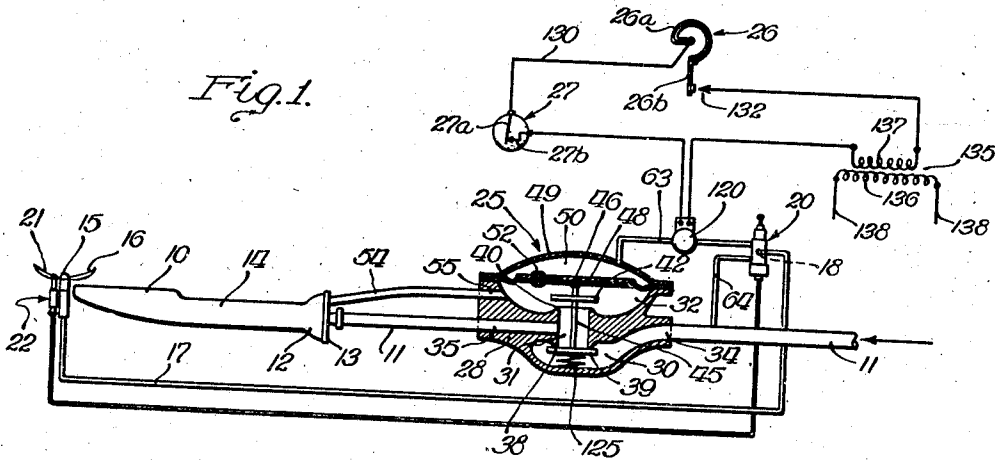
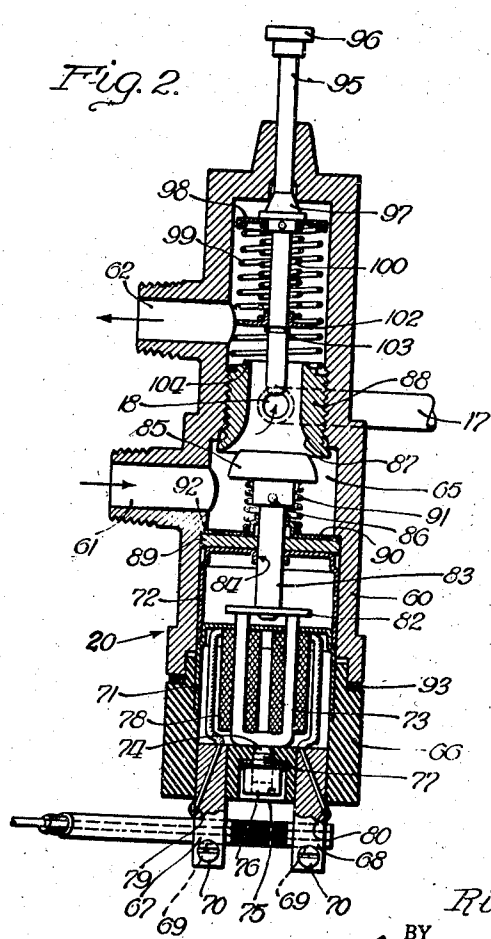
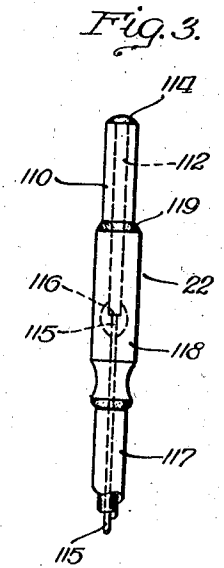


March 27, 1945.

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BURNER CONTROL APPARATUS

2,372,564

Filed July 21, 1941



UNITED STATES PATENT OFFICE

2,372,564

BURNER CONTROL APPARATUS

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Application July 21, 1941, Serial No. 403,256

20 Claims. (Cl. 158—117.1)

This invention relates, generally, to burner control apparatus, and it has particular relation to means for varying the proportioning of the gas or other fuel and air in the fuel-air mixture for a burner.

Heretofore in the art, quiet and effective ignition and shut-down of the burner were not always assured, especially where the fuel and air, and particularly the gas and air, have been proportioned to give best results during normal or continued burner operation. Instead, such systems have been subject to dangerous and annoying explosions upon ignition and shut-down of the burner.

One of the main objects of the present invention is to provide a system for varying the proportioning of the gas or other fuel and air in the fuel-air mixture for the burner, which system is operative to enrich the fuel mixture, and particularly the gas-air mixture for a gas burner upon ignition and shut-down of the burner.

The enrichment of the fuel-air mixture is secured by supplying excess fuel to the burner upon ignition and shut-down, and one of the chief advantages thereof is the ability to provide quiet and effective ignition and shut-down of the burner without dangerous or annoying explosions, and with the burner adjusted to give best results during normal or continued burner operation.

Another object of the invention is to provide a burner control apparatus having safety shutoff and condition responsive control means for the burner, which safety shutoff and condition responsive control means is operative to enrich the fuel mixture and, particularly, the gas-air mixture for the burner upon ignition and shut-down of the burner.

Another object of the invention is to provide an improved safety shutoff and condition responsive control means for the burner.

Another object of the invention is to provide burner control apparatus of the character described which is of simple character, effective in operation, and which will fail "safe."

While the particular structural features and combinations 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 burner control apparatus in accordance with the present invention, I will now describe, in connection

with the accompanying drawing, one preferred embodiment of the invention.

In the drawing:

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

Figure 2 is a vertical section through the thermoelectric control valve shown in Figure 1; and

Figure 3 is an enlarged elevational view showing the thermocouple in more detail.

The invention can be embodied in a wide variety of forms for use with a wide variety of systems, but for purposes of illustration the invention has been shown as embodied in a thermoelectric safety shutoff and condition responsive control system including a complete safety shutoff and condition responsive control which is operative to enrich the fuel mixture, and particularly the gas-air mixture, for a gas burner upon ignition and shut-down of the burner for the purposes set forth.

Referring to the drawing, 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 a floor furnace, an oven burner, one or more top burners for a gas range, or any other burner.

A gas or other fuel supply pipe 11 leads to the burner 10 for the delivery of gas or other fuel thereto—for example, through an outlet or delivery orifice into a mixing chamber 12 in which the fuel is mixed with air which enters the mixing chamber through one or more ports, usually provided at the outer end 13 of the mixing chamber, as well understood in the art. The combustible mixture of gas and air passes from the mixing chamber 12 through a conduit 14 to the burner 10 where it is delivered through the ports of the burner and ignited by a pilot burner 15.

The pilot burner 15, which is located in juxtaposition to the main burner 10 to maintain a pilot flame 16 for igniting the main burner, is supplied with gaseous fuel by a pilot supply pipe 17. The pilot supply pipe 17 is shown as receiving its fuel from the main fuel supply pipe 11 through the pilot outlet 18 of the thermoelectric valve, indicated in its entirety at 20. The pilot burner 15, when ignited, is shown as maintaining a second pilot flame 21 for heating the "hot" junction of the thermoelectric generator which is shown in the form of a thermocouple 22. It is understood, of course, that the thermoelectric generator may be in the form of a thermopile, or of any other desired form, and that the pilot burner 15 may maintain only a single pilot flame for igniting the

main burner and for heating the thermoelectric generator.

Interposed in the fuel supply pipe 11 is a main control valve 25 shown in the form of a diaphragm valve. This valve 25 is responsive to the pilot burner 15. It may also be responsive to other control devices shown, for purposes of illustration, in Figure 1 as a thermostat 26 and a limit switch 27. In the case of a room or space heater or floor furnace, the thermostat 26 may be in the form of a room thermostat mounted in appropriate position within the room or other space heated by the main burner 10, or, in the case of a hot water heater, the thermostat may be subject to the temperature of the water in the tank.

The limit switch 27 may be of a character to operate upon the occurrence of any abnormal, defective, or insufficient functioning of the apparatus, as, for example, upon the occurrence of an abnormal pressure in the tank of a hot water heater, or upon the occurrence of an abnormal temperature.

The diaphragm valve 25 comprises a main valve body part 28 having an inlet chamber 30 and a pair of outlet chambers 31 and 32. The outlet chamber 31 is interposed between the inlet chamber 30 and the other outlet chamber 32, and is adapted to supply gas from the inlet chamber 30 to the outlet chamber 32 as will presently appear. Contiguous sections of the fuel supply pipe 11 are connected at 34 and 35, respectively, in communication with the inlet chamber 30 and outlet chamber 31.

The valve body part 28 has at one end of the outlet chamber or passage 31 a valve seat 38 for a main shutoff valve member 39. At the other end of the outlet chamber or passage the valve body part 28 has a valve seat 40 for an excess gas shutoff valve member 42. The valve members 39 and 42 may be in the form of valve disc members carried by a valve stem 45 which may be guided, as desired, in the valve body, and which is shown as connected at 46 to a flexible diaphragm 48.

The periphery of the diaphragm 48 is clamped between the valve body part 28 and a hood or cover 49 which may be secured in place to the valve body part 28 by screws or other suitable means. A diaphragm chamber 50 is provided between the hood or cover 49 and the diaphragm 48. A restricted bleed port 52 is provided for bleeding the gas from the diaphragm chamber 50 into the chamber 32 to relieve the head pressure on the diaphragm upon shutting off the delivery of gas to the diaphragm chamber 50, as will presently appear.

An excess gas supply pipe 54 leads, at 55, from the outlet chamber 32 for the delivery of excess gas to the main burner 10, for example through the mixing chamber 12, upon ignition and shut-down of the main burner.

The particular thermoelectric valve 20 selected for illustration is similar to that more fully disclosed in the copending application of Stanley S. Guelson, Serial No. 334,159, filed May 9, 1940.

For the purpose of the present description, suffice it to state that the thermoelectric valve 20 comprises a valve body 60 having an inlet 61, the pilot outlet port 18 for delivering fuel to the pilot burner 15, and a second outlet port 62 and a pipe 63 connected thereto through which gas is adapted to be delivered into the diaphragm chamber 50. A pipe 64, connected at one end to the inlet 61 of the thermoelectric valve 20 and at its other end to the main gas supply pipe 11 anterior

of the diaphragm valve 25, delivers gas from the pipe 11 to the inlet chamber 65 of the valve 20.

A magnet mounting cup 66 of "Bakelite" or any other suitable or preferred insulating material is mounted upon and closes one end of the valve body 60. Fixed in the mounting cup 66, as, for example, by molding the insulating material of the cup thereto and extending endwise from the cup, are a pair of spaced metallic terminal members 67 and 68 having aligned openings 69. The terminal members 67 and 68 are split outwardly of the openings 69, and the split portions are adapted to be clamped together by screws 70.

A magnet housing in the form of an outwardly opening metal cup 71 is mounted upon the mounting cup 66, for example, by pressed fit engagement of its outer end in the mounting cup. The magnet cup 71 is reduced at its inner end, and the armature housing, which is also in the form of an outwardly opening metal cup 72, is mounted on the cup 71, for example, by pressed fit engagement of its outer open end telescopically over the reduced inner end of the cup 71. The inner end of the cup 72 is preferably reduced, as shown.

The electromagnet is shown as comprising a generally U-shaped magnet frame 73 positioned within the cup 71, with its legs extending through openings in the inner end of the cup 71 and presenting pole ends within the armature cup 72. The form of the magnet frame may be varied, and variations in the other parts of the apparatus are also contemplated within the scope of the present invention. The particular magnet frame 73 selected for illustration has a threaded stud 74 integral therewith, or welded or otherwise secured thereto. This stud 74 extends into an opening or recess 75 in the mounting cup 66, and has threaded engagement with a nut 76 for clamping the magnet frame rigidly and, at the same time, removably in place. The nut 76 has a kerf for engagement by a screw driver or other tool, and a sealing washer may be provided at 77.

The magnet coil 78 surrounds the legs of the magnet frame 73, and the leads of this coil have their bared ends connected to the terminal members 67 and 68 in a manner to have good conducting contact therewith, as, for example, at 79 and 80. The coil 78 is preferably covered with insulation between its bared ends. If desired, additional insulation may be provided between the turns of the coil and the legs of the magnet frame, and between the inner end of the cup 71 and the adjacent end of the coil.

The armature 82 is disposed in the armature cup 72, and is adapted to be held in attracted position against the pole ends of the magnet frame 73 when the electromagnet is energized. The armature 82 is of disc-like form and is secured to one end of a reciprocatory stem 83. The attachment of the armature 82 to the stem 83 may be sufficiently loose or otherwise of a character to permit self-accommodation of the armature to the pole ends of the magnet frame. The stem 83 is disposed generally concentrically of the armature housing 72 and extends inwardly for reciprocatory movement through an opening 84 in the inner end of the housing 72.

The valve member 85 is fixed by a pin 86 upon the opposite end of the stem 83, preferably for some relative movement thereon so as to have self-accommodating seating engagement with the cooperating valve seat 87 at the adjacent end of the valve seat member 88 which is shown as threaded into the valve body 60. Packing 89 of

felt or other suitable material is interposed between the inner end of the armature housing 72 and a valve spring seating disc 90. The valve spring 91 is in the form of a coil spring surrounding the inner end of the stem 83 and interposed between the valve member 85 and the spring seating disc 90. The spring 91 moves the armature 82 to retracted position and the valve member 85 to closed position, seating upon the valve seat 87 to shut off the flow of fuel to the pilot outlet 18 and to the outlet 62 when the electromagnet is deenergized.

The disc 90 seats inwardly upon a shoulder 92, and the action of the spring 91 compresses the packing 89 and maintains same in sealing engagement with the bore within the valve body 60 and with the stem 83. The interior of the armature housing is thus sealed from the gas or other fuel which passes through the valve body, and the escape of fuel out around the armature housing is prevented. A washer at 93 further seals the device against the escape of fuel.

A reset stem 95 extends out through the opposite end of the valve body 60. This reset stem is mounted coaxial with the valve member 85 and for reciprocatory movement. The stem 95 is provided at its outer end with a reset knob or button 96.

Fixed upon the stem 95 for reciprocatory movement therewith is a reset member 97 which has abutting engagement with a spring disc 98. The spring disc 98 is slidable in the cooperating cylindrical part of the housing and constitutes a reset guide in the resetting operation. A spring 99, shown as of coiled form, is interposed between the disc 98 and the valve seat member 88. A fuel flow interrupter spring 100 is interposed between the spring disc 98 and a flow interrupter disc valve 102. A retainer is provided at 103 for limiting inward movement of the disk valve 102 relative to the reset stem 95.

The flow interrupter valve 102 is adapted to seat upon the valve seat 104 at the adjacent end of the valve seat member 88 to shut off or interrupt the flow of fuel to the outlet 62 during the resetting operation and until the valve member 85 is held in open position by the thermoelectric current and the reset stem 95 is released. The reset member 97 has a tapered or generally conical portion which, under the action of the spring means, is held seated against a cooperating annular shoulder or seat on the valve body to seal the opening through which the reset stem 95 extends when the reset stem is positioned as shown in Figure 2.

While any other suitable or preferred thermocouple, thermopile, or other thermoelectric generator and lead connection may be employed within the scope of the present invention, the particular thermocouple and lead connection shown in the drawing are of the general character disclosed and claimed in Oscar J. Leins Patent No. 2,126,564, granted August 9, 1938.

The thermocouple designated in its entirety at 22 comprises an outer tubular metallic thermocouple member 110 and an inner metallic thermocouple member 112 disposed within the outer thermocouple member and joined at one end to the outer thermocouple member to form the thermal junction 114 which is positioned to be heated by the pilot flame 21.

An inner lead conductor 115 is joined to the inner thermocouple member to form an internal thermal junction 116, and an outer tubular lead conductor 117 is connected to the outer tubular

thermocouple member—for example, through a sleeve 118—to form a third thermal junction 119. The outer lead conductor and outer tubular thermocouple member enclose the inner lead conductor and inner thermocouple member. The inner lead conductor 115 is insulated from the outer lead conductor 117, for example, by a wrapping of insulation on the inner lead conductor.

The thermocouple may be supported with the "hot" junction 114 thereof in position to be heated by the pilot flame 21—for example, by a bracket on the pilot burner, or otherwise as desired. The pilot burner 15 may likewise be supported in position to ignite the main burner and to heat the "hot" junction of the thermocouple by any suitable or preferred means.

To start the operation of the system as thus far described, the following sequence is followed:

The reset stem 95 is pressed inwardly to actuate the valve member 85 to open position and the armature 82 to attracted position in contact with the pole faces of the magnet frame 73. This allows gas to flow from the gas supply pipe 11 through the pipe 64, inlet 61, inlet chamber 65, pilot outlet 18, and pilot supply pipe 17, to the pilot burner 15 where the same is ignited. The stem 95 is held in depressed position until the pilot flame 21 has heated the thermocouple sufficiently to energize the magnet 73 so that it will hold the armature 82 attracted thereto and thereby the valve member 85 in open position. The flow interrupter disc 102 seats upon the seat 104 to shut off the flow of fuel to the outlet 62 as long as the stem 95 is pressed inwardly.

When the magnet is energized sufficiently to hold the armature 82 in attracted position and the valve member 85 in open position, the reset stem 95 is released, thus allowing the flow interrupter disc to return to open or normal operating position. Fuel then flows out through the outlet 62 and pipe 63, assuming that the small solenoid valve 120 interposed in the pipe 63 is open, to the chamber 50 of the diaphragm valve. The flow of gas into the diaphragm chamber 50 forces the diaphragm 48 in a downward direction as the apparatus is viewed in Figure 1. As the diaphragm 48 is forced downwardly, the lower valve disc 39 is opened, and gas flows from the lower valve chamber 30 into the intermediate and upper valve chambers 31 and 32.

Gas thereupon flows out through the outlet 35 to the main burner orifice, and before the upper valve disc member 42 seats upon the seat 40 to shut off the upper valve chamber 32 gas also flows out through the outlet 55 and the excess gas pipe 54 to the burner. Momentarily, therefore, there is an excess amount of gas forced into the primary air stream for the main burner, and a soft ignition flame results. As the diaphragm 48 continues down, the upper valve disc member 42 seats upon the valve seat 40 and closes off the upper valve chamber 32, and, consequently, the excess gas supply for the main burner. Gas then flows to the main burner through the central valve chamber 31 and outlet 35 to supply fuel for the burner at the adjustment which is set to give best results during normal or continued burner operation. The excess gas which is discharged into the valve chamber 32 through the bleed port 52 as long as there is head pressure in chamber 50, and which passes through the pipe 54 into the mixing chamber 12 along with the fuel delivered through the orifice or pipe 11, may be considered as a part of the metered gas for normal operation.

If the pilot burner is not lighted to produce the thermoelectric current for holding the armature in attracted position and the valve member 85 open, the armature 82 will be actuated to retracted position and the valve member 85 to closed position upon release of the reset stem 95.

If, following normal or continuous burner operation, the pilot burner is extinguished so that the thermal junction 114 is no longer heated sufficiently to set up the thermoelectric current for energizing the electromagnet to hold the armature 82 attracted and the valve member 85 open, the armature 82 is released and the spring 91 moves the armature to retracted position and the valve member 85 to closed position, shutting off the flow of gas not only through the pipe 17 to the pilot burner, but also the flow of gas through the pipe 63 to the diaphragm chamber 50. With the supply of gas to the diaphragm chamber 50 shut off, the head pressure on the diaphragm 48 is bled off through the bleed port 52, and the spring 125 in the diaphragm valve moves the valve disc members 39 and 42 in an upward direction as the device is viewed in Figure 1.

As the lower valve disc member 39 starts to close, the upper valve disc member 42 immediately opens, allowing excess gas to flow to the burner, thus softening the flame momentarily upon shut-down of the main burner. Further movement of the lower valve disc member 39 in an upward direction seats the same upon the valve seat 38, thereby shutting down the supply of fuel to the main burner.

The small solenoid valve 120 in the gas supply pipe leading from the outlet 62 of the thermoelectric valve 20 to the chamber 50 of the diaphragm valve 25 constitutes a part of the additional condition responsive control.

This additional condition responsive control is provided by connecting the solenoid valve 120 into a condition responsive circuit 130, which is shown as including therein the thermostat 26 and the limit switch 27. The thermostat 26 comprises a bimetallic element 26a having a contact arm 26b. The contact arm 26b is moved by the bimetallic element 26a into engagement with a contact 132 when the temperature drops to a predetermined value, and when the temperature to which the bimetallic element 26a is subject rises to a predetermined value the contact arm 26b moves out of engagement with the contact 132 to open the circuit for the solenoid valve 120.

The limit switch 27 is shown as comprising a contact arm 27a which moves out of contact with the contact 27b upon the occurrence of the limiting temperature, limiting pressure, or other abnormal condition for which the limit switch is set, and remains in contact with the contact 27b as long as the limiting temperature, pressure, or other abnormal condition is not reached.

A step-down transformer 135 supplies power for the condition responsive circuit 130. This transformer is shown as comprising, for example, a line voltage primary winding 136 and a low voltage secondary winding 137. The primary winding 136 is connected to line wires 138 leading to any suitable source of power (not shown), and the secondary winding 137 is connected into the condition responsive circuit 130.

As long as the condition responsive circuit 130 is closed, the solenoid valve 120 is held in open position, and the system operates as already described.

Upon opening of either the thermostatic

switch at 26 or the limit switch at 27, the condition responsive circuit 130 is opened. This deenergizes the solenoid valve 120 which is closed, for example, by a spring (not shown), shutting off the supply of gas to the chamber 50 of the diaphragm valve 25, which together with the seating of valve 39 on seat 38 results in shutting down of the fuel supply to the main burner. At this time, however, the valve member 85 of the thermoelectric valve 20 remains open for the supply of fuel to the pilot burner 15 as long as the pilot burner is ignited.

If the main burner fuel supply is shut down by the operation of either the thermostatic switch 26 or the limit switch 27 with the pilot burner lighted, then, assuming that the pilot burner remains lighted, when the thermostatic switch at 26 or the limit switch at 27 again closes the condition responsive circuit 130, the solenoid valve 120 will open and ignition of the main burner will follow in the manner already described.

The embodiment of the invention shown in the drawing is for illustrative purposes only, and it is to be expressly understood that said drawing 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. A burner control apparatus comprising, a burner, a fuel supply pipe for supplying fuel to said burner, an excess fuel supply pipe for supplying excess fuel to said burner, a valve member controlling admission of fuel to said excess fuel pipe having open position upon starting the burner and operable to closed position to shut off the excess fuel supply to the burner as the burner reaches substantially normal or continuous burner operation, and means for moving said valve to open position upon starting the burner and to closed position as the burner reaches substantially normal operation, said means preventing starting the burner without an excess flow of fuel to the burner through said excess fuel supply pipe simultaneously with the supply of fuel to the burner through said first-mentioned fuel supply pipe.

2. A burner control apparatus comprising, in combination, a burner, a fuel supply pipe for supplying fuel to said burner, an excess fuel supply pipe for supplying excess fuel to the burner upon ignition and shut-down thereof, a main shutoff valve member for shutting off the supply of fuel to the burner, and a second valve member connected to said first valve member for controlling the excess fuel supply to the burner.

3. A burner control apparatus comprising, in combination, a burner, a fuel supply pipe for supplying fuel to said burner, an excess fuel supply pipe for supplying excess fuel to the burner upon ignition and shut-down thereof, a main shutoff valve member for shutting off the supply of fuel to the burner, and a second valve member connected to said first valve member for controlling the excess fuel supply to the burner, said second valve member being open when said first valve member is closed, and closed when said first valve member is completely open.

4. A burner control apparatus comprising, a burner, a valve having a pair of outlets for supplying fuel to said burner and an inlet, a fuel supply pipe leading to said inlet, shutoff valve means for shutting off the supply of fuel to both said outlets, and a valve member for shutting off

the supply of fuel to one of said outlets without shutting off the supply of fuel to the other outlet so as to permit the supply of fuel to the burner through the outlet not shut off by said valve member when said shutoff valve means is open.

5. A burner control apparatus comprising, a burner, a valve having a pair of outlets for supplying fuel to said burner and an inlet, a fuel supply pipe leading to said inlet, shutoff valve means for shutting off the supply of fuel to both said outlets, a valve member for shutting off the supply of fuel to one of said outlets without shutting off the supply of fuel to the other outlet so as to permit the supply of fuel to the burner through the outlet not shut off by said valve member when said shutoff valve means is open, and condition responsive means controlling both of said valve members.

6. A burner control apparatus comprising, a burner, a valve having a pair of outlets for supplying fuel to said burner and an inlet, a fuel supply pipe leading to said inlet, shutoff valve means for shutting off the supply of fuel to both said outlets, a valve member for shutting off the supply of fuel to one of said outlets without shutting off the supply of fuel to the other outlet so as to permit the supply of fuel to the burner through the outlet not shut off by said valve member when said shutoff valve means is open, and a safety shutoff and additional condition responsive means controlling said valve means.

7. A burner control apparatus comprising, a burner, a valve body having a main outlet chamber for supplying fuel to said burner for continuous burner operation, said valve body having a second chamber for supplying excess fuel to the burner upon ignition and shut-down thereof and an inlet chamber, a fuel supply pipe leading to said inlet chamber, a hood for said valve body, a flexible diaphragm clamped between said valve body and said hood and positioned between said excess fuel outlet chamber and a head pressure chamber on the other side of said diaphragm, said diaphragm having a bleed port opening from said head pressure chamber into said excess fuel outlet chamber, a pair of valve seats, one at each end of said main outlet chamber, a pair of connected valve members one cooperable with each of said valve seats and connected to said diaphragm, and means for supplying fuel from said fuel supply pipe anterior of said valve to said head pressure chamber.

8. A burner control apparatus comprising, a burner, a valve body having a main outlet chamber for supplying fuel to said burner for continuous burner operation, said valve body having a second chamber for supplying excess fuel to the burner upon ignition and shut-down thereof and an inlet chamber, a fuel supply pipe leading to said inlet chamber, a hood for said valve body, a flexible diaphragm clamped between said valve body and said hood and positioned between said excess fuel outlet chamber and a head pressure chamber on the other side of said diaphragm, said diaphragm having a bleed port opening from said head pressure chamber into said excess fuel outlet chamber, a pair of valve seats, one at each end of said main outlet chamber, a pair of connected valve members one cooperable with each of said valve seats and connected to said diaphragm, a pipe for supplying fuel from said fuel supply pipe anterior of said valve to said head pressure chamber, a safety shutoff valve interposed in said last mentioned pipe and having an outlet for a pilot burner in juxtaposition to the

main burner, said safety shutoff valve having an electromagnet for maintaining said valve open for the supply of fuel to the pilot burner and to said head pressure chamber, and a thermoelectric generator positioned to be heated by the pilot burner and connected in circuit with said electromagnet.

9. A burner control apparatus comprising, a burner, a valve body having a main outlet chamber for supplying fuel to said burner for continuous burner operation, said valve body having a second chamber for supplying excess fuel to the burner upon ignition and shut-down thereof and an inlet chamber, a fuel supply pipe leading to said inlet chamber, a hood for said valve body, a flexible diaphragm clamped between said valve body and said hood and positioned between said excess fuel outlet chamber and a head pressure chamber on the other side of said diaphragm, said diaphragm having a bleed port opening from said head pressure chamber into said excess fuel outlet chamber, a pair of valve seats, one at each end of said main outlet chamber, a pair of connected valve members one cooperable with each of said valve seats and connected to said diaphragm, a pipe for supplying fuel from said fuel supply pipe anterior of said valve to said head pressure chamber, a safety shutoff valve interposed in said last mentioned pipe and having an outlet for a pilot burner in juxtaposition to the main burner, said safety shutoff valve having an electromagnet for maintaining said valve open for the supply of fuel to the pilot burner and to said head pressure chamber, a thermoelectric generator positioned to be heated by the pilot burner and connected in circuit with said electromagnet, a solenoid valve interposed in the pipe for supplying fuel from said safety shutoff valve to said head pressure chamber, a condition responsive circuit for said solenoid valve, a thermostat in said circuit, and a limit switch in said circuit.

10. The method of burner control which comprises delivering to the burner a supply of fuel-air mixture with the fuel and air of such mixture proportioned to give satisfactory results during continuous burner operation, and automatically delivering an additional supply of fuel to enrich the fuel-air mixture upon ignition and shut-down of the burner prior to extinguishment thereof to assure proper ignition and shut-down of the burner with the air supply remaining substantially the same as for continuous burner operation.

11. The method of burner control which comprises delivering to the burner a supply of fuel-air mixture with the fuel and air of said mixture proportioned to give satisfactory results during continuous burner operation and automatically delivering an additional supply of fuel to enrich the fuel-air mixture upon shut-down of the burner prior to extinguishment thereof to assure proper shut-down of the burner with the air supply remaining substantially the same as for continuous burner operation.

12. A burner control apparatus comprising, in combination, a burner, valve controlled means for supplying a fuel-air mixture to said burner with the fuel and air of said mixture proportioned to give satisfactory results during continuous burner operation, and supplementary means for automatically delivering an additional supply of fuel to enrich the fuel-air mixture upon ignition and shut-down of the burner prior to extinguishment thereof to assure proper ignition and shut-

down of the burner with the air supply remaining substantially the same as for continuous burner operation.

13. A burner control apparatus comprising, in combination, a burner, valve controlled means for supplying a fuel-air mixture to said burner with the fuel and air of said mixture proportioned to give satisfactory results during continuous burner operation, and automatic means for delivering an additional supply of fuel to enrich the fuel-air mixture upon shut-down of the burner prior to extinguishment thereof to assure proper shut-down of the burner with the air supply remaining substantially the same as for continuous burner operation.

14. A burner control apparatus comprising, in combination, a burner, means for supplying a fuel-air mixture to said burner with the fuel and air of said mixture proportioned to give satisfactory results during continuous burner operation, means for delivering an additional supply of fuel to enrich the fuel-air mixture upon ignition and shut-down of the burner to assure proper ignition and shut-down of the burner with the air supply remaining substantially the same as for continuous burner operation, and means responsive to variations in temperature controlling the means for delivering the additional supply of fuel.

15. A burner control apparatus, comprising, in combination, a main burner, means for supplying a fuel-air mixture to the burner with the fuel and air of said mixture proportioned to give satisfactory results during continuous burner operation, a pilot burner in juxtaposition to the main burner, safety shutoff means responsive to the pilot burner for shutting off the main burner and the pilot burner upon extinguishment of the pilot burner, temperature responsive means operative in conjunction with said safety shutoff means for shutting off only the main burner, and means constituting a part of said safety shutoff means for delivering an additional supply of fuel to enrich the fuel-air mixture upon ignition and shut-down of the burner to assure proper ignition and shut-down of the burner with the air supply remaining substantially the same as for continuous burner operation.

16. A burner control apparatus comprising, in combination, a burner, a fuel supply pipe for supplying fuel to said burner, a second fuel supply pipe for supplying additional fuel to said burner, and a valve member controlling said second fuel supply pipe, said valve member having a closed position shutting off the supply of fuel through said second fuel supply pipe and an open position to supply an additional supply of fuel to the burner through said second fuel supply pipe, and means for closing and maintaining closed said valve member upon continuous operation of the burner and for opening said valve member upon shut-down of the burner, said valve member preventing an operation of the burner other than continuous burner operation without an additional supply of fuel to the burner

through said second fuel supply pipe simultaneously with the supply of fuel to the burner through said first fuel supply pipe.

17. A burner control apparatus comprising, in combination, a burner, a fuel supply pipe for supplying fuel to said burner, a second fuel supply pipe for supplying additional fuel to said burner, a valve member controlling said second fuel supply pipe, said valve member having a closed position shutting off the supply of fuel through said second fuel supply pipe and an open position to supply an additional supply of fuel to the burner through said second fuel supply pipe, means for delivering a supply of air which is substantially constant both during continuous burner operation and when said valve member is open to supply additional fuel for the burner through said second fuel supply pipe, and means for closing and maintaining closed said valve member upon continuous operation of the burner and for opening said valve member upon shut-down of the burner.

18. The method of burner control, which comprises delivering to the burner fuel under positive pressure, mixing the fuel with a substantially constant amount of air to produce a fuel-air mixture for the burner with the fuel and the air proportioned to give satisfactory results during continuous burner operation, and delivering to the burner responsive to variation in the fuel pressure incident to shutting-down of the burner an additional amount of fuel to assure proper shut-down of the burner with the air supply remaining substantially the same as for continuous burner operation.

19. The method of burner control, which comprises delivering to the burner fuel under positive pressure, mixing the fuel with a substantially constant amount of air to produce a fuel-air mixture for the burner with the fuel and the air proportioned to give satisfactory results during continuous burner operation, and delivering to the burner responsive to variations in the fuel pressure incident to starting-up and shutting-down of the burner an additional amount of fuel to assure proper ignition and shut-down of the burner with the air supply remaining substantially the same as for continuous burner operation.

20. A burner control apparatus comprising, in combination, a burner, a fuel supply pipe for supplying fuel to the burner for continuous burner operation, means for supplying additional fuel to said burner upon starting and shut-down of the burner, and means controlling said last means, said controlling means having a position shutting off the additional supply of fuel and a position in which an additional supply of fuel flows to the burner, said controlling means preventing starting and shut-down of the burner without an additional flow of fuel to the burner simultaneously with the supply of fuel for continuous burner operation through said fuel supply pipe.

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