

Nov. 29, 1960

R. B. MATTHEWS

2,962,093

CONTROL APPARATUS

Filed Jan. 22, 1957

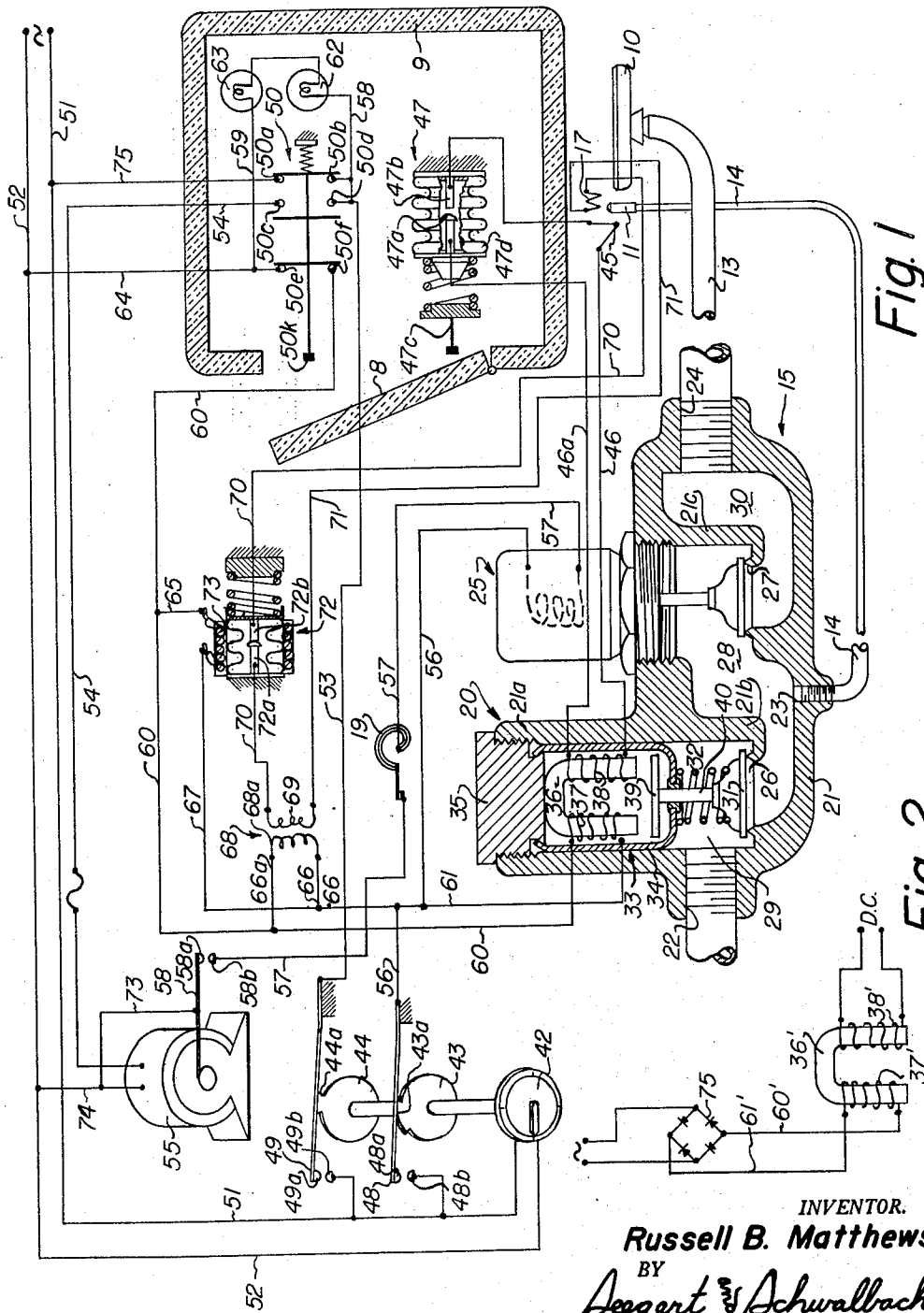


Fig. 1

Fig. 2

INVENTOR.

Russell B. Matthews

BY

Seibert & Schwallbach
Att'ys

1

2,962,093

CONTROL APPARATUS

Russell B. Matthews, Wauwatosa, Wis., assignor to Baso Inc., Milwaukee, Wis., a corporation of Wisconsin

Filed Jan. 22, 1957, Ser. No. 635,450

7 Claims. (Cl. 158—128)

This invention relates to control apparatus for fluid fuel burning systems and more particularly to control apparatus for controlling the flow of fluid fuel to and ignition of said fuel at main and pilot burners.

In the control of gaseous fuel to clothes dryers, and the like, it has long been desired to have a rather simple, safe, compact control apparatus which automatically ignites and controls fuel flow to the main and pilot burners while at the same time being designed to protect against overheating, current failures, gas failure, or mechanical malfunctioning.

It is a general object of this invention to provide an improved control apparatus affording the above-mentioned desirable operational features in the control of fluid fuel burning equipment which includes a novel flow-control means which affords both the "motor" and "safety" shut-off functions.

Another object of the invention is to provide novel apparatus wherein the flow-control means providing both "motor" and "safety" function is of the electromagnetic type which when electrically energized by a relatively high voltage source of electric energy (such as 110 volts) is moved from a first to a second controlling position, there being flame sensitive safety means operable to hold said flow-control means in said second position independent of the high voltage energization after movement thereof thereto.

Another object of this invention is to provide a device as above characterized wherein the flame sensitive safety means takes the form of a thermoelectric generator which is connected to a "safety" winding of an electromagnetic operator for a valve, there also being a high voltage (such as 110 volts) "motor" winding of said electromagnetic operator such that energization of the "motor" winding opens or cocks the valve and then energization of the "safety" winding holds the valve open upon cessation of the high voltage energization.

Another object of the invention is to provide a device as above characterized wherein the "motor" winding may be energized by either high voltage (such as 110 volts) alternating or direct current and the "safety" winding may be energized by low power direct current produced by a thermoelectric generator.

Another object of the invention is to provide an apparatus as above described wherein the thermoelectric circuit to the "safety" winding includes a combination switch responsive to both the position of a door and to temperature such that upon occurrence of either abnormal temperature (high limit) or opening of the door the thermoelectric circuit is opened.

Another object of the invention is to provide a control system having the foregoing characteristics which is simple to operate and only requires that the operator set a timing means and close the door to a clothes dryer and the like whereupon the apparatus will cycle in a predetermined sequence and after the completion of the time cycle will close down completely upon reopening of the dryer door.

2

Another object of the invention is to provide an improved fuel control and ignition system of the above type having electroresponsive ignition means which is actuated by a door switch, there being burn-out protection means associated with said ignition means.

Another object of the invention is to provide a safe system for controlling a clothes dryer and the like of the class aforementioned wherein the dryer door, a drum and fan motor and a main burner valve are interlocked such that the main burner valve never opens unless the drum and fan motor is energized and the motor is never energized unless the door is closed wherefore no fuel will flow to the main burner upon burn-out of the motor or when the door is open to thereby afford safe operation.

Another object of the invention is to provide an improved fuel control and ignition apparatus as above characterized which provides safe ignition of the pilot burner and 100 percent shut off of the fuel upon failure of pilot burner to initially ignite or upon outage subsequent to ignition.

Another object of the present invention is to provide apparatus of the aforementioned general characteristics which is well adapted for mass production manufacture, is easily installed by non-skilled technicians, and is otherwise well adapted for the purposes for which it was designed.

The novel features that are characteristic of the invention are set forth with particularity in the appended claims. The invention, itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood by the following description of a specific embodiment when read in connection with the accompanying drawing, in which:

Figure 1 is a semi-diagrammatic view of applicant's control apparatus associated for control of a clothes dryer, parts of the apparatus being shown semi-diagrammatically; and

Figure 2 is a view of an alternative circuit for the combination "motor" and "safety" valve.

While the improved fuel control and ignition apparatus is shown and described in connection with a clothes dryer, it is to be understood that the improved apparatus is not limited to use with this type of equipment, but is adapted for use equally well with other gaseous fuel burning equipment, for example, unit heaters, ovens, commercial and central housing heating equipment and other types of space heaters.

Referring now to Figure 1 of the drawings, a fluid fuel burner 10 and a pilot ignition burner 11 may be disposed to provide heat to the interior of an enclosure (such as a clothes dryer schematically illustrated at 9). The burners 10 and 11 may be supplied under pressure with fluid fuel through conduits 13 and 14 which are connected to a suitable source (not shown). Electroresponsive ignition means in the form of a glow coil or the like illustrated schematically at 17 may be disposed adjacent the pilot burner 11 for ignition of fuel emanating therefrom. The fuel flow in conduits 13 and 14 and hence the heat supplied to the dryer 9 is under the control of suitable valve means 15 which is interposed in the conduits 13 and 14 and which is of the electroresponsive type.

The valve means 15 comprises a pair of serially arranged electroresponsive valve assemblies 20 and 25, valve assembly 20 being a combination "motor" and "safety" valve and valve assembly 25 being a thermostatically controlled valve. The valve means 15 may be disposed anywhere about the dryer apparatus as suitable and is desired, and it is to be particularly noted that it need not be located for access by the operator for normal cycling of the valve, as shall be more fully explained later.

Energization of the electroresponsive valve means 15 is controlled both by a timer illustrated schematically at 42 which operates timer switches 48 and 49 and by the position of a door 8 of the dryer enclosure 9 which in turn controls door switches 50 and 47 as shall become apparent hereinafter. A drum and blower fan motor 55 is provided to revolve a drying cylinder or drum for tumbling the clothes (not shown) and to operate a blower fan (not shown). The drum and fan motor 55 has associated therewith a centrifugal switch 58 which may be attached to the motor shaft and which controls the circuit to thermostatic valve 25. A pair of lights, one being of the illuminating type 62, and the other 63 being germicidal in nature, are schematically shown disposed within the dryer interior, the circuitry to these lights being such that whenever the dryer is in operation or whenever the door 8 is open, the lights are energized. One other component in the electrical circuitry of the apparatus is the burn-out protector switch 72 which preserves the operating life of the glow coil for the ignited 17.

Proceeding now to a more detailed description of the device, the valve means 15 comprises a valve casing 21 having an inlet 22 and a main outlet 24 connected to main burner conduit 13. The interior of the valve casing 21 may be formed with successive chambers such as inlet chamber 29, intermediate chamber 28 and outlet chamber 30. A partition wall 21b in the interior of casing 21 may be formed with a first valve seat 26 which surrounds an outlet of the chamber 29 and another partition wall 21c is formed with a second valve seat 27 which is disposed to control an outlet of intermediate chamber 28. A pilot outlet 23 is formed in the bottom wall of the casing 21 for cooperation with conduit 14 thereby providing communication of the pilot burner 11 with the intermediate valve chamber 28.

The electroresponsive valve assembly 25 may take the form of any suitable electric valve of the energized-opened and deenergized-closed type, for example, a solenoid or the like, and is here shown disposed in the intermediate chamber 28 for cooperation with seat 27 to provide control of the fuel flow to the main burner only. As shown, the electrical circuit to valve 25 includes a pair of conductors 56 and 57, the latter being connected to line conductor 52 through a thermostat 19, the centrifugal switch 58 associated with drum and fan motor 55, and conductors 73 and 74. The energization of the valve is also controlled by the timer means 42 through timer switch 48 which connects conductor 56 to line conductor 51 in a manner and sequence as shall be more fully explained.

The combination "motor" and "safety" valve assembly 20 is disposed ahead of or upstream of the thermostatic valve assembly 25 and within the valve inner chamber 29 for cooperation with the seat 26. The configurations and structural details of the combination "motor" and "safety" valve 20 may be similar to that shown and described in the copending application of Russell B. Matthews and Robert A. Merrell, filed April 7, 1955, Serial No. 499,932, now Patent No. 2,911,183 and assigned to the same assignee. The subassembly comprising valve assembly 20 may be similar in all details except as to the electrical aspects such as number of turns of windings and the connections of said windings to two different sources of power as shall be apparent from the description hereinafter appearing. Suffice it to say, to understand the present invention, that the valve assembly 20 may comprise electromagnetic actuation means 33 which is here shown mounted in a generally tubular upstanding boss 21a of the outer valve casing. The actuation means 33 may comprise a tubular casing or hood member 34 which may be rigidly attached to a threaded end closure member 35, the latter in turn threadably engaging the interior of boss 21a to position the hood member 34 within the boss as shown.

First and second relatively movable magnetic mem-

bers, for example, an electromagnet core 36 and an armature 39 may be disposed within the hood member 34. More particularly, a generally U-shaped magnet core 36 is fixedly mounted to end member 35 within the hood member 34 and has energizing windings 37 and 38 wound on the legs thereof. An elongated stem 40 slidably projects through an end wall of hood member 34 one end of the stem carrying an armature 39 for cooperation with the pole faces of magnet core 36 and the other end carrying a valve disc 31 for cooperation with valve seat 26. A coil compression spring 32 is surroundingly disposed on the stem 40 one end of the spring abutting the valve disc 31 and the other end engaging a bottom wall of the tubular hood member 34 to bias the armature 39 away from magnet core 36 and valve disc 31 toward engagement with seat 26.

The aforementioned energizing winding 37 associated with the core 36 may be referred to as a "motor" winding and is operable when energized by a relatively high voltage source of electric energy (for example, 110 volts which is very large as compared to thermoelectric power) to attract the armature 39 from its retracted position into attracted relation with the pole faces against the bias of spring 32. It is contemplated that the energizing source used for this purpose would be either line power 110 volt alternating current, or as shown in Figure 2 winding 37' may be energized with line power 110 volt rectified direct current, either of which, with the proper number of winding turns in coil 37 will create sufficient magnetic flux in the core 36 to attract the armature 39 from its retracted position. If rectified current is used, a rectifier 75 may be placed across the winding lead conductors 60' and 61' as shown in Figure 2.

The other magnet energizing winding 38 may be referred to as a "safety" winding and for that purpose may be connected to flame sensitive source means, for example, thermoelectric generator means 45, by suitable conductors 46 and 46a. A switch 47 having low resistance encapsulated contacts 47a-47b therein is connected in conductor 46 and has the dual function of being temperature responsive (high limit) and responsive to the position of dryer door 8. As shown, switch 47 may take the form of an hermetically sealed flexible bellows having a temperature sensitive fill therein, which, upon reaching a predetermined temperature, expands the bellows separating contacts 47a-47b to interrupt the thermoelectric circuit. The circuit is also interrupted, i.e., contacts 47a-47b are opened when the dryer door 8 is opened and are made, i.e., in engagement, upon closing of the door 8 when the temperature sensed by the fill within the bellows is below said predetermined (high limit) temperature.

Mention is made that the electrical energy produced by the thermoelectric generator means 45 when energized is a direct current of very low order and predetermined steady value depending upon the construction of the thermoelectric circuit. Ordinarily, the thermoelectric generator 45 will produce sufficient current to energize "safety" winding 38 and create flux in the coil 36 to maintain the armature 39 in attracted relation once the position is obtained but insufficient flux to move the armature 39 to attracted relation from its retracted position against the bias of spring 32. If for some reason such as pilot outage, faulty apparatus, or opening of the switch 47, the thermoelectric generator does not produce or transmit current to winding 38 within a so-called normal range, the current flow decreases to a drop-out value where the bias of spring 32 is stronger than the attractive force of the flux generated by winding 38 and consequently the armature 39 moves away from the pole faces seating valve disc 31 upon seat 26. In this manner the valve assembly 20 provides the safety function to the apparatus since all fuel flow to both burners is terminated upon seating of disc 31.

It is to be noted that the attractive forces created by

5

"motor" winding 37 are considerably greater than the attractive forces created by winding 38. It is to be further noted that the voltage (line power) in winding 37 is very considerably greater than the voltage in winding 38 and the respective windings are such that when the former is energized by alternating current and the latter is energized by thermoelectrically generated direct current, there is not a drop-out of the armature 39 inasmuch as the amplitude of the voltage in winding 37 is so great, that as the voltage changes polarity, the time interval that the voltage and polarity of winding 37 is in a range to neutralize the flux of winding 38 to drop-out value is so short, that the phenomenon known as A.C. knock-out is eliminated. Of course, no A.C. knock-out problems are involved if the rectified voltage system shown in Figure 2 is used, care being taken that windings 37 and 38 aid, rather than oppose, each other.

The line power connections and switches in circuit to "motor" winding 37 will be described in an alternating current system, conductors 51 and 52 being the line conductors connected to a suitable source of 110 volt power (not shown). As shown the electrical circuit to "motor" winding 37 comprises a pair of conductors 60 and 61, the latter being connected to line conductor 51 through conductor 56 and timer switch 48. Conductor 60 is connected to line conductor 52 through door actuated switch contacts 50e—50f of switch 50 and conductor 64.

For purposes of this specification, line conductor 51 will be considered the hot or live conductor and conductor 52 the return conductor. As aforesaid the status of all of the various components of the device are mainly determined by the timer actuated switches 48 and 49 and door actuated switches 50 and 47. As shown, timer 42 may be electroresponsive in nature, or may be of the spring wound type as suitable and desired. The timer 42 is operable to control the position of cams 43 and 44 having upstanding actuating lugs 43a and 44a, respectively, which in turn actuate contact switching spring leaves 48 and 49. When lugs 43a and 44a are rotated so as to engage switch leaves 48 and 49 respectively, contacts 48a—48b and 49a—49b are opened and when the cams 43 and 44 are rotated so as to move the lugs 43a and 44a out of engagement with the switch leaves 48 and 49, the aforementioned contacts are made. When switch contacts 48a—48b are made, conductor 56 supplies line power to thermostatic valve 25 and conductor 61 supplies power to motor winding 37 of valve assembly 20 as aforesaid. The ignition means 17 is also energized at this time by transformer means 68, the primary 68a thereof being energized through conductor 66 which is connected to conductor 56 and conductor 66a which is connected to conductor 60. The transformer means 68 supplies reduced voltage energy to the ignition means 17 from a secondary winding 69 through conductors 70 and 71 and burn-out protector switch 72 if the contacts 72a—72b of switch 72 are in engagement. Burn-out protector switch 72 may take the form of an hermetically sealed bellows having a temperature sensitive fill and encapsulated contacts 72a—72b therein. The contacts 72a—72b are normally in engagement but separate upon the fill reaching a predetermined high temperature which will expand the bellows. A heating coil 73 surrounds the bellows and is operable when energized (and after a suitable time lag) to supply heat to the fill within the bellows. The coil 73 is energized through conductor 67 connected to conductor 66 and through conductor 65 connected to conductor 60.

The door actuated switch 50 may be of any suitable type which is responsive to the position of the door 8 and is semi-diagrammatically shown comprising three sets of contacts, set one comprising contacts 50a and 50b and set three comprising contacts 50e and 50f both sets of which are made when the door is opened and set two comprising contacts 50c and 50d the latter being open when the door is open. Conversely, sets one and three

6

(50a—50b and 50e—50f) are opened when the door is closed and set two (50c—50d) is made.

The energization of thermostatic valve assembly 25 is indirectly controlled by the door switch 50 through the second set of contacts 50c and 50d, the latter being in the circuit to the blower fan and drum motor 55 which controls the position of the centrifugal switch 58. The drum and fan motor 55 is energized separately from the other components through a circuit comprising line conductor 51, timer contacts 49a—49b, conductor 53, the second set of door switch contacts 50c and 50d, and conductors 54 and 74. Thus, whenever the timer actuated contacts 49a—49b are in engagement and door actuated contacts 50c—50d are made, the motor 55 is energized thereby making centrifugal switch contacts 58a—58b energizing valve 25 assuming the thermostat 19 contacts are made and timer contacts 48a and 48b are made. It is to be noted that timer contacts 49a and 49b also control energization of lights 62 and 63 through the circuit comprising conductors 53, 58, 59, and 64. An alternative circuit is provided for lights 62 and 63 comprising conductor 75 connected to line conductor 51, switch contacts 50a—50b, and conductors 58, 59, and 64 to assure energization of the lights 62 and 63 whenever the dryer door 8 is opened.

The operation of the device is as follows:

Assume the following initial conditions: Timer cams 43 and 44 so positioned that upstanding cam lugs 44a and 43a respectively engage switch leaves 48 and 49 so as to open contacts 48a—48b and 49a—49b. Thus, drum and fan motor 55 is deenergized causing centrifugal switch 58 to be open, motor winding 37 of valve 20 is deenergized and valve disc 31 seated, valve assembly 25 is deenergized, ignition means 17 is cold, the heating coil of burn-out switch 72 is cold making contacts 72a—72b. The pilot burner 11 and main burner 10 are cold and thus thermoelectric generator means 45 is cold, the temperature within the interior of the dryer 9 is below high limit. The dryer door 8 is open, causing both the separation of switch 47 contacts 47a—47b in thermoelectric circuit to safety winding 38, and the making of the first and third sets of door switch contacts 50a—50b and 50e—50f, the first set of contacts (50a—50b) causing causing lights 62 and 63 to be energized. Since the door 8 is open, the second set of switch 50 contacts 50c—50d are open.

To start the device in operation, it is to be noted that the dryer door 8 must be open. The operator then rotates or sets the timer 42 (in a clockwise direction as shown in the drawings) to cause the rotation of the cams 43 and 44 such that lugs 43a and 44a are rotated out of engagement with contact leaves 48 and 49 respectively. Both sets of timer actuated contacts are now made and contacts 48a—48b will immediately energize motor winding 37 of valve assembly 20 to attract armature 39 and move valve 31 away from seat 26. Fuel may now flow through pilot outlet 23 to the pilot burner 11, but may not flow to the main burner 10 inasmuch as valve 25 is still closed or seated on seat 27. The primary 68a of ignition transformer 68 is energized simultaneously and reduced voltage is provided to ignition means 17 to ignite the fuel emanating from the pilot burner 11. The heater coil 73 on the burn-out protector switch 72 in the igniter circuit is simultaneously energized also, but due to thermal lag does not separate contacts 72a—72b until a predetermined interval (such as, for example, seven minutes) passes. The ignition of the pilot burner 11 in turn causes energization of the thermoelectric generating means 45, the latter not energizing safety winding 38 inasmuch as switch contacts 47a—47b of switch 47 are open. The thermoelectric generating means 45 is generally producing electrical energy about twenty seconds after initiation of the cycle.

Thus, after a time delay of at least twenty seconds or so from initiation of the cycle (during which the oper-

ator presumably is placing clothes within the dryer enclosure), the dryer door 8 may be closed. Closure of door 8 causes actuation of switches 50 and 47; switch 47 contacts 47a—47b making to energize the safety winding 38 of valve assembly 20 which retains armature 39 in attracted relation upon the simultaneous breaking of the circuit through "motor" winding 37 caused by the opening of the third set of switch 50 contacts, i.e., contacts 50e—50f. Actuation of switch 50 by closing of the dryer door 8 also simultaneously deenergizes the igniter and the burn-out protector switch through the same third set of contacts (50e—50f) and through making of the second set of contacts (50c—50d) causes energization of drum and fan motor 55. Energization of motor 55 causes making or engagement of centrifugal switch contacts 58a and 58b to energize valve 25 which then opens and supplies fuel to the main burner 10 to heat the enclosure of the dryer 9.

The thermostatic valve 25 will continue to cycle in accordance with temperature requirements as sensed by the thermostat 19 as long as the timer remains on and as long as the door 8 remains closed (if the drum and fan motor operates properly). If the drum and fan motor should fail, switch 58 opens and valve 25 deenergizes preventing fuel flow to the main burner 11 thereby preventing the articles within the dryer enclosure from being overheated. Also, if, prior to the timer cycle re-opening the timer switches 48 and 49, the door 8 is opened, the dryer drum and fan motor 55 is immediately deenergized to in turn cause opening of centrifugal switch contacts 58a—58b thereby shutting off the thermostatic valve 25, and the motor winding 38 takes over the control of armature 39 from now deenergized safety winding 38 and holds the valve 31 in open position allowing pilot gas to continue to flow. Upon reclosing of the door the apparatus will continue as before.

A predetermined period (such as ten minutes) prior to the end of the timing cycle, cam lug 43a rotates into engagement with contact switch leaf 48 to separate contacts 48a and 48b thereby causing deenergization of valve 25, but not valve 20 which is under control of the thermoelectric circuit. The drum motor 55 continues to be energized through timer actuated contacts 49a and 49b which remain closed. The lights 62 and 63 remain on inasmuch as they are energized through the same contacts. The reason for the deenergization of the valve 25 prior to the end of the time cycle is to allow the thermal lag of the heat in the system to be more efficiently utilized. Cam lug 44a then opens contacts 49a—49b to thereby open the circuit to the motor 55 and the lights 62 and 63.

The pilot burner remains on inasmuch as valve 31 remains away from its seat under safety winding 38 until door 8 re-opens to open switch 47 contacts 47a—47b deenergizing the thermoelectric circuit to shut off pilot fuel flow. The operator may then open the door, remove the clothes, reshut the door, shutting off the lights, the entire cycle now being completed.

Although specific embodiments of the invention have been shown and described, it is with full awareness that many modifications thereof are possible. The invention, therefore, is not to be restricted with the exception insofar as is necessitated by the appended claims.

I claim:

1. In an electromagnet control device, biasing means, first and second magnetic members, said first member being biased by said biasing means toward a first and movable to a second position against said bias, a flow-control member operatively associated with said first magnetic member for movement therewith between first and second controlling positions, first and second flux generating winding means operatively associated only with said second magnetic member, a line voltage source connected for energization of said first winding means to afford by such energization movement of said first mag-

netic member and hence said control member from its first toward its second position against said bias, and flame sensitive thermoelectric generator means connected for energization of said second winding means to afford by such energization, holding of said second magnetic member in its second position against said bias independent of line voltage energization of said first winding means after movement of said first magnetic member to said second position, wherefore movement of said flow-control member to its second position is under the control of said line voltage source and holding of said flow-control member in said second position may be under the control of said thermoelectric generator means.

2. In an electromagnetic control device, biasing means, first and second magnetic members one of which is biased by said biasing means toward a first and movable to a second relative position against said bias, first and second flux generating winding means operatively associated with only one of said magnetic members, line voltage source means connected for energization of said first winding means to afford by such energization relative movement of said magnetic members from their first toward their second relative position against said bias, and flame sensitive thermoelectric generator means connected in circuit with said second winding means for energization thereof to afford thereby holding of said magnetic members in their second relative position against said bias independent of line voltage energization of said first winding means after movement of said magnetic members to said second position, condition responsive control means connected in circuit with said generator means and second winding means and responsive to first and second unrelated conditions for opening said circuit upon the occurrence of either condition, wherefore movement of said magnetic members to their second relative position is under the control of said line voltage source means and holding of said members in said second position may be under the control of said thermoelectric generator means and said condition responsive control means.

3. A control device comprising, magnetic core means having first and second winding means associated therewith, armature means biased toward a first and movable to a second relative position with respect to said core means, a line voltage source connected in circuit for energizing said first winding means to afford movement of said armature means from its first toward its second position, and flame sensitive thermoelectric generating means connected in circuit for energizing said second winding means which when so energized is inoperable to afford movement of said armature means from its first to its second position but is operable to maintain said armature means in its second position after movement thereto and upon deenergization of said first winding means, wherefore control of initial movement of said armature means to its second position against its bias is afforded by control of said line voltage circuit and control of subsequent return movement is afforded by control of the thermoelectric generator circuit.

4. A control device comprising magnetic core means having first and second winding means associated therewith, armature means biased toward a first and movable to a second relative position with respect to said core means, alternating current line voltage source means connected in circuit for energizing said first winding means to afford movement of said armature means from its first toward its second position, and flame sensitive low power direct current source means connected in circuit for energizing said second winding means which when so energized is inoperable to afford movement of said armature means from its first to its second position but is operable to maintain said armature means in its second position after movement thereto and upon deenergization of said first winding means, wherefore control of initial movement of said armature means to its second position against its bias is afforded by control of said line voltage

circuit and control of subsequent return movement is afforded by control of the low voltage circuit.

5. A control device comprising magnetic core means having first and second winding means associated therewith, armature means biased toward a first and movable to a second relative position with respect to said core means, a direct current rectified line voltage source means connected in circuit for energizing said first winding means to afford movement of said armature means from its first toward its second position, and a very low power flame sensitive direct current voltage source means connected in circuit for energizing said second winding means which when so energized is inoperable to afford movement of said armature means from its first to its second position but is operable to maintain said armature means in its second position after movement thereto and upon deenergization of said first winding means, wherefore control of initial movement of said armature means to its second position against its bias is afforded by control of said line voltage circuit and control of subsequent return movement is afforded by control of the low voltage circuit.

6. An automatic ignition and fuel control system in combination with fluid fuel burning apparatus having main and pilot burners responsive to the position of a door of an enclosure to be heated thereby comprising, a first circuit including line voltage source means, first electroresponsive flow-control means in said first circuit operable when energized by current from said source means to permit fuel flow toward said pilot and main burners and when deenergized to prevent fuel flow toward said main and pilot burners, second electroresponsive flow-control means in said first circuit operable when energized to permit and when deenergized to prevent fuel flow toward said main burner, a second circuit including pilot burner flame sensitive low voltage source means associated with said first flow-control means for low voltage energization of the latter, low voltage energization of said first flow-control means being sufficient to maintain the same in flow-permitting condition once said condition has been attained thereby, electroresponsive ignition means in said first circuit, door actuated control means having first and second operative positions for controlling said first and second circuits, said control means being operative when said door is in its first position, to connect said first flow-control means and said ignition means to said line voltage source means for energization thereby, said control means, in response to movement of said door to its second position being operative to disconnect said first flow-control means and said ignition means from said line voltage source means and connect said first flow-

control means to said low voltage source means and said second flow-control means to said high voltage source means, wherefore if said fuel at said pilot burner fails to ignite, fuel flow to both burners is terminated by said first flow-control means on movement of said door to its said second position.

7. An automatic ignition and fuel control system in combination with fluid fuel burning apparatus having burner means responsive to the position of a door of an enclosure to be heated thereby comprising, a first circuit including a first voltage source means, first electroresponsive flow-control means in said first circuit operable when energized by current from said source means to permit fuel flow toward said burner means and when deenergized to prevent fuel flow toward said burner means, second electroresponsive flow-control means in said first circuit operable when energized to permit and when deenergized to prevent fuel flow toward a portion of said burner means, a second circuit including a second voltage source means and of the flame sensitive type associated with said first flow-control means for energization of the latter, energization of said first flow-control means by said second circuit being sufficient to maintain the same in flow-permitting condition once said condition has been attained thereby, electroresponsive ignition means in said first circuit, door actuated control means having first and second operative positions for controlling said first and second circuits, said control means being operative when said door is in its first position, to connect said first flow-control means and said ignition means to said first source means for energization thereby, said control means, in response to movement of said door to its second position being operative to disconnect said ignition means and said first flow-control means from said first source means and connect the latter to said flame sensitive second source means, and to connect said second flow-control means to said first source means, wherefore if said fuel at said burner means fails to ignite, all fuel flow is terminated by said first flow-control means on movement of said door to its said second position.

References Cited in the file of this patent

UNITED STATES PATENTS

45	Re. 23,470	Betz	Mar. 18, 1952
	1,767,058	Eiseman	June 24, 1930
	1,835,028	Eiseman	Dec. 8, 1931
	1,940,718	Koch	Dec. 26, 1933
	2,290,047	Hildebrecht	July 14, 1942
50	2,290,048	Hildebrecht	July 14, 1942
	2,797,909	Rulseh	July 2, 1957