operated by said control unit and open when said control unit is in starting position, a relay in control of said control motor, a circuit for said relay, a condition responsive element for closing said circuit, the resultant movement of said control unit from its starting position causing closure of said first switch, switch means operated by said control unit for deenergizing said control motor when said control unit reaches a running position, a normally open return switch for energizing said control motor independently of said switch means, a latch for latching said return switch in closed position, a member biased to a position in which it latches said return switch closed, said member being restrained by said relay when it is energized but permitting such latching operation when deenergized, and means operated by said control unit for removing the bias from said latching member and for tripping said return switch to open position when said control unit reaches its starting position.

3. In a motor operated oil burner control system, a control motor, a control unit operated thereby and having a starting position, an oil burner motor associated with an oil burner, an electrically operated oil valve for alternately cutting off and permitting the flow of oil to the burner, a relay in control of said control motor, a relay switch in series with said oil valve, a first switch in control of both said burner motor and oil valve, a condition responsive switching means for energizing said relay thus closing said relay switch and causing operation of said control motor, said control unitl closing said first switch as it is moved from its starting position by said control motor to energize simultaneously said burner motor and open said oil valve, means operated by said control unit for stopping said control motor when said control unit reaches a running position, a return switch for said control motor, means controlled by said relay for closing said return switch upon deenergization thereof for reenergizing said control motor, said oil valve closing immediately upon deenergization of said relay, said control unit opening said first switch as it moves from its starting position, and means operated by said control unit for opening said return switch when it reaches its starting position.

4. In a motor operated oil burner control system, a control motor, a control unit operated thereby and having a starting position, an oil burner motor associated with an oil burner, an electrically operated oil valve for alternately cutting off and permitting the flow of oil to the burner, means for igniting the fuel at the burner, a relay in control of said control motor, a relay switch in series with said oil valve, a first switch in control of said oil valve, burner motor and igniting means, a second switch in series with said igniting means, a condition responsive switching means for energizing said relay thus closing said relay switch and causing operation of said control motor, said control unit closing said first switch as it moves from its starting position, means operative by said control unit for closing said second switch before said first switch is

closed whereby the opening of said oil valve and the energization of said burner motor and igniting means occur simultaneously, said control unit opening said second switch as it reaches an intermediate position, and then deenergizing said control motor as it reaches a running position, a return switch for said control motor, means controlled by said relay for closing said return switch upon deenergization thereof for reenergizing said control motor, said oil valve closing immediately upon deenergization of said relay, said control unit opening said first switch as it moves from its starting position, and means operated by said control unit for opening said return switch when its reaches its starting position.

5. In a motor operated fuel burner control system, a control motor, a control unit operated thereby and having a starting position, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch in control of said device, said first switch being operated by said control unit and open when said control unit is in starting position, a relay in control of said control motor, a circuit for said relay, a condition responsive element for closing said circuit, the resultant movement of said control unit from its starting position causing closure of said first switch, a safety switch in control of said electric device, means controlled by said control unit for opening said safety switch when said control unit reaches an intermediate position, means including a closed hot combustion switch for preventing such opening of the safety switch, switch means operated by said control unit for deenergizing said control motor when said control unit reaches a running position, a return switch for energizing said control motor independently of said switch means, means controlled by said relay upon deenergization thereof for closing said return switch, and means operated by said control unit when it reaches its starting position for opening said return switch, said first switch being opened by said control unit as it leaves its running position.

6. In a motor operated fuel burner control system, a control motor, a control unit operated thereby and having a starting position, an electric device which, when energized, causes the delivery of fuel to a burner, means for igniting the fuel delivered to the burner, a first switch in control of said electric device and said igniting means, said first switch being operated by said control unit and being open when said control unit is in its starting position, a relay in control of said control motor, a circuit for said relay, a condition responsive element for closing said circuit, the resultant movement of said control unit from its starting position causing closure of said first switch, switch means operated by said control unit as it reaches a first intermediate position for deenergizing said igniting means, a safety switch in control of said electric device, means operated by said control unit as it reaches a second intermediate position for opening said safety switch, means including a closed hot combustion switch for preventing such opening of the safety switch, switch means operated by said control unit for deenergizing said control motor when said control unit reaches a running position, a return switch for energizing said control motor independently of said switch means, means controlled by said relay upon deenergization thereof for closing said return switch, and means operated by said control unit when it reaches its starting position for opening said return switch, said first switch being opened by said control unit as it leaves its running position.

7. In a motor operated fuel burner control system, a control motor, a control unit having a starting position, a running position, and an intermediate position operated thereby, a relay in control of said control motor for rotating said control unit successively from its starting position through its intermediate position, running position, and back to its starting position again, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch for energizing said device, said first switch being closed by said control unit as it leaves its starting position and opened as it leaves its running position, a normally closed safety switch in control of said electric fuel feeding device, operating means for said safety switch, said means being biased to open switch position by said control unit when it is in its intermediate position, means operated by said relay when energized for preventing the opening of said safety switch, a condition responsive switch for energizing said relay for causing energization of said control motor, means operated by said control unit for deenergizing said relay to permit opening of said safety switch when said control unit reaches its intermediate position, and means including a closed hot combustion switch for maintaining energization of said relay to prevent opening of said safety switch if combustion is established first.

8. In a motor operated fuel burner control system, a control motor, a control unit having a starting position, a running position, and an intermediate position operated thereby, a relay in control of said control motor for rotating said control unit successively from its starting position through its intermediate position, running position, and back to its starting position again, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch for energizing said device, said first switch being closed by said control unit as it leaves its starting position and opened as it leaves its running position, a normally closed safety switch in control of said electric fuel feeding device, operating means for said safety switch, said means being biased to open switch position by said control unit when it is in its intermediate position, means operated by said relay when energized for preventing the opening of said safety switch, a condition responsive switch for energizing said relay for causing energization of said control motor, means operated by said control unit for deenergizing said relay to permit opening of said safety switch when said control unit reaches its intermediate position, a return switch for energizing said control motor being closed by said safety switch operating means as said safety switch is being opened, means for opening said return switch as said control unit reaches its starting position, and means including a closed hot combustion switch for maintaining energization of said relay to prevent opening of said safety switch if combustion is established first.

9. In a motor operated fuel burner control system, a control motor, a control unit having a starting position, a running position, and an intermediate position operated thereby, a relay in control of said control motor for rotating said control unit successively from its starting position through its intermediate position, running

position, and back to its starting position again, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch for energizing said device, said first switch being closed by said control unit as it leaves its starting position and opened as it leaves its running position, a normally closed safety switch in control of said electric fuel feeding device, operating means for said safety switch, said means being biased to open switch position by said control unit when it is in its intermediate and running position, means operated by said relay when energized for preventing the opening of said safety switch, a condition responsive switch for energizing said relay for causing energization of said control motor, means operated by said control unit for deenergizing said relay to permit opening of said safety switch when said control unit reaches its intermediate position, means including a closed hot combustion switch for maintaining energization of said relay to prevent opening of said safety switch if combustion is established first, means operated by said control unit deenergizing said control motor when said control unit reaches its running position, a return switch for energizing said control motor, said operating means closing said return switch upon deenergization of said relay by said condition responsive switch, and means for opening said return switch when said control unit reaches its starting position, said control unit preventing said operating means from opening said safety switch except at its said intermediate position.

10. In a motor operated fuel burner control system, a control motor, a control unit having a starting position, a running position, and an intermediate position operated thereby, a relay in control of said control motor for rotating said control unit successively from its starting position through its intermediate position, running position, and back to its starting position again, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch for energizing said device, said first switch being closed by said control unit as it leaves its starting position and opened as it leaves its running position, a normally closed safety switch in control of said electric fuel feeding device, operating means for said safety switch, said means being biased to open switch position by said control unit when it is in its intermediate and running position, means operated by said relay when energized for preventing the opening of said safety switch, a condition responsive switch for energizing said relay for causing energization of said control motor, means operated by said control unit for deenergizing said relay to permit opening of said safety switch when said control unit reaches its intermediate position, a return switch for energizing said control motor being closed by said safety switch operating means as said safety switch is being opened, means for opening said return switch as said control unit reaches its starting position, means including a closed hot combustion switch for maintaining energization of said relay to prevent opening of said safety switch if combustion is established first, means operated by said control unit deenergizing said control motor when said control unit reaches its running position, a return switch for energizing said control motor, said operating means closing said return switch upon denergization of said relay by said condition responsive switch, and means for opening said return switch when said control unit reaches its starting position, said control unit preventing said operating means from opening said safety switch except at its said intermediate position.

11. In a motor operated fuel burner control system, a control motor, a control unit having a starting position, a running position, and an intermediate position operated thereby, a relay in control of said control motor for rotating said control unit successively from its starting position through its intermediate position, running position, and back to its starting position again, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch for energizing said device, said first switch being closed by said control unit as it leaves its starting position and opened as it leaves its running position, a normally closed safety switch in control of said electric fuel feeding device, a movable member for actuating said safety switch, said member being continuously biased to switch open position, said control unit cooperating with said movable member to prevent it from opening said safety switch except when said control unit is in its intermediate position, an operating member having a first position in which it prevents said movable member from opening said safety switch and a second position in which it permits such action, said operating member normally assuming its first position, means operated by said control unit as it moves to its intermediate position for biasing said operating member for movement to its second position, means controlled by said relay when energized for preventing such movement, a condition responsive switch for energizing said relay for causing energization of said control motor, means operated by said control unit for deenergizing said relay to permit opening of said safety switch when said control unit reaches its intermediate position, and means including a closed hot combustion switch for maintaining energization of said relay to prevent opening of said safety switch if combustion is established first.

12. In a motor operated fuel burner control system, a control motor, a control unit having a starting position, a running position, and an intermediate position operated thereby, a relay in control of said control motor for rotating said control unit successively from its starting position through its intermediate position, running position and back to its starting position again, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch for energizing said device, said first switch being closed by said control unit as it leaves its starting position and opened as it leaves its running position, a normally closed safety switch in control of said electric fuel feeding device, a movable member for actuating said safety switch, said member being continuously biased to switch open position, said control unit cooperating with said movable member to prevent it from opening said safety switch except when said control unit is in its intermediate position, an operating member having a first position in which it prevents said movable member from opening said safety switch and a second position in which it permits such action, said operating member normally assuming its first position, means operated by said control unit as it moves to its intermediate position for biasing said operating member for movement to its second position, means controlled by said relay when energized for preventing such movement, a condition responsive switch for energizing said relay

for causing energization of said control motor, means operated by said control unit for deenergizing said relay to permit opening of said safety switch when said control unit reaches its intermediate position, a normally open return switch, means associated with said movable member for closing said return switch as it moves to its second position to permit opening of said safety switch whereby said control motor will be energized, means operated by said control unit as it reaches its starting position for opening said return switch, and means including a closed hot combustion switch for maintaining energization of said relay to prevent opening of said safety switch if combustion is established first.

13. In a motor operated fuel burner control system, a control motor, a control unit having a starting and a running position operated thereby, a relay in control of said control motor for rotating said control unit successively from its starting position through its running position and back to its starting position again, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch for energizing said device, said first switch being closed by said control unit as it leaves its starting position and opened as it leaves its running position, a condition responsive switch for energizing said relay for causing energization of said control motor, switch means operated by said control unit as it reaches its running position for deenergizing said control motor, a return switch, a movable member for closing said return switch, means controlled by said control unit for biasing said movable member to its switch closed position when said control unit is in its running position and switch open position when said control unit is in its starting position, means positioned by said relay for preventing movement of said movable member to its switch closed position when said relay is energized but permitting such movement when said relay is deenergized, means for holding said return switch in closed position once it has been closed by said movable member, and means operated by said control unit when it reaches its starting position for releasing said holding means.

14. In a motor operated fuel burner control system, a control motor, a control unit having a starting position, a running position and an intermediate position operated thereby, a relay in control of said control motor for rotating said control unit successively from its starting position through its intermediate position, running position, and back to its starting position again, an electric device which, when energized, causes the delivery of fuel to a burner, a first switch for energizing said device, said first switch being closed by said control unit as it leaves its starting position and opened as it leaves its running position, a normally closed safety switch in control of said electric fuel feeding device, a movable member for actuating said safety switch, said member being continuously biased to switch open position, said control unit cooperating with said movable member to prevent it from opening said safety switch except when said control unit is in its intermediate position, an operating member having a first position in which it prevents said movable member from opening said safety switch and a second position in which it permits such action, said operating member normally assuming its first position, means operated by said control unit as it moves to its intermediate and running position for biasing said operating member for movement to its second position, means controlled by said relay for preventing such movement when energized and permitting such movement when deenergized, a return switch for energizing said control motor independently of all other switches, said return switch being normally open, said operating member closing said return switch when it moves to its second position, means for holding said return switch closed once it has been closed by said operating member, means operated by said control for releasing said holding means when said control unit is in starting position, a condition responsive switch for energizing said relay for causing energization of said control motor, means operated by said control unit for deenergizing said relay to permit opening of said safety switch when said control unit reaches its intermediate position, means including a closed hot combustion switch for maintaining energization of said relay to prevent opening of said safety switch if combustion is established first, and means operated by said control unit for deenergizing said control motor when said control unit reaches running position.

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