July 26, 1960 J. H. THORNBERY ET AL 2,946,376

MULTIPLE BURNER CONTROL SYSTEM OR THE LIKE

Filed April 5, 1954 2 Sheets-Sheet 1

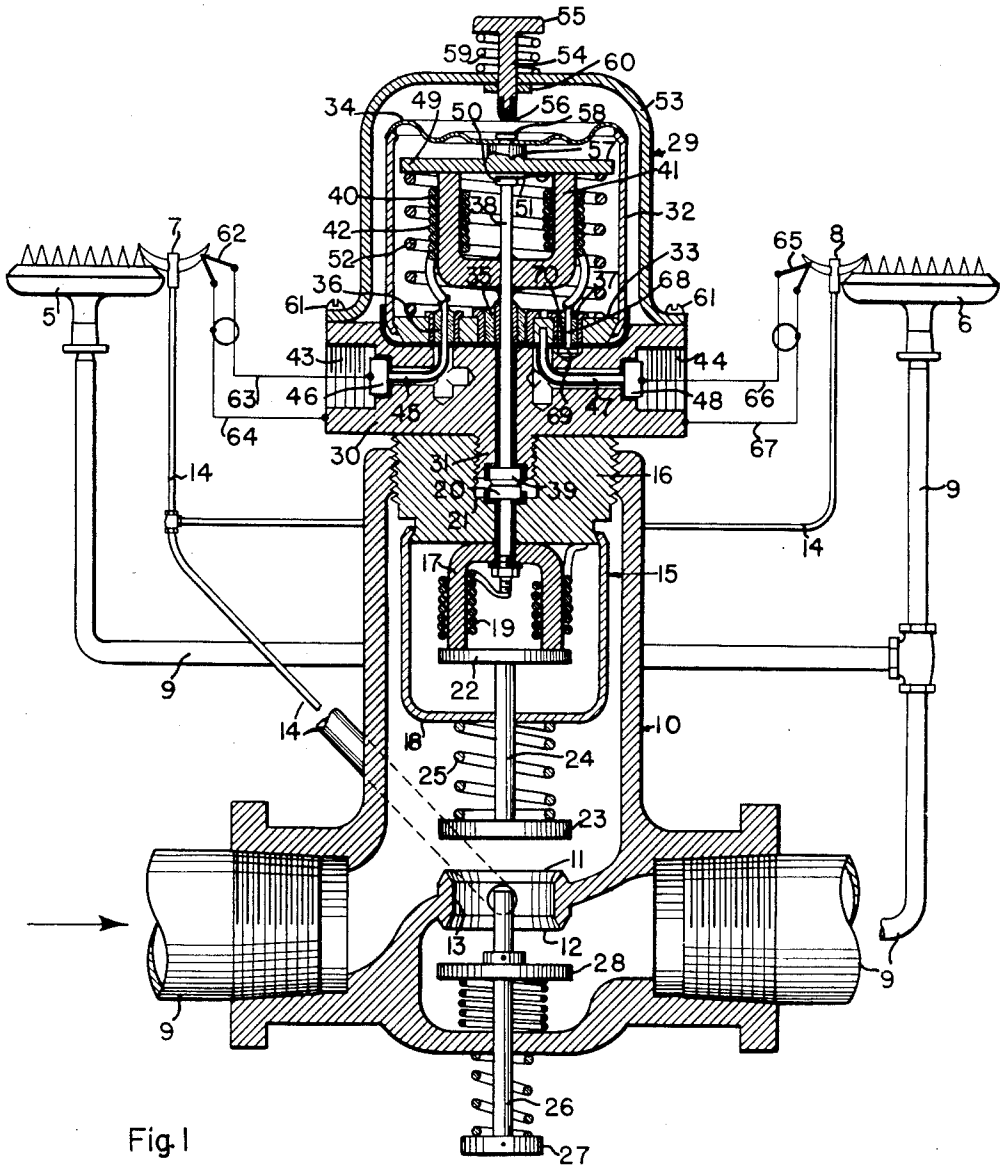


Fig. 1

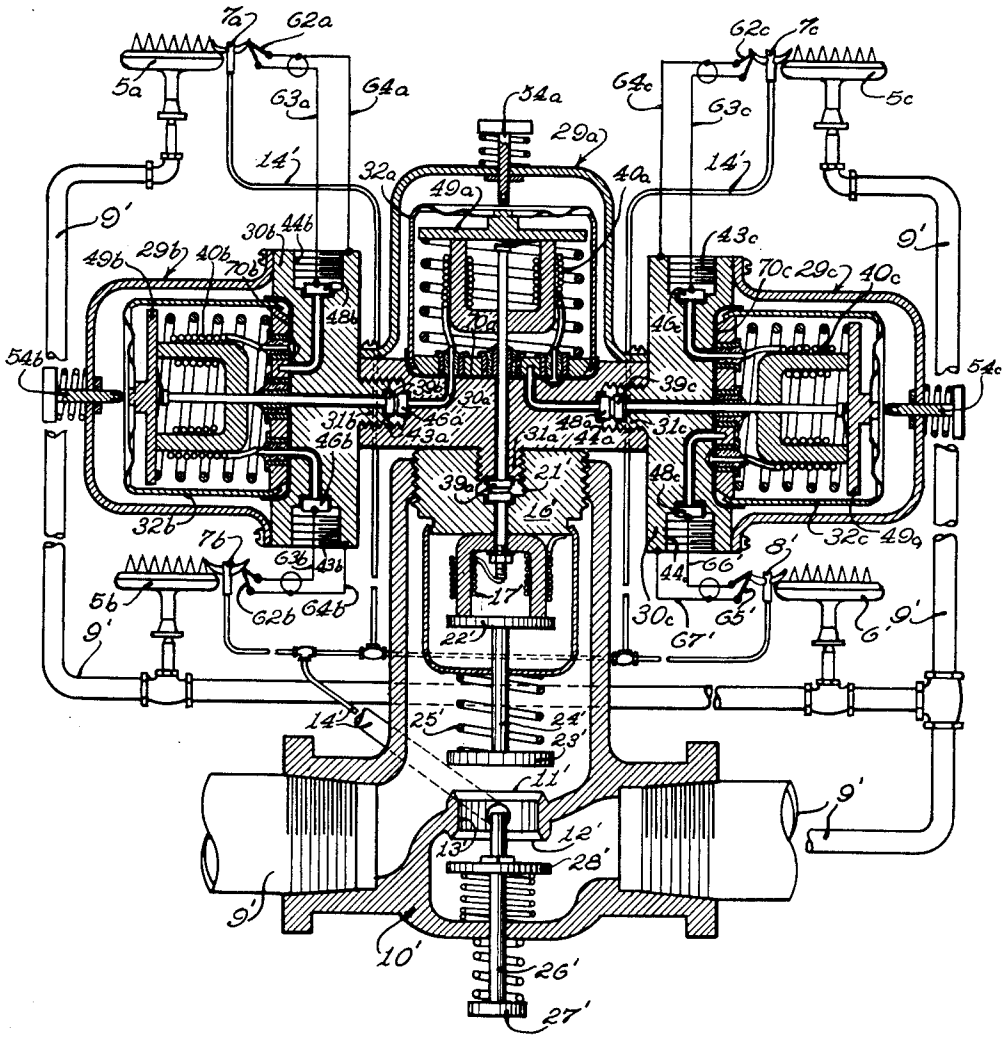
INVENTORS.
John H. Thornbery
Russell B. Mattews
BY Siegert & Schwalbach
Attys

July 26, 1960 J. H. THORNBERY ET AL 2,946,376

MULTIPLE BURNER CONTROL SYSTEM OR THE LIKE

Filed April 5, 1954 2 Sheets-Sheet 2

Fig. 2.



INVENTOR.
John H. Thornbery
Russell B. Matthews
BY Seegert & Schwalbach
Att'ys

United States Patent Office 2,946,376 Patented July 26, 1960

2,946,376

MULTIPLE BURNER CONTROL SYSTEM OR THE LIKE

John H. Thornbery, Whitefish Bay, and Russell B. Matthews, Wauwatosa, Wis., assignors to Baso Inc., Milwaukee, Wis., a corporation of Wisconsin

Filed Apr. 5, 1954, Ser. No. 421,072

11 Claims. (Cl. 158—131)

This invention relates to improvements in multiple burner control systems or the like.

In certain fluid fuel burning apparatus, for example sectional furnaces, a plurality of main burners are used, each of said burners being provided with an ignition or pilot burner. In apparatus of this type it is desirable to provide safety shut-off of the fuel flow to all of the main and pilot burners in the event of outtage of any of the pilot burners.

It is a general object of the present invention to provide an improved control system for multiple burner fluid fuel burning apparatus or the like which effects the aforementioned shut-off of all fuel flow on outtage of any one of a number of burners, for example pilot burners.

Another object of the invention is to provide an improved control system of the character described which is entirely self-powered, said system including a separate thermoelectric generator subject to the heat of each controlling burner, for example each pilot burner, and also including a single electromagnetic valve for effecting safety shut-off of the fuel flow to all burners immediately upon cooling of any of said generators, for example as the result of outtage of the associated pilot burner.

A more specific object of the invention is to provide an improved control system of the class described utilizing an electromagnetic control device of novel construction, said control device being adapted to be readily connected, both physically and electrically, to other like control devices, as well as to thermoelectrically powered control devices, for example valves, of standard construction.

Another object of the invention is to provide an improved control device of the character described including an electromagnet and a coacting armature, both encapsulated within a hermetically sealed enclosure containing an inert fluid fill, said armature and the frame of said electromagnet coacting electrically as well as magnetically to afford contact means. The encapsulation of the aforementioned contact means insures low and constant contact resistance for a given contact pressure, thereby rendering said device well adapted for the control of thermoelectric circuits.

Another object of the invention is to provide the improved control system which is readily adaptable to a change in the number of burners in the apparatus controlled by said system, it being necessary merely to add to or subtract from said system one of the improved control devices and a thermoelectric generator for each controlling burner, for example pilot burner, added to or subtracted from the apparatus controlled.

Another object of the invention is to provide an improved control system and electromagnetic control device therefore which are simple and inexpensive in construction, easy to assemble and install, positive in operation, and otherwise well adapted for the purposes described.

Other objects and advantages of the invention will become apparent as the description proceeds, reference being had to the accompanying drawings in which:

Figure 1 is a semi-diagrammatic view illustrating the use of the improved control system for controlling a fuel burning apparatus having two main burners and associated pilot burners, the electromagnetic control device and the safety shut-off valve being shown in vertical section; and

Figure 2 is a semi-diagrammatic view similar to Figure 1 and illustrating the use of the improved control system for controlling a fuel burning apparatus having four main burners and associated pilot burners.

Referring more particularly to Figure 1, the fluid fuel control apparatus to which the improved control system is applied comprises a pair of main burners 5 and 6 having associated pilot burners 7 and 8 respectively. A branched main fuel supply line 9 delivers fluid fuel from a suitable source to both of the main burners 5 and 6. An electromagnetic valve 10, which may be a safety shut-off type of valve, i.e., non-cycling and manually resettable, is interposed in the fuel supply line 9 as shown, and controls the flow of fuel to the burners 5 and 6, and, as will hereinafter appear, to the pilot burners 7 and 8.

The valve 10 is provided with a pair of spaced annular valve seats 11 and 12 connected by a passage 13, and a branched pilot fuel supply line 14 affords communication between the passage 13 and pilot burners 7 and 8. The valve 10 includes a removable operating mechanism or power unit 15 comprising a mounting nut 16 to which is fixed an electromagnet 17 and a hood or casing 18 surrounding said electromagnet. The electromagnet 17 has an energizing coil 19, one end of which is grounded to the nut 16, and hence to the body of valve 10, and the other end of which is connected in circuit with a terminal tip 20 insulatably disposed within an internally threaded socket 21 formed in the nut 16. An armature 22 within the casing 18 coacts with the electromagnet 17 and is connected to a valve member 23 by means of a stem 24 slidably extending through the end wall of said casing. A compression spring 25 surrounding the stem 24 and interposed between the casing 18 and valve member 23 biases the valve member 23 toward the seat 11 and the armature 22 away from the electromagnet 17. It is apparent that closure of the valve member 23 onto the seat 11 shuts off all fuel flow to the main burners 5 and 6, as well as to the pilot burners 7 and 8.

The valve 10 is provided with mechanism for resetting the armature to the electromagnet 17 and the valve member 23 to open position, said mechanism including a reset stem 26 axially slidable in a suitable aperture in the valve body, said stem being provided with an external manually engageable button 28. The inner end of the stem 26 is coaxially engageable with the valve member 23, and said stem may also carry a flow interrupter disk 28 cooperable with the seat 12 for preventing fuel flow to the main burners while permitting fuel flow to the pilot burners during a resetting operation.

Mounted on the connector nut 16 of the valve 10 is a non-cycling electromagnetic control device 29 comprising a metallic base member 30 having a central externally threaded tubular projection 31 threaded into the recess 21 and the nut 16 as shown. Insulatably mounted on the base member 30 is an hermetically sealed metallic enclosure 32 having a metallic base plate or fixed end wall 33 and having a movable opposite end wall 34 which may take the form of a flexible metallic diaphragm. The base plate 33 is apertured to accommodate glass seals 35, 36 and 37. As shown, suitable insulation 70 prevents electrical contact between base member 30 and base plate 33. The base member 30 and the projection 31 thereof are bored to insulatably receive an electrically conducting stem 38 which extends through the glass seal

35, terminating at one end within the enclosure 32, and terminating at its other end in a terminal tip 39 insulatably carried by the projection 31 and effecting a low-resistance electrical connection with the terminal tip 20. An electromagnet 40 is mounted within the enclosure 32 and comprises a generally U-shaped magnetically permeable frame 41 which is fixed on the stem 38 and is connected in circuit therewith. An energizing coil 42 is wound on the frame 41.

The base member 30 is formed with a pair of internally threaded recesses or sockets 43 and 44 which are preferably identical with the internally threaded recess 21 in nut 16, so that the externally threaded projection 31 is complemental thereto. An electrical connector 45 is provided with a terminal tip 46 insulatably mounted within the socket 43, and said conductor insulatably extends through an angular passage in the base member 30 and through the glass seal 36 to an electrical connection with one end of the energizing coil 42. The other end of the electromagnet coil 42 is connected in circuit with one end of a conductor 68 which extends through the glass seal 37 and is provided with a terminal tip 69 which effects a low resistance electrical connection with the base member 30. An electrical connector 47 is provided with a terminal tip 48 insulatably mounted within the socket 44, and said connector insulatably extends through an angular passage in the base member 30 to an electrical connection with the metallic enclosure base plate 33.

An armature 49 within the enclosure 32 is fixed to the movable wall 34 of said enclosure, as by an integral stem 57 having a portion of reduced diameter extending through an aperture in the wall 34 and having an external head portion 58 sealingly fixed and electrically connected to the outer surface of said wall, as by soldering. The magnet frame 41 has a pair of substantially coplanar pole faces on the ends of the arms thereof, and the armature 49 has a flat surface engageable with said pole faces, said armature being movable toward and away from said pole faces. The armature 49 may be provided with a contact member 50 engageable with the adjacent end of the stem 38 and carried by a resilient contact arm 51. This contact may be omitted if desired. A coiled compression spring 52 surrounds the electromagnet 40 and biases the armature 49 toward a first position spaced away from the pole faces of the magnet frame 41. It is apparent that terminal tips 39 and 48 form first and second connector means in circuit with the contact 50 and stem 38 and armature 49 and frame 41, and that terminal tip 46 forms a third connector means in circuit with the winding of the electromagnet 40.

The control device 29 is provided with mechanism for resetting the armature 49 to a second position in engagement with the pole faces of the magnet frame 41 against the bias of the spring 52, said mechanism comprising a bracket or cup-shaped cover 53 fixed to the base member 30, as by screws 61, said cover carrying a reset stem 54 coaxial with the movable enclosure wall 34 and axially slidable in a suitable aperture in the end wall of said cover. The stem 54 is provided with an external manually engageable button 55 and has an insulated inner end portion 56 which is engageable with the armature stem head 58. Since the armature 49 may be fixed to the enclosure wall 34 by any suitable means, in the absence of the head 58, the stem tip 56 may engage a central portion of the wall 34 for resetting said armature by inward movement of said wall. The stem 54 is biased outwardly by a spring 59, and a shoulder member 60 on said stem limits said outward movement.

The hermetically sealed enclosure 32 preferably contains an inert fluid fill, for example dry nitrogen. The encapsulation of the electromagnet and armature, and the use of the inert fill in the enclosure 32, keeps all of the parts within said enclosure clean and prevents the formation of films or other material on said parts which might

increase the contact resistance between the armature 49 and the pole pieces of the magnet frame 41 or between the contact 50 and the end of the stem 38.

A thermoelectric generator 62 is positioned to be subject to the heat of the flame of the pilot burner 7. One terminal of the generator 62 is connected in circuit with the terminal tip 46 by a conductor 63, the other terminal of said generator being grounded to the base plate 30 by a conductor 64, said conductors preferably forming a coaxial lead as shown diagrammatically. A thermoelectric generator 65 is positioned to be subject to the heat of the pilot burner 8. One terminal of the generator 65 is connected in circuit with the terminal tip 48 by a conductor 66, and the other terminal of said generator is grounded to the base member 30 by a conductor 67, the conductors 66 and 67 may also take the form of a coaxial lead as shown diagrammatically.

When the apparatus shown in Figure 1 is shut down, the valve 23 is seated on the seat 11 to shut off all fuel flow to the main and pilot burners, and the electromagnet 40 is deenergized so that the armature 49 and its contact 50 are held by the spring 52 away from the pole pieces of the frame 41 and stem 38 respectively. To place the control system into operation, the valve reset stem 26 is depressed to move the valve member 23 and armature 22 to the position shown in Figure 1 while at the same time moving the flow interrupter disk 28 into engagement with the seat 12. This permits fuel flow to the pilot burners 7 and 8, which upon ignition thereof, heats the generators 62 and 65. The generator 62 generates a current which energizes the electromagnet 40 sufficiently so that when the armature 49 is reset to the attracted position shown by depression of the reset button 55, said armature is held in said attracted position by the attractive force exerted thereon by said electromagnet.

The armature 49 and its contact 50 coact with the magnet 41 and stem 38 to provide a set of contacts for the control device 29 which are in connected series circuit between the generator 65 and the valve electromagnet coil 19. When the aforementioned contacts are closed by movement of the armature 49 to the position shown the power circuit between the generator 65 and the valve electromagnet 19 is completed. This circuit includes the conductor 66, conductor 47, metallic enclosure 32, armature 49 and its contact 50, magnet frame 41 and stem 38, terminal connector 20 and energizing coil 19. The mounting nut, base member 30 and conductor 67 comprise the ground position of said circuit. Energization of the electromagnet 17 holds the armature 22 in the attracted position shown and thereby holds the valve member 23 in the open position shown after release of the reset stem 26. Retraction of the flow interruption disk 28 to the position shown permits fuel to flow to the main burners 5 and 6 as well as to the pilot burners 7 and 8.

In the illustrated apparatus the improved control system effects closure of the safety shut-off valve 10 and 100 percent shut-off of all fuel flow immediately upon cooling of either of the generators 62 or 65, for example on outtage of the associated pilot burner. It is apparent that cooling of the generator 65 and the corresponding reduction in the current output thereof deenergizes the valve electromagnet 17 to cause drop-out of the armature 22 and closure of the valve member 23 and to thereby provide the aforementioned 100 percent fuel shut-off. On the other hand, cooling of the generator 62 while the generator 65 remains heated causes deenergization of the control device electromagnet 30 and drop-out of the armature 49 to thereby interrupt the current flow in the power circuit for the valve electromagnet 17. Interruption of the current flow to the electromagnet 17 causes immediate drop-out of the armature 22 and closure of the valve member 23 to provide 100 percent shut-off of the fuel flow as aforementioned.

Figure 2 illustrates the use of the improved control system in controlling the flow of fuel to first, second, third and fourth main burners 6', 5a, 5b and 5c, and their associated first, second, third and fourth pilot burners 8', 7a, 7b, and 7c respectively. The main burners are supplied with fuel through a branched line 9' in which the safety shut-off valve 10', which may be identical to the valve 10 of Figure 1, is interposed. The pilot burners are all supplied with fuel through a branched fuel supply line 14' as shown. The parts indicated in Figure 2 by reference characters which are primed or bear a suffix may be identical to similar parts in Figure 1 indicated by the same reference characters unprimed and without a suffix. In Figure 2, a second control device 29a is associated with the first control device or safety shut-off valve 10' in the same manner in which the control device 29 is associated with the valve 10 in Figure 1. A third control device 29b is associated with the second device 29a by threading the projection 31b into the recess or socket 43a to effect a low-resistance electrical connection between the terminal tips 39b and 46a. A fourth control device 29c is associated with the control device 29a by threading the projection 31c into the recess or socket 44a to effect a low-resistance electrical connection between the terminal tips 39c and 48a.

A first thermoelectric generator 65' is positioned to be subject to the heat of the pilot burner 8' and has one terminal connected to the terminal tip 48c by lead conductor 66', the other terminal of said generator being grounded to the base member 30c by a conductor 67'. Current from the generator 65' energizes the valve electromagnet 17', said current flow being under the control of the contacts of the control devices 29c and 29a which are connected in series circuit with each other and with said generator and said electromagnet.

The second, third and fourth thermoelectric generators 62a, 62b and 62c are positioned to be subject to the heat of the pilot burners 7a, 7b and 7c respectively. One terminal of the generator 62a is connected to the terminal tip 48b by a lead conductor 63a, and the other terminal of said generator is grounded to the base member 30b by a lead conductor 64a. The generator 62a supplies current for energization of the electromagnet 40a of the control device 29a, said current flow being under the control of the contacts of the control device 29b which are connected in series circuit with the generator 62a and said electromagnet.

A thermoelectric generator 62b is positioned to be subject to the heat of the pilot burner 7b and supplies current for energization of the electromagnet 40b of the control device 29b. One terminal of the generator 62b is connected in circuit with the terminal tip 46b by a lead conductor 63b, and the other terminal of the generator 62b is grounded to the base member 30b by a lead conductor 64b.

A thermoelectric generator 62c is subject to the heat of the pilot burner 7c and supplies a current for energization of the electromagnet 40c of the control device 29c. One terminal of the generator 62c is connected to the terminal tip 46c by lead conductor 63c and the other terminal of said generator is grounded to the base member 30c by a lead conductor 64c.

It is apparent that when the armatures of the control devices 29a, 29b and 29c are in attracted or reset position, i.e. the contacts of said control devices are closed, and each of the thermoelectric generators is heated and generating current, the safety shut-off valve 10' is held in open position by energization of the electromagnet 17' with current from the generator 65'. In event of outtage of the pilot burner 8', the generator 65' cools and the electromagnet 17' is deenergized to drop out the armature 22' and close the valve 23', thereby shutting off all fuel flow to the pilot burner.

Closure of the safety shut-off valve 10' may also be effected by outtage of either of the pilot burners 7a, 7b or 7c. Outtage of the pilot burner 7a and cooling of the adjacent generator 62a causes deenergization of the control device electromagnet 40a and drop-out of the coacting armature 49a. This interrupts the current flow from the generator 65' to the valve electromagnet 17' and causes closure of the valve member 23'.

Outtage of the pilot burner 7b and cooling of the adjacent generator 62b causes deenergization of the control device electromagnet 40b and drop-out of the coacting armature 49b, thereby interrupting the current flow from the generator 62a to the electromagnet 40a. This causes deenergization of the electromagnet 40a and drop-out of the coacting armature 49a. As previously noted, drop-out of the armature 49a interrupts the current flow to the electromagnet 17' and causes closure of the safety shut-off valve 10'.

Outtage of the pilot burner 7c and cooling of the generator 62c causes deenergization of the electromagnet 40c and drop-out of the armature 49c Drop-out of the armature 49c interrupts the current flow from the generator 65' to the valve electromagnet 17', thereby deenergizing said electromagnet causing closure of the safety shut-off valve 10'.

While the invention has been illustrated in connection with two and four burner systems, it is within the concept of the invention to utilize the improved control system with fuel burning apparatus having a different number of burners, for example three burners or more than four burners. In Figure 2, if the burner 5c were omitted, the pilot burner 7c, generator 62c and control device 49c could also be omitted, in which event the lead conductor 66' should be connected in circuit with the terminal tip 48a, and the lead conductor 67' grounded to the base member 30a of the control device 29a. Where it is desired to control more than four burners, each additional burner should be provided with a thermoelectric generator subject to the heat of an associated pilot burner. An additional control device similar to 29a must also be provided with each additional burner, the electromagnet of said control device being energized by current from the additional generator, and the contacts of said control device being inserted in the power circuit to the electromagnet of one of the other control devices or to the electromagnet 17' to control the flow of energizing current to the connected electromagnet.

The specific illustrations and corresponding description are used for the purpose of disclosure only and are not intended to impose unnecessary limitations on the claims, or to confine the patented invention to a particular use. It is apparent that other changes and modifications may be made without departing from the spirit of the invention, and all of such changes are contemplated as may come within the scope of the claims.

What is claimed as the invention is:

1. In combination: First, second and third thermoelectric generators; a first electroresponsive control device; second and third electroresponsive control devices each comprising coacting relatively movable contacts biased toward a circuit-interrupting position, said contacts having a circuit-making position in which they are held by energization of the electroresponsive device comprising said contacts when said contacts are moved thereto, means connecting the contacts of said second device in series circuit with said first device and first generator to permit energization of said first device by current from said first generator when said second device is energized and the contacts thereof in circuit-making position, the contacts of said third device being connected in series circuit with said second device and second generator to permit energization of said second device by current from said second generator when said third device is energized and the contacts thereof in circuit-making position, said third thermoelectric generator being connected in circuit with said third control device for energizing the latter, wherefore failure of any of said generators causes deenergization of said first device

2. In combination: First and second thermoelectric generator; a first electroresponsive control device; second, third and fourth electroresponsive control devices each comprising coacting relatively movable contacts biased toward a circuit-interrupting position and having a circuit-making position in which they are held by energization of the electroresponsive device comprising said contacts when said contacts are moved thereto, the contacts of said second and fourth devices being connected in series circuit with each other and with said first device and first generator to permit energization of said first device by current from said first generator when said second and fourth devices are energized and the contacts thereof in circuit-making position, the contacts of said third device being connected in series circuit with said second device and second generator to permit energization of said second device by current from said second generator when said third device is energized and the contacts thereof in circuit-making position; and third and fourth thermoelectric generators connected in circuit with said third and fourth control devices respectively for energizing the latter, wherefore failure of any of said generators causes deenergization of said first device.

3. In combination: First and second thermoelectric generators; a first non-cycling electromagnetic control device; second, third and fourth electromagnetic control devices each comprising coacting relatively movable manually resettable contacts encapsulated within an hermetically sealed enclosure, said contacts being biased toward a circuit-interrupting position and having a circuit-making position in which they are held by energization of the device comprising said contacts when said contacts are moved thereto, the contacts of said second and fourth devices being connected in series circuit with each other and with said first device and first generator to permit energization of said first device by current from said first generator when said second and fourth devices are energized and the contacts thereof in circuit-making position, the contacts of said third device being connected in series circuit with said second device and second generator to permit energization of said second device by current from said second generator when said third device is energized and the contacts thereof in circuit-making position; and third and fourth thermoelectric generators connected in circuit with said third and fourth control devices respectively for energizing the latter, wherefore failure of any of said generators causes deenergization of said first device.

4. In combination: First, second and third burners; first, second and third thermoelectric generators subject respectively to the heat of said first, second and third burners; a first electromagnetic safety shut-off valve controlling the fuel flow to all of said burners; second and third electromagnetic control devices each comprising coacting relatively movable contacts biased toward a circuit-interrupting position and having a circuit-making position in which they are held by energization of the device comprising said contacts when said contacts are moved to said position, means connecting the contacts of said second control device in series circuit with said safety shut-off valve and first generator to permit energization of said valve by current from said generator when said second control device is energized and the contacts thereof in circuit-making position, the contacts of said third device being connected in series circuit with said second control device and second generator to permit energization of said second control device by current from said second generator when said third control device is energized and the contacts thereof in circuit-making position, said third thermoelectric generator being connected in circuit with said third control device for energizing the latter, wherefore outtage of any of said burners causes deenergization and closure of said safety shut-off valve.

5. In combination: First, second, third and fourth main burners; a pilot burner for each of said main burners; first and second thermoelectric generators subject respectively to the heat of the pilot burners of said first and second main burners; a first electromagnetic control device comprising safety shut-off valve controlling the fuel flow to all of said burners; second, third and fourth electromagnetic control devices each comprising coacting relatively movable contacts biased toward a circuit-interrupting position and having a circuit- making position in which they are held by energization of the device comprising said contacts when said contacts are moved to said position, the contacts of said second and fourth control devices being connected in series circuit with each other and with said safety shut-off valve and first generator to permit energization of said valve by current from said second generator when said first and fourth control devices are energized and the contacts thereof in circuit-making position, the contacts of said third device being connected in series circuit with said second control device and second generator to permit energization of said second control device by current from said second generator when said third control device is energized and the contacts thereof in circuit-making position; and third and fourth thermoelectric generators subject respectively to the heat of the pilot burners of said third and fourth main burners and connected in circuit with said third and fourth control devices respectively for energizing the latter, wherefore outtage of any of said pilot burners causes deenergization and closure of said safety shut-off valve.

6. In combination: First, second, third and fourth burners; first, second, third and fourth thermoelectric generators subject respectively to the heat of said first-second, third and fourth burners; a first electromagnetic control device comprising a safety shut-off valve controlling the fuel flow to all of said burners; and second, third and fourth electromagnetic control devices each comprising coacting relatively movable contacts encapsulated within an hermetically sealed enclosure, said contacts being biased toward a circuit-interrupting position and having a circuit-making position in which they are held by energization of the devices comprising said contacts when said contacts are moved to said position, the contacts of said second and fourth control devices being connected in series circuit with each other and with said safety shut-off valve and first generator to permit enregization of said valve by current from said first generator when the contacts of said second and fourth control devices are in circuit-making position, the contacts of said third control device being connected in series circuit with said second control device and second generator to permit energization of said second control device by current from said second generator when the contacts of said third control device are in circuit-making position, said third and fourth thermoelectric generators being connected in circuit with said third and fourth control devices respectively for energizing the latter, wherefore outtage of any of said burners causes deenergization and closure of said safety shut-off valve.

7. A control system for fluid fuel burning apparatus having at least three burners each having a thermoelectric generator subject to the heat thereof, comprising: An electromagnetic valve for controlling the flow of fuel to said burners and having an energizing coil, said valve being held open by energization of said coil and being closed by deenergization of said coil, said closure effecting shut-off of the fuel flow to all of said burners; and a plurality of electromagnetic control devices one less in number than the number of said generators, said control devices each comprising an energizing coil and cooperating contacts encapsulated within an hermetically sealed enclosure, said contacts having a circuit-making position in which they are held by energization of the coil associated therewith in the same control device and a circuit-interrupting position to which they are moved by deener-

gization of said coil, said valve coil being connected in series circuit with the contacts of at least one of said control devices and with one of said generators for energization by said one generator when the contacts of said one control device are in circuit-making position, and the energizing coil of each of the other control devices being connected for energization thereby in circuit with a separate one of the generators other than said one generator, the contacts of at least one of said other control devices being connected in series circuit relation with the energizing coil of said one control device, whereby failure of any of said generators effects deenergization of the valve coil, closure of the valve and shut-off of the fuel flow to all of the burners.

8. A control device for connection with any desired number of like control devices to provide a unitary control apparatus sensitive to a corresponding number of conditions comprising in combination, an electrically conductive base provided with an externally threaded projection, an insulated terminal forming with said projection first connector means, said base also being provided with a pair of identical internally threaded recesses complemental to said projection, an insulated terminal within each of said recesses forming therewith second and third connector means, circuit controlling means in series circuit with the terminals of said first and second connector means and having first and second circuit controlling positions, means biasing said circuit controlling means toward said first circuit controlling position, electromagnetic holding means energizable to hold said circuit controlling means in said second circuit controlling position when moved thereto against said biasing means, said holding means comprising an electromagnet winding having one end in circuit with the terminal of said third connector means and having the other end thereof grounded to said base, each of said second and third connector means being adapted to selectively receive therein a complemental connector means of a given lead connector or the first connector means of a like control device.

9. A control device for connection with any desired number of like control devices to provide a unitary control apparatus sensitive to a corresponding number of conditions comprising in combination, an electrically conductive base provided with an externally threaded projection, an insulated terminal forming with said projection first connector means, said base also being provided with a pair of identical internally threaded recesses complemental to said projection, an insulated terminal within each of said recesses forming therewith second and third connector means, circuit controlling means comprising cooperating electrical contact means in series circuit with the terminals of said first and second connector means and having circuit-interrupting and circuit-making positions, means biasing said contact means toward circuit-interrupting position, electromagnetic holding means energizable to hold said contact means in circuit-making position when moved thereto against said biasing means, said holding means comprising an electromagnet winding having one end in circuit with the terminal of said third connector means and having the other end thereof grounded to said base, each of said second and third connector means being adapted to selectively receive therein a complemental connector means of a given lead connector or the first connector means of a like control device.

10. A control device for connection with any desired number of like control devices to provide a unitary control apparatus sensitive to a corresponding number of conditions comprising in combination, an electrically conductive base provided with an externally threaded projection, an insulated terminal forming with said projection first connector means, said base also being provided with a pair of identical internally threaded recesses complemental to said projection, an insulated terminal within each of said recesses forming therewith second and third connector means, circuit controlling means comprising cooperating electrical contacts encapsulated within an hermetically sealed enclosure and connected in series circuit with the terminals of said first and second connector means, said contacts having circuit-interrupting and circuit-making positions, means biasing said contacts toward circuit-interrupting position, electromagnetic holding means energizable to hold said contacts in circuit-making position when moved thereto against said biasing means, said holding means comprising an electromagnet winding having one end in circuit with the terminal of said third connector means and having the other end thereof grounded to said base, each of said second and third connector means being adapted to selectively receive therein a complemental connector means of a given lead connector or the first connector means of a like control device.

11. A control device for connection with any desired number of like control devices to provide a unitary control apparatus sensitive to a corresponding number of conditions comprising in combination, an electrically conductive base provided with an externally threaded projection, an insulated terminal forming with said projection first connector means, said base also being provided with a pair of identical internally threaded recesses complemental to said projection, an insulated terminal within each of said recesses forming therewith second and third connector means, circuit controlling means comprising cooperating electrical contacts encapsulated within an hermetically sealed enclosure and connected in series circuit with the terminals of said first and second connector means, said contacts having circuit-interrupting and circuit-making positions, means biasing said contacts toward circuit-interrupting position, electromagnetic holding means energizable to hold said contacts in circuit-making position when moved thereto against said biasing means, said holding means comprising an electromagnet winding having one end in circuit with the terminal of said third connector means and having the other end thereof grounded to said base, each of said second and third connector means being adapted to selectively receive therein a complemental connector means of a given lead connector having circuit connection with a condition responsive source of electrical energy for energization of said winding and holding of said contacts in circuit-making position while a given condition exists or to receive the first connector means of a like control device also having second and third connector means for selective connection in circuit with a separate condition responsive source of energy or with the first connector of another like control device to provide a cascade arrangement of said control devices affording a control apparatus responsive to a plurality of conditions.

References Cited in the file of this patent

UNITED STATES PATENTS

1,869,829	Skellett	Aug. 2, 1932
2,183,855	Mansky	Dec. 19, 1939
2,460,055	Wilson et al.	Jan. 25, 1949
2,479,797	Wasser	Aug. 23, 1949
2,553,517	Isserstedt	May 15, 1951
2,666,196	Kinsley	Jan. 12, 1954