May 8, 1945. L. V. McCARTY 2,375,569

BURNER CONTROL APPARATUS

Original Filed April 25, 1941 2 Sheets-Sheet 1

Fig. 1.

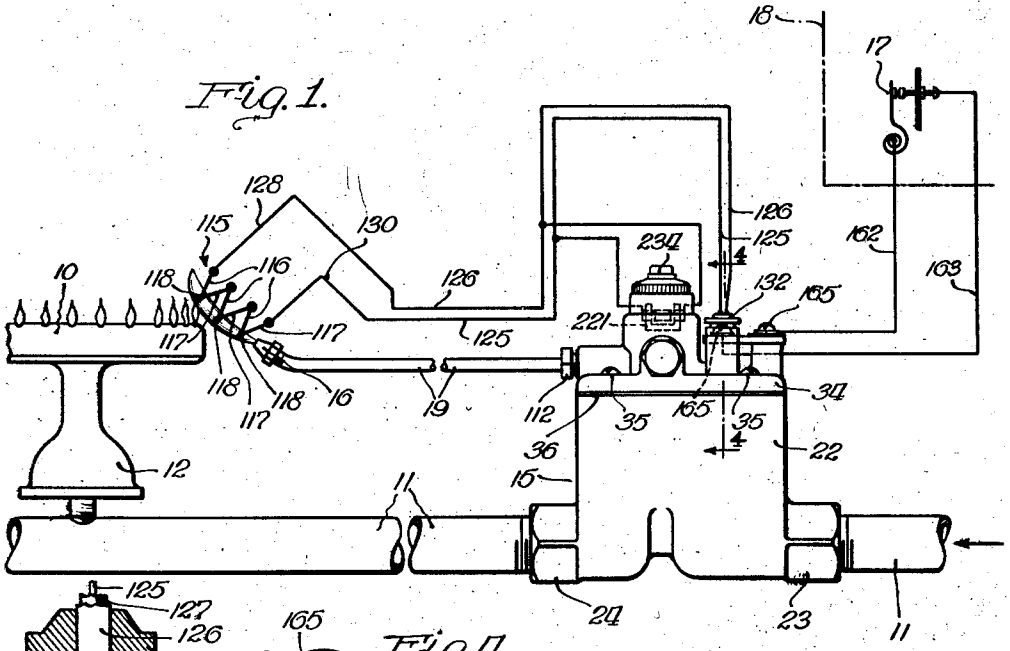


Fig. 4.

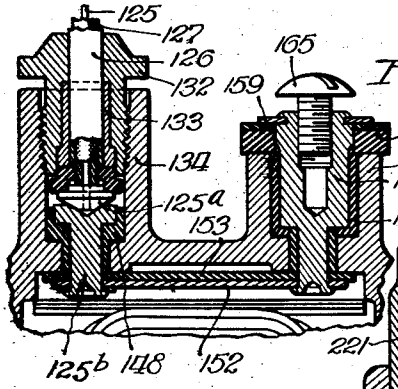
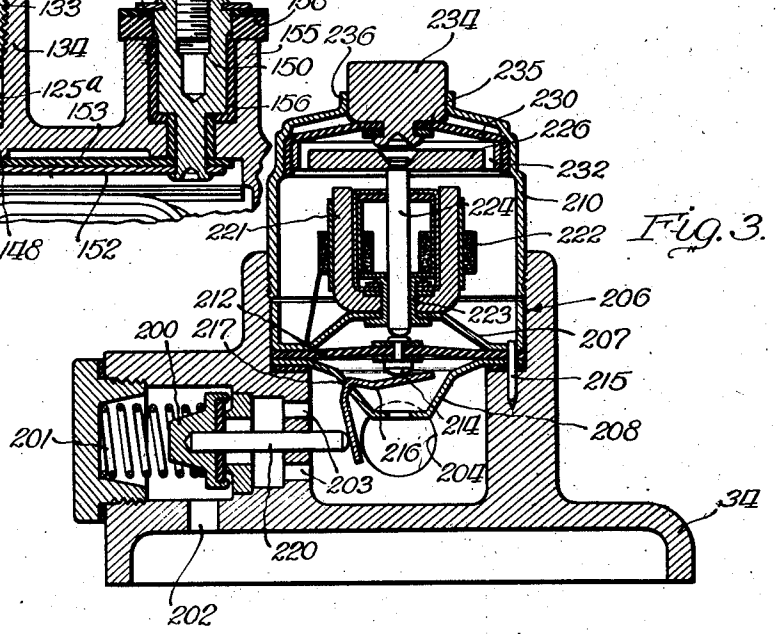


Fig. 3.



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BURNER CONTROL APPARATUS

Original Filed April 25, 1941 2 Sheets-Sheet 2

Fig. 2.

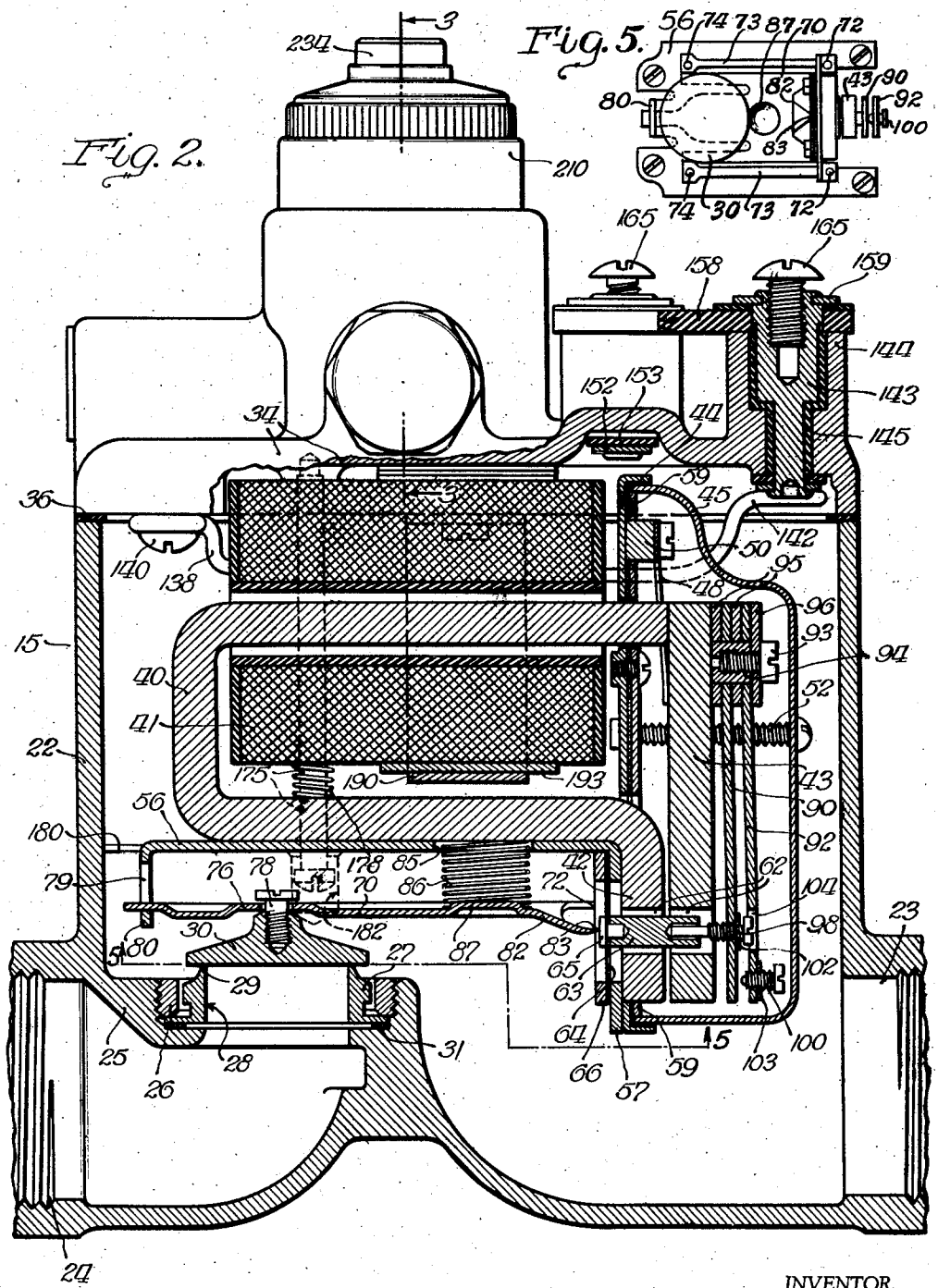


Fig. 5.

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Patented May 8, 1945 2,375,569

UNITED STATES PATENT OFFICE

2,375,569

BURNER CONTROL APPARATUS

Lourdes V. McCarty, Milwaukee, Wis., assignor to Milwaukee Gas Specialty Company, Milwaukee, Wis., a corporation of Wisconsin

Original application April 25, 1941, Serial No. 390,247. Divided and this application November 21, 1941, Serial No. 419,844

11 Claims. (Cl. 158—117.1)

This invention relates, generally, to apparatus for controlling fluid flow in conduits, and it has particular relation to an improved burner control apparatus of the character employing electromagnet means, an electrical operating circuit therefor, and a thermoelectric generator energized by the heat of a flame for supplying current to the operating circuit.

The invention may be embodied in a wide variety of forms for controlling the supply of fuel to a wide variety of gas or other fuel burners. For purposes of illustration, I shall refer to an illustrative embodiment of the invention, but it is to be understood that the invention is not limited to the particular embodiment herein set forth.

One of the main objects of the present invention is to provide in apparatus of the class described, a pair of electroresponsive valves or other electroresponsive control devices, for example an electroresponsive valve for the main burner and an electroresponsive valve for a pilot burner, the electroresponsive valves or control devices each including an electromagnet, and there being a thermoelectric generator connected in circuit with the electromagnets for energizing the same by the heat of a flame on the thermoelectric generator in combination with means controlling the energization of one of the electromagnets, for example the electromagnet for the valve or control device for the main burner independently of the electromagnet for the other valve or control device.

One of the chief advantages of the combination set forth is that it provides for pilot control of valve means for both the main burner and the pilot burner, and, at the same time, for condition responsive or other control, for example, of the main burner valve independently of the valve for the pilot burner. This permits closing and opening the main burner valve by an automatic timer actuated switch, or a thermostatic or pressure actuated switch, or other condition responsive device, while maintaining the pilot valve open as long as the thermoelectric generator is heated by the pilot flame, the valve means for the main burner and the valve means for the pilot burner both operating to closed position upon extinguishment of the pilot flame.

Another object of the invention is to eliminate in the combination set forth the necessity of manual cocking or reset means for the valve for the main burner and the necessity of a manual cocking or resetting operation for this valve, and to provide a thermoelectric control and safety shutoff device in which the valve for the main burner is actuated to open position as well as held in open position through the instrumentality of the minute electromotive force generated by the heat of the pilot flame on the thermoelectric generator.

Another object of the invention is to provide mechanism of simple and improved construction which will operate effectively to accomplish the results set forth.

While the particular structural features by which I obtain a device of the character set forth are important features within the more specific aspects of the invention, it is to be understood that the precise features shown and described may be varied within the broader aspects of the invention.

In order to acquaint those skilled in the art with the manner of constructing and operating a device in accordance with the present invention, I will now describe in connection with the accompanying drawings an illustrative embodiment of the invention.

In the drawings:

Figure 1 is a fragmentary and more or less diagrammatic view showing an embodiment of the invention in a pilot burner and main burner gas supply system;

Figure 2 is a vertical longitudinal section through the thermoelectric control and safety shutoff device shown in Figure 1;

Figure 3 is a fragmentary vertical section taken on the line 3—3 of Figure 2;

Figure 4 is a fragmentary vertical transverse section taken on the line 4—4 of Figure 1; and

Figure 5 is a bottom plan view of the electromagnetic operating unit taken substantially on the line 5—5 of Figure 2 and showing the valve member, its operating lever, and the hinge mounting for the operating lever.

This application is a division of my prior Patent No. 2,349,443, issued May 23, 1944, on application Serial No. 390,247, filed April 25, 1941.

Referring now to the drawings, in Figure 1 the burner 10 is any suitable or preferred main burner. It may be the main burner for a room or space heater, or it may be the burner for a water heater, or for a floor furnace, an oven burner, one or more top burners for a gas range, or any other burner. A fuel supply pipe 11 leads to the burner 10 for the delivery of gaseous or other fuel thereto—for example, through a mixing chamber 12 to which air is admitted in the usual way, as well understood in the art.

Interposed in the fuel supply pipe 11 is the thermoelectric control and safety shutoff device indi-

cated in its entirety at 15 in Figure 1. The device 15 is responsive to the pilot burner 16. It may also be responsive to a control device 17 shown, for purposes of illustration in Figure 1, as a thermostatically actuated switch which, in the case of a hot water heater, may be subject to the temperature of the water in the tank, or, in the case of a room or space heater or floor furnace, may be mounted in appropriate position within the room or other space heated by the burner 10. Instead of being in the form of a thermostatically actuated switch, the control device 17 may be of a character to operate, for example, upon the occurrence of an abnormal pressure in the tank of a hot water heater, or upon the occurrence of any other abnormal, defective or insufficient functioning of the apparatus. The room or space in which the control device 17 is located is indicated more or less diagrammatically by dot and dash lines 18 in Figure 1.

The pilot burner 16, which is located in juxtaposition to the main burner 10 to maintain a pilot flame for igniting the main burner, is supplied with gaseous fuel by a pilot supply pipe 19 which is shown as leading from the housing or case of the thermoelectric control and safety shutoff device 15. This may vary within the scope of the present invention.

Referring now in detail to the thermoelectric control and safety shutoff device 15, the housing or case 22 for this device has an inlet at 23 and an outlet at 24. The inlet 23 opens into the interior of the housing, and a partition or wall 25 separates the interior of the housing from the outlet 24. The partition 25 has an opening into which is threaded a retaining ring 26 which secures a valve seat member 27 in place. The valve seat member 27 defines an opening 28 for placing the interior of the housing 22 in communication with the outlet 24. The upper end of the valve seat member 27 is provided with an annular valve seat 29 upon which the shut-off valve disc 30 is adapted to seat to shut off the supply of fuel to the burner 10. A gasket may be provided at 31.

Contiguous sections of the fuel supply pipe 11 are connected to the inlet at 23 and to the outlet at 24 as shown in Figure 1. A cover 34 is removably secured upon and closes the top of the housing 22. The cover 34 is shown as secured to the housing 22 by screws 35, and a cover gasket may be provided at 36.

The electromagnetic operator for the valve or controlling member, and the valve, valve lever, and energy storing means constitute a unitary assembly which is carried by the cover 34, preferably resiliently, as will hereinafter appear. This assembly is enclosed within the housing 22 when the cover 34 is applied and is removable from the housing by removing the cover.

The electromagnetic operator includes an electromagnet consisting of a magnet frame 40 shown as of generally U-shaped form, although this may vary. The coil 41 is shown as wound around one leg of the magnet frame, and the end of the other leg of the magnet frame is shown as turned at 42 to position generally parallel to the armature 43 to present a relatively large pole face to the armature.

The ends of the magnet frame 40 extend through openings in a sealing plate 44, the margin of which is turned or flanged laterally to receive a sealing cover 45 between which and the plate 44 the pole faces of the magnet frame 40, the armature 43, and the energy storing means are enclosed and sealed. The armature 43 is hinged by hinge means 48 to a spacer 50 fixed to or integral with the sealing plate 44. The hinge means 48 hinges the armature 43 in position adjacent the pole faces of the magnet frame, and the hinge means 48 is preferably of spring character to maintain the armature in the desired position. The cover 45 is removably secured to the sealing plate, for example by screw 52, and the cover, when in place, may limit movement of the armature away from the electromagnet.

The magnet frame 40 is mounted on and carried by a mounting plate 56 which has a downturned lug 57 positioned against the back of the downturned end 42 of the magnet frame. Screws (not shown) secure the sealing plate 44 to the downturned lug 57 on the mounting plate 56. A sealing gasket is preferably provided at 59.

The armature 43 and the downturned end 42 of the magnet frame have registering openings 62. A plunger 63, movable endwise in these openings, is secured to the center of a flexible diaphragm 64 by a diaphragm pin 65. The diaphragm 64 is clamped in place to the back of the downturned lug 57 on the mounting plate 56 by a retaining plate 66 which may be secured in place by screws and cooperating nuts (not shown), or otherwise as desired. The retaining plate 66 and the downturned lug 57 on the mounting plate 56 have registering openings, and the diaphragm 64 seals the space between the sealing plate 44 and the cover 45 against the entry of deleterious matter through the openings 62.

A valve or controlling member operating lever 70 is hinged in a suitable manner at 72 by a pair of hinge springs 73 to lugs on the sealing plate 44 at opposite sides of the lever, or to lugs on a mounting plate secured in place with the sealing plate. The opposite ends of the hinge springs 73 are secured, for example, at 74, to lateral lugs (not shown) on the operating lever 70. The lever 70 has a lug 76 offset upwardly therefrom, and the valve disc member 30 or controlling member is secured to this lug 76 by a valve disc screw 78. The outer end of the lug 76 engages in a slot 79 in the downturned lug 58 on the mounting plate 56.

Engagement of the outer end of the lug 76 with the lug 80 at the bottom of the slot 79 serves to prevent undue separation of the valve disc 30 from the mounting plate 56 and electromagnetic operator assembly, particularly when the assembly is removed from the housing 22.

At its opposite end the lever 70 is provided centrally between its opposite sides with a downwardly offset lug 82 having a pointed end for engagement at 83 with the adjacent end of the diaphragm pin 65. The lever 70, being hinged or fulcrumed close to the pointed engagement at 83 with the plunger 63, provides for imparting relatively great movement to the valve disc 30 with relatively slight movement of the plunger 63. The mounting plate 56 has an opening 85, and a relatively light coiled spring 86 is disposed to extend through this opening and between the magnet frame 40 and the lever 70 for returning the valve disc 30 to closed position upon deenergization of the electromagnet. The thermoelectric control and safety shutoff device is preferably positioned vertically in use, as shown in Figures 1 and 2, in which case I contemplate returning the valve disc 30 to closed position by gravity and without the use of a spring, such as the spring 86, or by gravity in conjunction with the spring 86, or otherwise as desired. A circular raised portion 87 on the lever 70 engages in the

lower end convolution of the spring 88 for holding the lower end of the spring in place and against lateral displacement.

It will be noted that the gas pressure within the housing 22 acting upon the top of the valve disc 30 holds the valve disc to its seat 29. When the valve is closed it requires the greatest force to lift it or move it from its seat 29, and as the valve disc 30 is lifted or moved away from its seat, the drop in pressure across the valve causes a rapid drop in the force required to continue movement of the valve disc 30 to full open position.

The energy storing means is shown as comprising a pair of flat leaf springs 90 and 92 normally disposed in substantially parallel relation. The upper ends of these leaf springs 90 and 92 are attached to the armature 43, for example, by a screw 93 threaded into an armature bushing 94, which bushing 94 in turn is suitably secured or fixed to the armature 43. Spacers are provided at 95, one between the armature 43 and the spring 90 and the other between the spring 90 and the spring 92. A retaining clamp 96 is provided between the spring 92 and the head of the screw 93.

An adjusting pressure screw 98, threaded through the spring 90 near its lower end, has endwise engagement with the plunger 63 preferably extending into an axial opening in the plunger as shown in Figure 2. A second adjusting pressure screw 100 is threaded through the spring 92 near its lower end, and the pointed inner end of the screw 100 is adapted to engage or contact the spring 90 after initial tensioning of the spring 90, as will presently appear. In that the spring 90 alone is tensioned in the initial movement of the armature from retracted to attracted position, the pointed inner end of the screw 100 is normally spaced from or out of contact with the spring 90, as shown more or less diagrammatically in Figure 2. The screws 98 and 100 are adjustable to adjust the action of the device and may be locked in adjusted positions as desired, tension clamps being indicated more or less diagrammatically at 102 and 103 respectively. The spring 92 has an opening 104 which operates over the head of the screw 98 to permit movement of the spring 92 toward the spring 90 and free of the spring 90 in the initial movement of the armature to attracted position.

By reference to Figure 3 it will be seen that the pilot valve member 200, which is adapted to shut off or control the supply of fuel to the pilot burner, is urged toward its seat and toward a closed position by a coiled spring 201. The valve member 200 will be in open position only when the pilot light is burning, and, when in open position, the fuel for the pilot burner passes from the housing 22 through an opening 202, and thence through the opening defined by the valve seat member and through openings 203 and an outlet 204 into the pilot supply pipe 19 leading to the pilot burner 16.

The cover 34 has a boss provided with a bore 206. A magnet support 207 and a lever support 208 are clamped in place in the inner end of the bore 206 by a generally cup-shaped member 210 threaded at its inner end into the outer end of the bore 206. A flexible diaphragm 212 clamped in place marginally between the members 207 and 208 carries a diaphragm pin 214. A dowel pin may be provided at 215. A lever 216 is fulcrumed at 217 on the lever support 208 and has one end positioned to be actuated by the diaphragm pin 214, and its other end is positioned to actuate the plunger or stem 220 for the valve member 200.

An electromagnet is housed within the member 210 and comprises a magnet frame 221, shown of generally U-shaped form, and an energizing coil 222. The magnet frame 221 is attached by a sleeve member 223 to the center of the raised bottom portion of the magnet support 207. An armature stem 224 passes slidingly through the sleeve 223, and has an armature 226 mounted on its outer end, preferably with sufficient looseness or play to enable the armature to accommodate itself to the pole faces of the magnet frame when in attracted position. The inner end of the armature stem 224 contacts the diaphragm pin 214.

A flexible diaphragm 230 is secured marginally in the outer end of the member 210 by a retainer ring 232, and a reset button 234 is secured at 235 to the center of the diaphragm 230. The reset button projects slidingly through an opening 236 in the outer end of the member 210. When the button 234 is engaged by the finger and pressed inwardly, it moves the armature 226 to attracted position, and the accompanying inward movement of the stem 224 swings the lever 216 in a clockwise direction about its fulcrum 217, the engagement of the lever 216 with the valve stem 220 moving the valve 200 to open position against the action of the spring 201 as the reset button is pressed inwardly.

For purposes of illustration, the thermoelectric generator, which is energized by the heat of the pilot flame for supplying thermoelectric current to the thermoelectric operating circuit for energizing the electromagnet for the main burner valve as well as the electromagnet for the pilot burner valve, is shown more or less diagrammatically as a thermopile 115 comprising a plurality of thermocouples—three being shown—connected in series. This, of course, may vary within the scope of the present invention, any thermoelectric generator which will generate the required thermoelectric current being contemplated within the scope of the appended claims.

Suffice it for purposes of the present application to state that each of the three thermocouples of the thermoelectric generator 115 comprises the usual or any suitable elements 116 and 117 of different thermoelectric characteristics, each pair of said elements being joined at 118 to provide the "hot junctions" which are placed in position to be heated by the pilot flame as long as the pilot flame is burning. Any other suitable thermoelectric or electric generator may be employed.

The lead conductors for the thermoelectric generator may be of the type more fully disclosed in Oscar J. Leins Patent No. 2,126,564, granted August 9, 1938, or the construction of the thermoelectric leads may be of any other suitable or preferred form.

For the purpose of this description suffice it to state that the thermoelectric lead conductors may comprise, as shown fragmentarily in Figure 4, an inner lead conductor 125 and an outer tubular lead conductor 126 surrounding the inner lead conductor. The inner lead conductor is insulated from the outer lead conductor, for instance, by a wrapping of insulation 127 on the inner lead conductor. One terminal of the thermoelectric generator is shown more or less diagrammatically as connected at 128 to the outer tubular lead conductor 126. The other terminal of the thermoelectric generator is shown as connected at 130 to the inner lead conductor 125.

A quick detachable or removable connection is preferably provided between the electromagnet for the main valve of the thermolelectric control

and safety shutoff device and the ends of the leads 125 and 126 opposite the ends which are connected to the thermoelectric generator. This removable lead connection may be of any suitable form. Suffice it, for purposes of this description, to state that the inner lead 125 has a connector cone 125a which seats in the correspondingly recessed outer end of the terminal tip 125b, and is clamped in contact therewith by a connector sleeve 132. The adjacent end of the outer tubular lead conductor 126 is grounded to the cover 34 of the housing through a bushing 133 and the connector sleeve 132 to the internally threaded boss 134 on the cover 34.

One end of the coil 41 (Figure 2) is secured to the under side of the cover 34 by a binding screw 140, and thereby is grounded to the cover and thus connected to the outer lead conductor 126. The other end 142 of the coil 41 is connected to a terminal post 143 fixed in a boss 144 on the cover 34 and insulated therefrom by a terminal bushing 145. The terminal tip 125b, which is insulated from the cover by an insulator bushing 148, is connected in circuit with a second terminal post 150 by a connector strip 152. An insulator strip is provided at 153 (Figure 4). The terminal post 150 is fixed in a boss 155 on the cover 34 and is insulated therefrom by a terminal insulator 156. An insulating terminal board 158 is mounted across the tops of the bosses 144 and 155, suitable washers being provided at 159 and the upper ends of the terminal posts 143 and 150 being peened over or otherwise formed to secure the terminal board in place.

Where a thermostat or other condition responsive device is employed as indicated at 17 in Figure 1, the leads 162 and 163 for this device are connected to the terminal posts 143 and 150 by suitable binding screws 165. The thermostat or other condition responsive device 17 is thus placed in series circuit relation with the thermoelectric generator and the coil 41 of the electromagnet for the main valve.

To secure accurate positioning of the valve disc 30 or other controlling member with respect to the valve seat 29 or cooperating part, and independently, for example, of the attachment of the cover 34 to the housing 22, I provide a resilient mounting for the electromagnetic operator assembly. This resilient mounting comprises vertically elongated screws or posts having their heads disposed beneath the mounting plate 56 and their shanks extending up relatively loosely through openings in the mounting plate. The upper ends of the screws or posts 175 have threaded engagement (not shown) with the cover 34, and springs 178 are coiled about the respective posts and interposed between the cover 34 and the mounting plate 56. When the cover 34 is applied, the electromagnetic operator is positioned within the housing 22 and the mounting plate 56 seats upon horizontal seating surfaces, one of which is indicated at 180, in the interior of the housing 22, thus assuring accurate positioning of the valve disc with respect to its valve seat 29; as is disclosed more fully in my copending application Serial No. 390,247, above mentioned. The cover 34 may be clamped in place, and any improper fit of the cover or nonuniformity in the clamping of the same in place will not disturb the proper positioning of the valve disc 30. The heads and the lower ends of the screws or posts 175 are spaced below the mounting plate 56 and are positioned in recesses 182 in the housing 22.

The magnet frames and armatures are preferably formed on an alloy of relatively low magnetic reluctance, and the operating circuit for the device is preferably of low resistance characteristics.

The energizing coil 222 for the pilot valve electromagnet is preferably connected in parallel circuit relation with the electromagnet for opening the main valve and for holding same open. This permits the thermostat or other condition responsive device at 17, for example, to operate to deenergize the electromagnet for the main valve without deenergizing the electromagnet for the pilot valve. When the pilot light is extinguished, both the main valve and the pilot valve operate to closed position. The spring 201 closes the valve 200 when the electromagnet therefor is deenergized, and through the stem or plunger 220, lever 216, diaphragm pin 214, and armature stem 224 moves the armature to retracted position and the reset button to its outwardly projected position as shown in Figure 3. When the reset button is pressed inwardly in resetting or cocking the device, the armature is moved to attracted position, and assuming that the electromagnet for the pilot valve is sufficiently energized by the heat of the pilot flame on the thermoelectric generator, the armature will be held magnetically in attracted position, thus holding the pilot valve open as long as the pilot light is burning.

As thus described, the pilot generator shown, for example, at 115 in Figure 1, supplies the thermoelectric current for energizing the electromagnet for the pilot valve as well as the thermoelectric current for energizing the electromagnet for the main valve.

The operation of the device is as follows:

Assume that the pilot light is lighted and heating the "hot" junctions 118 of the thermoelectric generator to supply the operating thermoelectric current to the circuit for energizing the two electromagnets, and that the thermostat or other condition responsive device at 17 has operated to open or disable the thermoelectric circuit to deenergize the electromagnet for the main burner valve. The armature 43 is then positioned in retracted position with an air gap between it and the magnet frame by the screw 98 and plunger 63 pushing against the diaphragm pin 65 and point 83 on the valve lever 70, the armature and energy storing springs 90 and 92 being positioned substantially as shown in Figure 2. The main valve disc 30 will be closed upon its seat 29 to shut off the supply of fuel to the main burner, and will be held closed by the pressure of the gas within the housing 22.

Now, when the thermostat or other condition responsive device 17 closes or enables the thermoelectric circuit for the main burner valve electromagnet, the thermoelectric generator will supply thermoelectric current for energizing that electromagnet.

When the main burner valve electromagnet is energized, the armature 43 is pulled toward the pole faces of the magnet frame by the magnetic attraction. The lower end of the energy storing spring 90 is held against following the armature by engagement of the adjusting pressure screw 98 with the plunger 63 which, in turn, is prevented from moving by the gas pressure acting on the valve disc 30, said valve disc being operatively connected to the spring 90 by means of the adjusting screw 98, plunger 63, point 83, pivot point 72, and lever 70. As a result, the spring 90 is tensioned by a scissors-like action or

separation of the lower end of the armature 43 from the lower end of the spring 90.

The lower end of the second spring 92 being free, it follows the movement of the armature 43 without tensioning of the second spring in the initial movement of the armature to attracted position. As the armature 43 moves toward the pole faces of the magnet frame and after initial tensioning of the spring 90, the pressure adjusting screw 100, carried by the spring 92 contacts the spring 90. Further movement of the armature 43 toward attracted position thereupon further tensions the spring 90 and, at the same time, tensions or stores up energy in the second spring 92. At the time when the movement of the armature 43 to attracted position is tensioning only the spring 90, the magnetic attraction is least, and when the movement of the armature is tensioning both springs 90 and 92, the armature is closer to the magnet frame and the magnetic attraction is greater. The tension in the leaf springs 90 and 92 is built up or energy is stored until the combined tension or energy in both springs is sufficient to lift or open the valve disc 30 against the gas pressure, whereupon the stored energy operates to open the valve quickly and effectively to set up the supply of fuel to the burner 10. As the valve disc 30 begins to lift or open, the pressure across it drops and leaf spring 90 continues to lift the valve and moves away from the spring 92—that is, the point of the pressure screw 100 loses contact with the spring 90.

The position of the armature 43 when the valve disc 30 is being lifted depends upon the gas pressure across the disc—that is, the greater the gas pressure the further the armature moves toward the pole faces of the magnet frame before the valve disc begins to open. The force or energy in the leaf springs 90 and 92 must exceed the combined force of the gas pressure and other counteracting forces before the valve disc 30 can be opened. It should be borne in mind that neither spring 90 nor 92 is stressed when the valve disc 30 is in the closed position—that is, on the valve seat. The spring 90 is slightly stressed when the valve disc is in the open position. This is caused by the pressure drop across the valve, the weight of the valve, and the force of spring 86. However, spring 92 is not tensioned at this time because the point of the screw 100 is not in contact with the spring 90. The energy storing means presents to the armature in all positions thereof in its movement to attracted position a resistance less than the magnetic attraction between the electromagnet and the armature at the corresponding position of the armature, and therefore the energy storing means does not prevent or obstruct movement of the armature to attracted position.

From the foregoing it will be apparent that as long as the thermoelectric generator is heated by the pilot flame, the main valve will be opened and closed automatically by the condition responsive or equivalent means.

If, for any reason, the pilot burner is extinguished with the thermostatic or other condition responsive switch at 17 closed, the resulting discontinuance of the thermoelectric current results in deenergization not only of the electromagnet for the pilot burner valve but deenergization of the electromagnet for the main burner valve. The armatures are thereupon actuated to retracted position, which results in closing of the main burner valve and pilot burner valve completely to shut off the supply of fuel. When the pilot burner is reignited, the heat of the pilot flame will energize the electromagnet for the main burner valve whereupon, assuming that the thermoelectric circuit for this valve is closed, the valve will be automatically operated to open position in the manner already described. The pilot burner valve selected for illustration requires manual resetting of the same to open position, but the use of a pilot burner valve which will open automatically is contemplated.

I have determined, by experiment, that in one preferred embodiment of the invention the ratio of the air gap with the armature in retracted position to the length of air gap with the armature in attracted position is preferably approximately over three times the ratio of pull with the armature in attracted position to the pull with the armature in retracted position.

The embodiment of the invention shown in the drawings is for illustrative purposes only, and it is to be expressly understood that said drawings and the accompanying specification are not to be construed as a definition of the limits or scope of the invention, reference being had to the appended claims for that purpose.

I claim:

1. In burner control apparatus, in combination, a main burner, a pilot burner positioned to light said main burner, a fuel supply line leading to the main burner, a fuel supply line leading to the pilot burner, a main burner shutoff valve in the fuel supply line leading to the main burner, a first electromagnet, an electroresponsive shutoff valve in the fuel supply line leading to the pilot burner, a second electromagnet adapted when energized to hold said pilot valve open, a thermoelectric generator positioned to be heated by the pilot burner and connected in circuit with said first and second electromagnets to energize the same by the heat of the pilot burner on said thermoelectric generator, and mechanical connections between said first electromagnet and said main burner shutoff valve whereby said first electromagnet, when energized by said thermoelectric generator, opens said main burner valve and holds it open.

2. In burner control apparatus, in combination, a main burner, a pilot burner positioned to light said main burner, a fuel supply line leading to the main burner, a fuel supply line leading to the pilot burner, a main burner shutoff valve in the fuel supply line leading to the main burner, a first electromagnet, an electroresponsive shutoff valve in the fuel supply line leading to the pilot burner, a second electromagnet adapted when energized to hold said pilot valve open, a thermoelectric generator positioned to be heated by the pilot burner and connected in circuit with said first electromagnet to energize the same by the heat of the pilot burner on said thermoelectric generator, mechanical connections between said first electromagnet and said main burner shutoff valve whereby said first electromagnet, when energized by said thermoelectric generator, opens said main burner valve and holds it open, automatically operable switch means connected into the thermoelectric circuit including said thermoelectric generator and said first electromagnet for automatically opening and closing said thermoelectric circuit, and means connecting said second electromagnet in parallel circuit relation with the thermoelectric circuit including said thermoelectric generator and ahead of said automatically operable switch means for energization of said second electromagnet by the heat of the pilot burner on the

thermoelectric generator and independently of said automatically operable switch means.

3. In burner control apparatus, in combination, a main burner, a pilot burner positioned to light said main burner, a fuel supply line leading to the main burner, a fuel supply line leading to the pilot burner, a main burner shutoff valve in the fuel supply line leading to the main burner, a first electromagnet, an electroresponsive shutoff valve in the fuel supply line leading to the pilot burner, a second electromagnet adapted when energized to hold said pilot valve open, a thermoelectric generator positioned to be heated by the pilot burner and connected in circuit with said first and second electromagnets to energize the same by the heat of the pilot burner on said thermoelectric generator, and means supplementary to and operating in conjunction with said first electromagnet and the thermoelectric generator to open the main burner shutoff valve upon energization of the thermoelectric generator by the heat of the pilot burner on said thermoelectric generator and independently of the pressure of the fuel in said main burner fuel supply line.

4. In burner control apparatus, in combination, a main burner, a pilot burner positioned to light said main burner, a fuel supply line leading to the main burner, a fuel supply line leading to the pilot burner, a main burner shutoff valve in the fuel supply line leading to the main burner, a first electromagnet, an armature for said electromagnet having an attracted position and a retracted position, an electroresponsive shutoff valve in the fuel supply line leading to the pilot burner, a second electromagnet adapted when energized to hold said pilot valve open, a thermoelectric generator positioned to be heated by the pilot burner and connected in circuit with said first and second electromagnets to energize the same by the heat of the pilot burner on said thermoelectric generator, energy storing means whereby movement of the armature to attracted position stores energy for opening said main valve, and operating connections between said energy storing means and said main shutoff valve effective for moving said main shutoff valve to open position by the energy stored in said energy storing means as the armature approaches its attracted position.

5. In burner control means, in combination, a main burner, a pilot burner positioned to light said main burner, a fuel supply line leading to the main burner, a fuel supply line leading to the pilot burner, a main burner shutoff valve, means for operating said valve comprising a first electromagnet, a pilot burner shutoff valve, means for operating said pilot valve comprising a second electromagnet, and a thermoelectric generator positioned to be heated by the pilot burner and connected in circuit with said first and second electromagnets to energize the same by the heat of the pilot burner on said thermoelectric generator, the operating means for both of said valves being closed against escape of fuel to the atmosphere and effective for holding the respective valves open when the respective electromagnets are energized by said thermoelectric generator.

6. In burner control means, in combination, a main burner, a pilot burner positioned to light said main burner, a fuel supply line leading to the main burner, a fuel supply line leading to the pilot burner, a main burner shutoff valve, means for operating said valve comprising a first electromagnet, a pilot burner shutoff valve, means for operating said pilot valve comprising a second electromagnet, a thermoelectric generator positioned to be heated by the pilot burner and connected in circuit with said first and second electromagnets to energize the same by the heat of the pilot burner on said thermoelectric generator, the operating means for both of said valves being closed against escape of fuel to the atmosphere and effective for holding the respective valves open when the respective electromagnets are energized by said thermoelectric generator, automatically operable switch means in the thermoelectric circuit including said thermoelectric generator and said first electromagnet for automatically opening and closing said thermoelectric circuit, and means connecting said second electromagnet in parallel circuit relation with the thermoelectric circuit including said thermoelectric generator and ahead of said automatically operable switch means for energization of said second electromagnet by the heat of the pilot burner on the thermoelectric generator and independently of said automatically operable switch means.

7. In burner control apparatus, a main burner, a pilot burner positioned to light said main burner, a fuel supply line leading to the main burner, a fuel supply line leading to the pilot burner, a pair of electroresponsive devices respectively controlling said fuel supply lines each comprising a valve and an electromagnet having mechanical operating connection to the valve and effective when energized for holding it in open position, a thermoelectric generator adapted to be heated by said pilot burner and connected in circuit with both of said electromagnets for energizing the same, and means for controlling the energization of one of said electromagnets independently of the other thereof.

8. In burner control apparatus, a main burner, a pilot burner positioned to light said main burner, a fuel supply line leading to the main burner, a fuel supply line leading to the pilot burner, a pair of electroresponsive devices respectively controlling said fuel supply lines each comprising a valve and an electromagnet having mechanical operating connection to the valve and effective when energized for holding it in open position, a thermoelectric generator adapted to be heated by said pilot burner and connected in circuit with both of said electromagnets for energizing the same, and condition responsive means for opening and closing the circuit connection between said thermoelectric generator and one of said electromagnets independently of the circuit connection between said thermoelectric generator and the other of said electromagnets.

9. In burner control apparatus, in combination, a main burner, a pilot burner positioned to light said main burner, a fuel supply line leading to the main burner, a fuel supply line leading to the pilot burner, a main burner shutoff valve in the fuel supply line leading to the main burner, a first electromagnet, an electroresponsive shutoff valve in the fuel supply line leading to the pilot burner, a second electromagnet adapted when energized to hold said pilot valve open, a thermoelectric generator adapted to be heated by said pilot burner and connected in circuit with said first and second electromagnets for energizing said electromagnets, and mechanical connections between said first electromagnet and said main burner shutoff valve whereby said first electromagnet when energized by said thermo-

electric generator opens said main burner valve and holds it open.

10. In burner control apparatus, in combination, a main burner, a pilot burner positioned to light said main burner, a fuel supply line leading to the main burner, a fuel supply line leading to the pilot burner, a main burner shutoff valve in the fuel supply line leading to the main burner, a first electromagnet, an electroresponsive shutoff valve in the fuel supply line leading to the pilot burner, a second electromagnet adapted when energized to hold said pilot valve open, a thermoelectric generator adapted to be heated by said pilot burner and connected in circuit with said first and second electromagnets for energizing said electromagnets, mechanical connections between said first electromagnet and said main burner shutoff valve whereby said first electromagnet when energized by said thermoelectric generator opens said main burner valve and holds it open, and condition responsive means controlling the energization of the electromagnet for the main burner shutoff valve independently of the energization of the electromagnet for said pilot valve.

11. A fuel burner control apparatus comprising a main burner and a fuel supply pipe therefor, a pilot burner in juxtaposition to said main burner, a main burner valve, a pilot burner valve, an electromagnetic operator having mechanical connection to said main burner valve for operating the latter to open position and for holding same in open position, electromagnetic means effective when energized for holding the pilot burner valve open, means for resetting said pilot burner valve, and thermoelectric generator means adapted to be heated by said pilot burner and connected in circuit with the electromagnetic operator for the main valve and in circuit with the electromagnetic holding means for the pilot valve for energizing said electromagnetic operator and said electromagnetic holding means.

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