

Aug. 24, 1954

G. MAURICE

2,687,169

BURNER CONTROL APPARATUS WITH SAFETY CONTROL MEANS

Filed Feb. 9, 1948

3 Sheets-Sheet 1

Fig. 1.

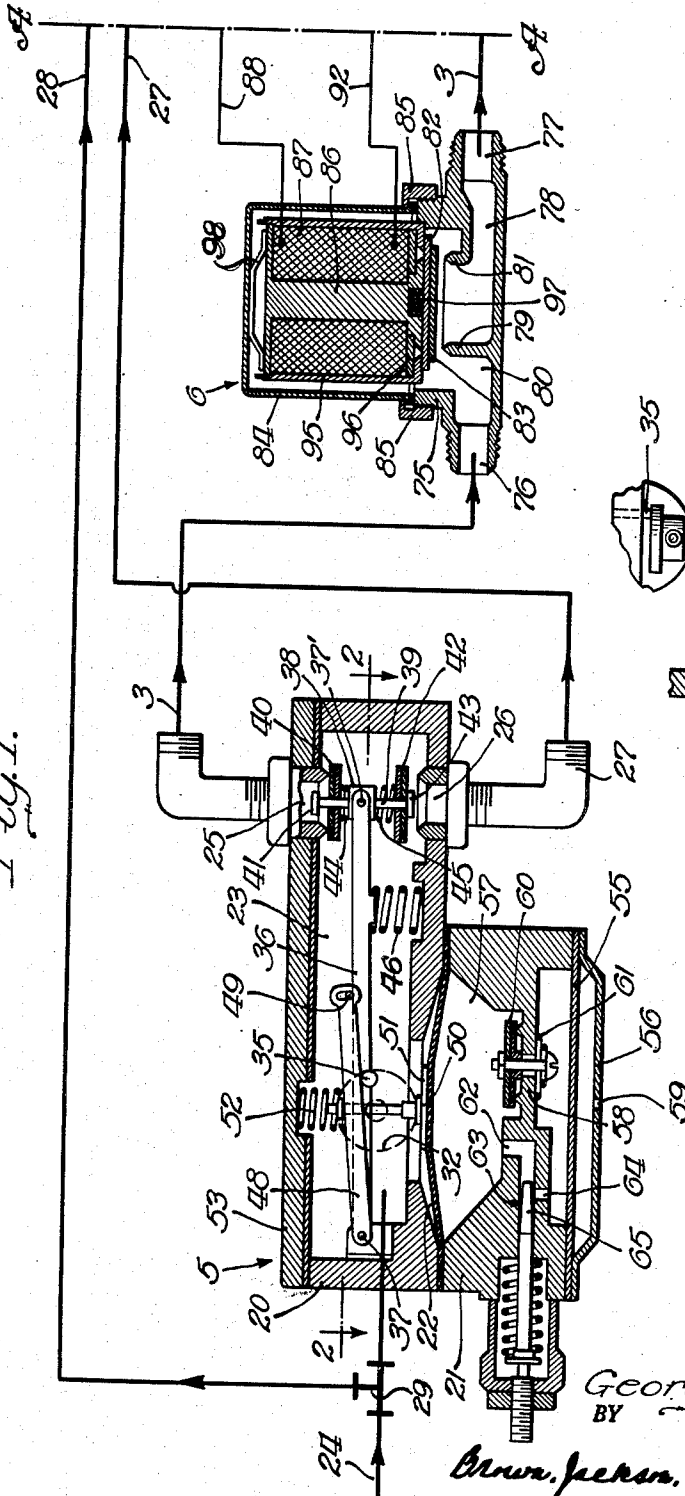
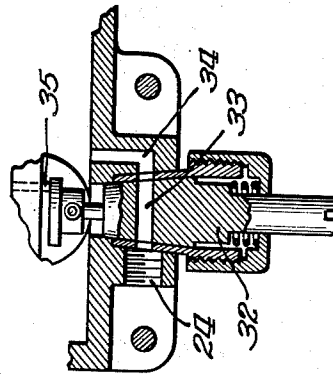


Fig. 2.



INVENTOR.

George Maurice

BY

Brown, Jackson, Butcher & Dixon
Attorneys

Aug. 24, 1954

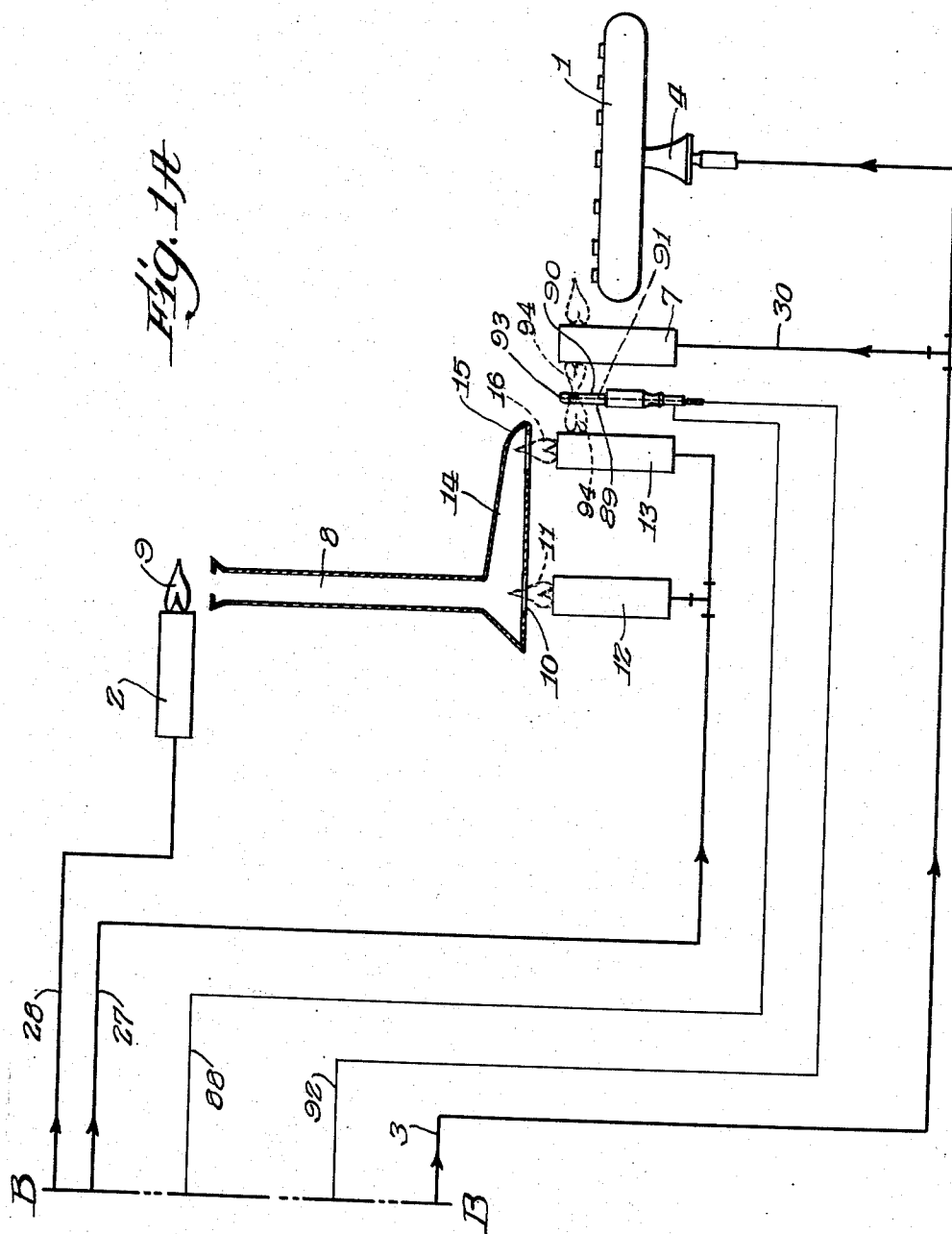
G. MAURICE

2,687,169

BURNER CONTROL APPARATUS WITH SAFETY CONTROL MEANS

Filed Feb. 9, 1948

3 Sheets-Sheet 2



Inventor:
George Maurice
By *Arthur J. Fenn, Attorney*
attys.

Aug. 24, 1954

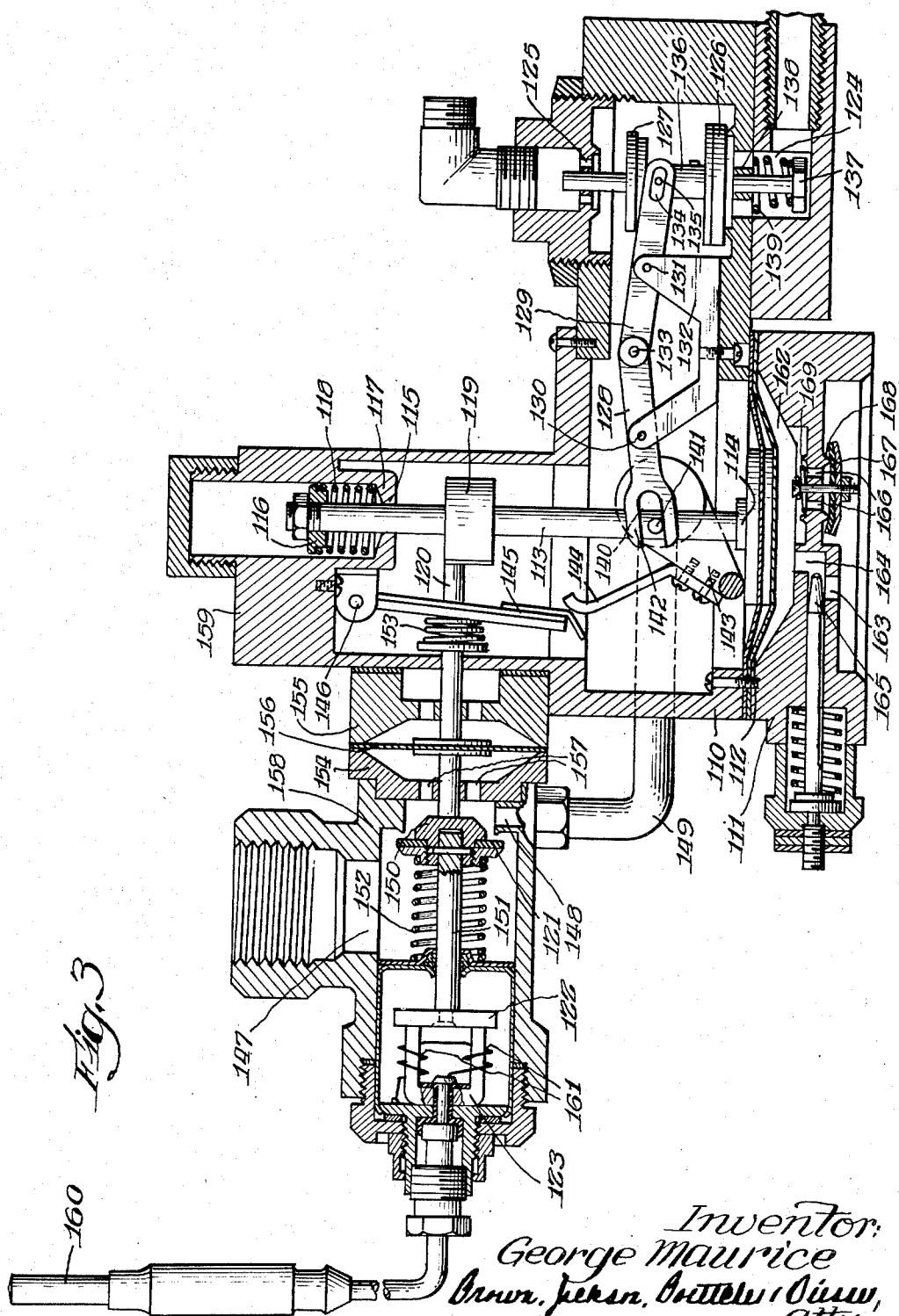
G. MAURICE

2,687,169

BURNER CONTROL APPARATUS WITH SAFETY CONTROL MEANS

Filed Feb. 9, 1948

3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE

2,687,169

BURNER CONTROL APPARATUS WITH
SAFETY CONTROL MEANS

George Maurice, Muskego, Wis., assignor to Milwaukee Gas Specialty Company, Milwaukee, Wis., a corporation of Wisconsin

Application February 9, 1948, Serial No. 7,203

20 Claims. (Cl. 158—130)

1

This invention relates to a burner control apparatus with safety control means.

While the particular embodiment of the invention which I shall describe hereinafter in connection with the drawings is a single point ignition system adapted for use with domestic gas ranges, it is to be understood that the invention is not limited to such use but may be employed for all similar purposes, for example, in connection with various commercial forms of apparatus having a baking oven burner, a broiler oven burner, or other burner remotely located relative to the pilot burner.

In the usual domestic gas range, the pilot burner is in the form of a single, constantly burning pilot burner located in juxtaposition to the top burners at the upper part of the range, and the baking oven, broiler, or like burners are located in the lower part of the range. Although the top burners are usually provided with a constantly burning pilot burner for lighting the same, at the present time a match is usually employed for lighting the baking oven, broiler or like burners.

The stooping and hazards of lighting an oven burner or the like with a match are well known in the art.

An all gas ignition system has advantages over electric systems, and it does not require electric supply connections and will maintain supply of gas to pilot burners, whereas a failure of electric power supply may interrupt the pilot burner operation. In general, electric power failure would automatically shut off the gas supply, i. e., make the functioning of a gas appliance dependent upon another utility.

The copending applications of Ernst Witzel, Serial No. 738,412, filed March 31, 1947, and Serial No. 748,969, filed May 19, 1947, now U. S. Patent No. 2,527,286, and the copending application of Russell Matthews, Serial No. 742,017, filed April 17, 1947, now U. S. Patent No. 2,578,194, provide an improved system of flash tubes and intermediate pilot burner means for assuring ignition of a pilot burner in juxtaposition to the oven or like burner from a constantly burning top pilot burner; also improved single point ignition systems wherein means, shown in the form of thermally responsive means, is provided for extinguishing the intermediate pilot burner means and establishing a flow of fuel to the oven or like burner after a time delay following ignition of the pilot burner for the main burner, and improved thermoelectric control devices and other instrumentalities for accomplishing the new and

2

advantageous results set forth. The foregoing copending applications are owned by the assignee of the present application.

In the copending application of Ernst Witzel, Serial No. 744,905, filed April 30, 1947, now U. S. Patent No. 2,645,280, the time delay is obtained by an orifice limiting the escape of air compressed by the gas line pressure.

One of the main objects of the present invention is to provide a simple, improved, and effective system and control means which will provide the advantageous results obtained with the systems disclosed and claimed in the above identified copending applications, and in which the time delay does not require thermally responsive means and is not dependent upon the gas pressure in the fuel supply line.

Another object of the invention is to provide a system and control device of the class described in which the fuel supply for one or more intermediate pilot burners is definitely shut off after a given time interval and independently of the valve controlling the supply of fuel to the main burner.

Another object of the invention is to provide means wherein the time delay is set into operation by manipulation of the gas cock or other shut-off means.

Another object of the invention is to provide, for a system of the class described, one embodiment of the invention having improved shut-off and time delay means incorporated in a single device, and a thermoelectric generator operated device adapted to be separately installed, and another embodiment of the invention having improved shut-off and time delay means and thermoelectric generator operated means incorporated in a single device.

Another object of the invention is to provide a system, control means, and instrumentalities therein, as will hereinafter appear, having various features of novelty and advantages, and which are particularly characterized by their simplicity in construction, their economy in manufacture and installation, and their effectiveness in use.

Further objects and advantages of the invention will appear from the following detailed description, taken in connection with the accompanying drawings which illustrate the manner of constructing and operating an illustrative embodiment of the invention.

In the drawings:

Figures 1 and 1A are parts of a diagrammatic view which, when placed with Figure 1A to the

right of Figure 1 and the line B—B of Figure 1A on the line A—A of Figure 1, form a complete diagrammatic view of one form of system and control means embodying the present invention;

Figure 2 is a fragmentary sectional view through the gas shut-off means taken substantially on the line 2—2 of Figure 1; and

Figure 3 is a longitudinal sectional view through another form of device embodying the present invention.

Referring now to the drawings, the burner 1 is the baking oven, broiler, or other remote burner. It is usually located in the lower part of the range or other appliance.

The pilot burner 2 is the constantly burning pilot burner. It may be, for example, the top pilot burner for the top burners of a gas range, or other constantly burning pilot burner. The pilot burner 2 is usually located in the upper part of the appliance.

A fuel supply pipe 3 leads to the burner 1 for the delivery of gaseous or other fuel thereto, for example, through a mixing chamber 4 to which air is admitted through adjustable air inlets (not shown) as well understood in the art. The flow of gas through pipe 3 is controlled by a shut-off and time delay device 5, and by a thermoelectric generator (such as a thermocouple or thermopile) operated device 6.

The oven or like burner 1 is provided with an oven or like pilot burner 7 for igniting it. A flash tube 8 opens at its upper end directly beneath the flame 9 of the constantly burning pilot 2. This tube extends vertically downwardly from the pilot burner 2, and opens at its lower end at 10 directly above the flame (not shown) of an intermediate pilot burner 12. The intermediate pilot burner 12 is spaced laterally from another intermediate pilot burner 13 in juxtaposition or igniting relation with respect to the oven pilot burner 7. The lower end of the tube 8 has a branch 14 extending laterally therefrom and opening at its outer end at 15 directly above the flame (not shown) of the intermediate pilot burner 13.

The shut-off and time delay device 5 comprises a pair of valve body parts 20 and 21 secured together with a flexible diaphragm 22 clamped marginally therebetween.

Valve body part 20 has a fuel chamber 23 provided with a fuel inlet 24 (Figure 2) and fuel outlets 25 and 26. Contiguous sections of fuel supply pipe 3 are connected to inlet 24 and outlet 25, which is for the delivery of fuel to the main burner 1 and pilot burner 7. The outlet 26 is connected by a pipe or tube 27 with intermediate pilot burners 12 and 13 for the purpose of supplying fuel thereto, as will presently appear. The constantly burning pilot burner 2 is supplied with fuel through a pipe or tube 28 connected at 29, with the fuel supply line 3 anterior of the shut-off and time delay device. A pipe or tube 30 is adapted to supply fuel to pilot burner 7 from fuel supply line 3.

Gas cock 32 or other gas shut-off means—such as a remotely controlled valve—has, for example, a tapered plug part rotatable in the wall of valve body part 20 adjacent to inlet 24. The shut-off means 32 has a port 33 (Figure 2) adapted by turning of the shut-off means to be placed in register with inlet 24 and a passage 34 opening into chamber 23. The shut-off means 32 is closed by turning it to position in which port 33 is out of register with passage 34 and inlet 24.

An eccentric pin 35 projects from the inner end

of shut-off means 32 for operation beneath levers 36 and 48. Lever 36 is pivoted at one end at 37 on body part 20. The opposite end of lever 36 is suitably connected, for example, by a slot and pin connection at 37' with a collar 38 slidable on a valve stem 39. One end of valve stem 39 has sliding movement through a valve 40 at the axis thereof, and has a head or abutment 41. The opposite end of stem 39 has sliding movement through a valve 42 at the axis thereof, and has a head or abutment 43.

Valve 40 is adapted to seat on a valve seat surrounding the adjacent end of the outlet 25. Valve 42 is adapted to seat on a valve seat surrounding the adjacent end of the outlet 26. The valves 40 and 42 preferably have suitable yielding facings for cooperation with their respective valve seats. A coiled spring 44 is interposed between valve 40 and the adjacent end of collar 38. A coiled spring 45 is interposed between the valve 42 and the adjacent end of collar 38. A coiled spring 46, positioned as shown or otherwise as desired, is interposed between the lever 36 and the wall of the valve body part 20.

The second lever 48 is pivoted at one end, for example, by pivot 37 on valve body part 20. The opposite end of this lever has an arcuate slot in which a pin 49, carried by lever 36, engages. A pin or stem 50 is secured at one end to lever 48. The opposite end of pin 50 is secured at 51 to diaphragm 22 at the axis thereof. A coiled spring 52 is interposed between lever 48 and a cover 53 attached to body part 20, preferably with a gasket therebetween.

An air filter 55 is clamped marginally between body part 21 and a filter cover plate 56. Chamber 57 is adapted for the entry of air into the same from atmosphere through port 59, air filter 55, and passage or port 58. Passage or port 58 is adapted to be closed by a valve 60 which seats on an annular valve seat under the action of a spring 61, as shown.

A passage 62 opens from chamber 57 into a bore 63 which, in turn, opens through passage 64, air filter 55 and port 59 to atmosphere. The communication between chamber 57 and atmosphere through bore 63 is controlled by a tapered pin 65. The pin 65 is adjustable for the purpose of adjusting the amount of restriction or displacement of air from chamber 57 through bore 63, and thereby the time delay secured by the action of the diaphragm 22, as will presently appear.

The device 6, which is operated by the thermoelectric generator, comprises a valve body part 75 having an inlet 76 and an outlet 77. Contiguous sections of the fuel supply pipe 3 are connected to inlet 76 and outlet 77, for example, by connecting the section of the pipe leading from the outlet 25 of the shut-off and time delay device 5 to the inlet 76 and the section of the fuel supply pipe 3 leading to the main burner 1 to the outlet 77.

Internally, valve body part 75 has a generally L-shaped outlet chamber 78 having a longitudinally extending part in open communication with the outlet 77 and a transversely extending portion defined by a cylindrical wall 79. An inlet chamber 80 in open communication with the inlet 76 terminates at its inner end in a generally annular chamber which embraces the wall 79.

The wall 79 terminates in an annular valve seat 81. An armature 82, of disc-like form, has a yielding or other suitable valve or valve facing 83 adapted to seat against the seat 81 to shut off

the flow of gas from the inlet 76 to outlet 77. A hood 84 is clamped to the valve body part 75 by a union nut 85, and preferably with a hood gasket therebetween.

The means for operating the valve 83, and more particularly the means for opening this valve, is in the form of an electromagnet comprising a magnet frame or coil spool 86 and a coil 87. One side of the coil 87 is connected by a lead 88 to one of the thermocouple elements 89 of a thermocouple 90 or other suitable thermoelectric generator (such as a thermopile). The other element 91 of the thermocouple 90 is connected to a lead 92 to the other side of the coil 87.

The thermocouple 90 and lead connections therefor may be of the general character disclosed and claimed in Oscar J. Leins Patent No. 2,126,564, granted August 9, 1938, or it may be of any other suitable character, or in the form of a thermopile or other thermoelectric generator. The thermoelectric generator has one or more hot junctions, for example, the hot junction 93 which is placed in position to be heated by the flame of intermediate pilot burner 13 and by the flame of the pilot burner 7.

In the illustrated embodiment of the invention, the electromagnet has a flux shell 95 and a spacer ring 96. The lower end of the coil spool 86 has an axial recess, and disposed in this recess and interposed between spool 86 and armature 82 is a coiled spring 97 which operates to move armature 82 to retracted position and to seat valve 83 on valve seat 81 when the electromagnet is deenergized. Energization of the electromagnet by heating of the hot junction of the thermocouple 90 is sufficient to lift valve 83 to open position against the action of spring 97. A hood spring 98, interposed between the top of the spool 86 and hood 84, seats the shell 95 in the valve body part at 100.

Assuming that the apparatus is in shut-down position with the main burner valve 40 and the shut-off means 32 in their closed positions and the intermediate pilot burner valve 42 in open position as shown in Figure 1, the operation is as follows:

When shut-off means 32 is turned (counterclockwise) as viewed in Figure 1, pin 35 lifts levers 36 and 48, closing valve 40 and opening valve 42. No gas can flow to the intermediate pilot burners 12 and 13 at this time however, since shut-off means 32 is then closed. The lower edge of lever 36 adjacent to pin 35 may be notched to permit the pin to lift lever 48 to the desired position, although this may vary.

When gas cock or shut-off means 32 is turned to open position the pin 35 moves downwardly into spaced relation beneath levers 36 and 48. This permits spring 52 to move lever 48 downwardly. Due to the tapered pin 65, the air in chamber 57 beneath diaphragm 22 is released very slowly, thereby effecting a predetermined and adjustable time delay. The arcuate slot in lever 48 adjacent to pin 49 also provides a time delay before the pin 49 is engaged by lever 48. As the pin 49 is engaged by lever 48, the lever 36 moves downwardly with lever 48.

As long as valve 42 and shut-off means 32 are open, gas is delivered from chamber 23, outlet 26 and pipe or tube 27 to intermediate pilot burners 12 and 13. The unburned gas from the intermediate pilot burners rises in the tube 8, which is relatively cool to permit this action. As it reaches the flame of constantly burning pilot burner 2, the gas is ignited and then recedes

or flashes back to light the intermediate pilot burners 12 and 13.

The springs and headed ends of valve stem 39 are so arranged that as the lever 36 is moved downwardly by engagement of lever 48 with pin 49, it operates to open valve 40, and, a few seconds later, to close valve 42. The thermoelectric generator has been heated by intermediate pilot burner 13 to open valve 83 during the delay, and the delay is such that a gas supply is set up to the pilot burner 7 and main burner 1 for ignition of the pilot burner 7 from the intermediate pilot burner 13 before the valve 42 is closed to shut off the supply of fuel to the intermediate pilot burners 12 and 13.

When the shut-off means 32 is turned in the opposite direction to closed position, pin 35 returns levers 36 and 48 to their lifted positions. At this time the diaphragm 22 raises with the upward movement of the stem 50, producing a suction in the chamber 57 which opens the valve 60 for free entry of air through the port 58 so that the closing of valve 40 and opening of valve 42 will occur promptly upon closing of shut-off means 32 and without time delay such as would result if the air had to be drawn in through the restricted duct 63 in this operation of the device.

The time delay prevents the flow of gas to the burner when, after some operation, the gas cock or other gas shut-off means is closed and immediately opened again. In such case the thermocouple or other thermoelectric generator would be still hot enough to hold the valve 83 open and supply the burner with gas which could not be ignited by the pilot burners which have been extinguished by the closing of the gas cock. This gas would then escape unburned and constitute a hazard. However, the arrangement and time delay of the present invention provides:

1. That upon opening the shut-off means 32 the time delay means maintains the valve 40 closed until the thermoelectric generator 90 is heated sufficiently by the flame of the intermediate pilot burner 13 to energize the coil 7 and open or maintain open the valve 83.

2. That a certain time is given the thermocouple or other thermoelectric generator to cool and deenergize and close valve 83 so that, in case the flash tube system should fail to function, the valve 83 will be closed before valve 40 opens.

In the embodiment of the invention shown in Figure 3, the thermoelectrically operated means and the shut-off and time delay means are combined in a single device.

The valve body parts 110 and 111 are secured together with a diaphragm 112 clamped marginally therebetween. A stem or pin 113 is secured at one end at 114 to diaphragm 112 at the axis thereof, and operates reciprocally through an opening 115. The opposite end of the stem 113 has an abutment 116 between which and flange 117 (in which opening 115 is provided) is confined a coiled spring 118. Intermediate its ends the stem 113 carries a member 119 which, with the device in the position shown in the drawing, cooperates with the adjacent end of a pin 120 to hold the thermoelectric valve 121 open and armature 122 in attracted position against the pole ends of the magnet frame 123.

The outlet 124 is for delivering fuel to the main burner and the pilot burner for the main burner, and the outlet 125 is for the delivery of fuel to the intermediate pilot burners. The outlets 124 and 125 correspond to the outlets 25 and 26 of

the preceding embodiment of the invention, and may be connected to the burner and pilot burners as shown in Figure 1A. The valves 126 and 127 correspond to the valves 40 and 42 of Figure 1, and are operated by levers 128 and 129 pivotally mounted at 130 and 131, respectively, on a bracket 132. Levers 128 and 129 are pivotally connected at 133, and the outer end of the lever 129 has an elongated slot 134 into which a pin 135 on valve stem 136 extends. The valve stem 136 extends at one end through a guide, and has an abutment 137 between which and ported abutment 138 a coiled spring 139 is interposed.

The gas cock or other shut-off means 140, which may be similar to the gas cock shown at 32 in Figures 1 and 2, is shown in closed position and may be rotated manually or otherwise operated to open and closed positions. It carries an arm 143 which cooperates with the adjacent plate of diaphragm 112 and carries an actuating member 144 for actuating valve 121 to open position and armature 122 to attracted position by cooperation with the adjacent end of an arm 145, the opposite end of which is pivotally mounted at 146. The stem or pin 113 carries a pin 141 which operates between the prongs of a fork 142 on the adjacent end of the lever 128.

When valve 121 is open, gas enters through the inlet 147 of the thermoelectric valve and passes through passage 148 and a tube 149 into the chamber for the gas cock 140. The pin 120 abuts endwise with the abutment 150 at the adjacent end of the stem 151 of armature 122 and valve 121. The member 119, by cooperation with the adjacent end of pin 120, is adapted to hold armature 122 in attracted position and valve 121 in open position until the electromagnet has a chance to energize and the member 119 has moved up to position clear of pin 120. The diaphragm 112 and related mechanism constitutes a time delay, and the member 119 holds the armature 122 in attracted position and valve 121 in open position during the time delay which is such as to permit the electromagnet to be energized by the heat of the pilot means on the thermoelectric generator. When the member 119 is clear of the adjacent end of the pin 120 and the electromagnet is deenergized, for example, upon extinction of the pilot flame, a coiled spring 152 closes valve 121, and abutment of stem 151 with pin 120 moves pin 120 to the right from the position shown in Figure 3; a coiled spring 153 swinging arm 145 in a counterclockwise direction from its illustrated position.

The parts 154 and 155 are clamped together with the diaphragm type seal 156 clamped marginally therebetween and secured axially to the pin 120. The parts 154 and 155 are ported at 157 and secured, for example, between the valve body part 158 of the thermoelectric valve and the adjacent valve body part 159.

The thermocouple 160 or other thermoelectric generator, such as a thermopile, which may be arranged, for example, as shown in Figure 1A, is connected in circuit with the coil 161 of the electromagnet which includes the magnet frame 123 and the coil 161.

Chamber 162 is adapted for the entry of air into the same from atmosphere through a port 163 and passage 164. Communication between atmosphere and chamber 162 is controlled by a tapered pin 165. The pin 165 may be adjustable for the purpose of adjusting the amount of restriction or displacement of air into chamber 162 through the passage 164 and thereby the time delay secured by the action of the diaphragm 112.

Ports or passages 166 open from the chamber 162 to atmosphere. These ports or passages 166 are adapted to be closed by a valve 167 which seats on an annular valve seat 168, for example, under the action of a spring 169. An air filter may be provided as shown at 55 in the preceding embodiment of the invention.

The operation of the system shown in Figure 3 is, in general, as follows:

With gas cock 140 in closed position as shown, the thermoelectric safety shut-off valve 150 is held in open position by cooperation of the member 119 with the pin 120, admitting gas through passage 148 and tube 149 into the gas cock chamber. When the gas cock 140 is turned in a clockwise direction (Figure 3) to open position, the arm 143 moves away from the adjacent plate of the diaphragm 112 permitting the spring 118 to actuate the pin or stem 113 upwardly as shown in Figure 3, and pin 141 carried by stem 113 positions levers 128 and 129 in preparation for shutting off the intermediate pilot burner gas by the valve 127 and for opening valve 126 to supply the burner and the pilot burner therefor, which may be arranged as in Figure 1A. The diaphragm 112 is urged upwardly by the spring 118. The time delay is secured by adjustable tapered pin 165 which permits a slow replacement of the air into the chamber 162 below diaphragm 112.

After a regulated time interval the pin 136, through levers 128 and 129, and pin 141 and fork 142, operates to move valve 126 slowly to open position to establish a supply of fuel to the main burner and the pilot burner for the main burner.

At the same time the valve 127 slowly closes to shut off the gas to the intermediate pilot burner. During the time delay provided by the diaphragm 112, the electromagnet is energized by the heat of the pilot burner means on the thermoelectric generator, and as the member 119 moves up to position clear of the pin 120 the energized electromagnet holds the armature 122 in attracted position and valve 121 in open position. In case of pilot failure, the armature 122 is released from the electromagnet and the valve 121 closes and automatically shuts off all supply of fuel to the burner and pilot burners.

It is evident from the foregoing that the system shown in Figure 3 has advantages over the preceding embodiment of the invention as follows:

- a. Only one combination valve is required.
- b. In case of flash tube failure, both the intermediate and the oven pilot burners and also the main burner supply are shut off by the thermoelectric valve after the time delay.
- c. The thermoelectric valve may be operated by a thermocouple as distinguished from a thermopile.

d. The magnet and coil may be much smaller, and many of the parts are of standardized form.

The device illustrated in Figure 3 shows only one of the possibilities of arranging the various elements of such a device. It is to be understood that the arrangement may be altered completely without disturbing the general function of the control.

The sequence of operations shows that intermediate pilot burners 12 and 13 are definitely closed to gas supply after the time delay, no matter whether they have been ignited or not; thus no gas can escape in case of flash tube failure. The particular mechanisms shown in the drawings represent only certain illustrated solutions within the scope of the present invention for operating the valves 40 and 42 or 126 and 127 in the manner described.

Therefore the embodiments of the invention shown in the drawings are 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 apparatus of the class described, in combination, a pair of valve body parts, a flexible diaphragm secured marginally between said valve body parts, one of said body parts having a fuel chamber provided with a first outlet for supplying fuel to intermediate pilot burner means and a second outlet for supplying fuel to a main burner, the other body part having an air chamber provided with a restricted and adjustable outlet, a first valve for said first outlet, a second valve for said second outlet, a fuel supply line, shut-off means in said fuel supply line, and means within said fuel chamber, under the control of said shut-off means, and connected to said diaphragm for opening said second valve and then after a time delay closing said first valve upon movement of said shut-off means to open position.

2. Apparatus according to claim 1 wherein said last means comprises a first spring actuated lever connected to said diaphragm and a second lever operable by said first lever after lost motion movement thereof for operating said first and second valves as set forth.

3. Apparatus according to claim 1 wherein said last means comprises a first spring actuated lever connected to said diaphragm and a second lever operable by said first lever after lost motion movement thereof for operating said first and second valves as set forth and wherein there is intermediate pilot burner means connected to said first outlet, a main burner connected to said second outlet, an additional pilot burner in juxtaposition to said intermediate pilot burner means and said main burner, an electroresponsive valve in the fuel supply line for the main burner, and a thermoelectric generator subject to the heat of both said intermediate pilot burner means and said additional pilot burner and connected in circuit with said electroresponsive valve for operation of said valve to open position by the heating of said thermoelectric generator.

4. In apparatus of the class described, in combination, a first valve for intermediate pilot burner means, a second valve for a main burner, lever means for said valves, a shut-off device for shutting off the fuel supply for both said pilot burner means and said main burner and comprising a part mounted for turning movement, means under the control of said shut-off device and having means operable to prepare said lever means for closing said first valve and opening said second valve, time delay means operable firstly to open said second valve and then to close said first valve, thermoelectric control means comprising an electromagnet, an armature for said electromagnet, a safety shutoff valve connected to said armature, and means operated by said shut-off means for actuating said armature to attracted position and said safety shutoff valve to open position.

5. Apparatus according to claim 4 wherein said shut-off device has means for actuating the armature to attracted position and said shutoff valve to open position.

6. Apparatus according to claim 4 wherein the

time delay means has a chamber provided with means for displacing air from said chamber and wherein there is a restricted inlet for relatively slow replacement of air into said chamber.

7. Apparatus according to claim 4 wherein the time delay means has a chamber provided with means for displacing air from said chamber and wherein there is a restricted inlet for relatively slow replacement of air into said chamber, said chamber having a diaphragm and a stem connected to said diaphragm and carrying means for holding the armature in attracted position and said safety shutoff valve in open position until the electromagnet has a chance to energize.

8. In a system of the class described, in combination, a constant burning pilot burner, a main burner remote from said pilot burner, an ignition pilot burner adjacent to said main burner for igniting same, intermediate pilot burner means and said ignition pilot burner for igniting said ignition pilot burner from said constantly burning pilot burner, a fuel supply line, a main burner valve for shutting off the supply of fuel for said main burner, an intermediate pilot burner valve for shutting off the supply of fuel for said intermediate pilot burner means, shut-off means in said fuel supply line, mechanical actuating mechanism operated by closing operation of said shut-off means to open the intermediate pilot burner valve for the intermediate pilot burner means and to close said main burner valve, timing mechanism having a time delay action imposed thereon by the operation of said mechanical actuating mechanism by the opening operation of said shut-off means, said timing mechanism being operatively associated with said main burner valve and said intermediate pilot burner valve and rendered effective by the opening of said shut-off means to open said main burner valve for the main burner and to close the pilot burner valve after a time delay following opening of said shut-off means, a safety shut-off valve biased to closed position shutting off the flow of fuel to said main burner and said intermediate pilot burner means, a thermoelectric generator, an electromagnet energized by said thermoelectric generator and effective when so energized to hold said safety shut-off valve in open position, and means actuated by closing of said shut-off means for holding said safety shut-off valve in open position during the time delay in the opening of said main burner valve and closing of said intermediate pilot burner valve.

9. In apparatus of the class described, in combination, a first valve, a second valve, a third valve, mechanical actuating means operated by operation of said third valve first to open said first valve and to close said second valve, and pneumatic timing mechanism comprising a chamber having an inlet which is relatively unrestricted during the opening of said first valve and closing of said second valve and an outlet which is relatively restricted during the opening of said second valve and closing of said first valve, said timing mechanism having a diaphragm for imposing a time delay action thereon by said mechanical actuating means upon operation by said third valve, said timing mechanism operating to close said first valve and to open said second valve after a delay period following opening of said third valve.

10. In apparatus of the class described, in combination, a valve body, a flexible diaphragm dividing the interior of said valve body into a fuel

chamber and an air chamber, said valve body having a first outlet for supplying fuel from said fuel chamber to intermediate pilot burner means and a second outlet for supplying fuel from said fuel chamber to a main burner, said valve body having an unrestricted inlet and a restricted outlet for said air chamber, a first valve for said first outlet, a second valve for said second outlet, a fuel supply line, shut-off means for said fuel supply line, and means within said fuel supply line under the control of said shut-off means and connected to said diaphragm for opening said second valve and then, after a time delay, closing said first valve upon movement of said shut-off means to open position, said air chamber being operatively related to said shut-off means and said first and second valves to provide by said restricted outlet from said air chamber a time delay in closing said first valve and opening said second valve following opening of said shut-off means, said unrestricted inlet for said air chamber enabling quick closing of said second valve and opening of said first valve upon actuation of said shut-off means to closed position.

11. Apparatus according to claim 10 wherein there is a third valve ahead of said first and second valves and means for actuating said third valve to open position by the closing of said second valve.

12. Apparatus according to claim 10 wherein there is a third valve ahead of said first and second valves, and means for actuating said third valve to open position by the closing of said second valve, said third valve being held in open position after said second valve is opened by energization of an electromagnet.

13. In apparatus of the class described, in combination, a pair of coaxial valve seats, a pair of coaxial valve members one cooperable with one valve seat and the other cooperable with the other valve seat, a valve stem projecting axially through both of said valve members for movement there-through, a collar slidable on said valve stem between said valve members, a pair of springs one interposed between said collar and one valve member and the other interposed between said collar and the other valve member, a pair of abutments on the projecting ends of said stem, and means for actuating said collar in opposite directions.

14. Apparatus according to claim 13 wherein the means for actuating the collar in opposite directions comprises lever means connected to said collar, movement of said collar in one direction actuating one of said valve members to a closed position through its cooperating spring and the other valve member to open position through one of the abutments on the stem and movement of said collar in the opposite direction actuating the other valve member to closed position through its cooperating spring and the other valve member to open position through the other abutment on said stem.

15. Apparatus according to claim 13 wherein the means for actuating the collar in opposite directions comprises a pair of levers having a lost motion connection therebetween.

16. In a system of the class described, in combination, a constantly burning pilot burner, a main burner remote from said pilot burner, an ignition pilot burner adjacent to said main burner for igniting same, intermediate pilot burner means intermediate said constantly burning pilot burner and said ignition pilot burner

for igniting said ignition pilot burner from said constantly burning pilot burner, a fuel supply line, a main burner valve for shutting off the supply of fuel for said main burner, an intermediate pilot burner valve for shutting off the supply of fuel for said intermediate pilot burner means, shut-off means in said fuel supply line, mechanical actuating mechanism operated by closing operation of said shut-off means to open the intermediate pilot burner valve for the intermediate pilot burner means and to close said main burner valve, and timing mechanism having a time delay action imposed thereon by the operation of said mechanical actuating mechanism by the opening operation of said shut-off means, said timing mechanism being operatively associated with said intermediate pilot burner valve and said main burner valve to close said intermediate pilot burner valve for the intermediate pilot burner means and to open the main burner valve after a delay period following opening of said shut-off means, said timing mechanism comprising a chamber provided with means for displacing air from said chamber, said chamber having a restricted outlet opening therefrom.

17. In a system of the class described, in combination, a constantly burning pilot burner, a main burner remote from said pilot burner, an ignition pilot burner adjacent to said main burner for igniting same, intermediate pilot burner means intermediate said constantly burning pilot burner and said ignition pilot burner for igniting said ignition pilot burner from said constantly burning pilot burner, a fuel supply line, a main burner valve for shutting off the supply of fuel for said main burner, an intermediate pilot burner valve for shutting off the supply of fuel for said intermediate pilot burner means, shut-off means in said fuel supply line, mechanical actuating mechanism operated by closing operation of said shut-off means to open the intermediate pilot burner valve for the intermediate pilot burner means and to close said main burner valve, and timing mechanism having a time delay action imposed thereon by the operation of said mechanical actuating mechanism by the opening operation of said shut-off means, said timing mechanism being operatively associated with said intermediate pilot burner valve and said main burner valve to close said intermediate pilot burner valve for the intermediate pilot burner means and to open the main burner valve after a delay period following opening of said shut-off means, said timing mechanism comprising a chamber provided with means for displacing air from said chamber, said chamber having a restricted outlet opening therefrom which is adjustable to adjust the time delay.

18. In a system of the class described, in combination, a constantly burning pilot burner, a main burner remote from said pilot burner, an ignition pilot burner adjacent to said main burner for igniting same, intermediate pilot burner means intermediate said constantly burning pilot burner and said ignition pilot burner for igniting said ignition pilot burner from said constantly burning pilot burner, a fuel supply line, a main burner valve for shutting off the supply of fuel for said main burner, an intermediate pilot burner valve for shutting off the supply of fuel for said intermediate pilot burner means, shut-off means in said fuel supply line, mechanical actuating mechanism operated by closing operation of said shut-off means to open the intermediate pilot burner valve for the intermediate

13

pilot burner means and to close said main burner valve, and timing mechanism having a time delay action imposed thereon by the opening operation of said shut-off means, said timing mechanism being operatively associated with said intermediate pilot burner valve and said main burner valve to close said intermediate pilot burner valve for the intermediate pilot burner means and to open the main burner valve after a delay period following opening of said shut-off means, said timing mechanism comprising a chamber provided with means for displacing air from said chamber, said chamber having a restricted outlet opening therefrom and a less restricted air inlet to said chamber.

19. In a system of the class described, in combination, a constantly burning pilot burner, a main burner remote from said pilot burner, an ignition pilot burner adjacent to said main burner for igniting same, intermediate pilot burner means intermediate said constantly burning pilot burner and said ignition pilot burner for igniting said ignition pilot burner from said constantly burning pilot burner, a fuel supply line, a main burner valve for shutting off the supply of fuel for said main burner, an intermediate pilot burner valve for shutting off the supply of fuel for said intermediate pilot burner means, shut-off means in said fuel supply line, mechanical actuating mechanism operated by closing operation of said shut-off means to open the intermediate pilot burner valve for the intermediate pilot burner means and to close said main burner valve, timing mechanism having a time delay action imposed thereon by the operation of said mechanical actuating mechanism by the closing operation of said shut-off means, said timing mechanism being operatively associated with said intermediate pilot burner valve and said main burner valve to close said intermediate pilot burner valve for the intermediate pilot burner means and to open the main burner valve after a delay period following opening of said shut-off means, a safety shut-off valve biased to closed position shutting off the flow of fuel to said main burner and said intermediate pilot burner means, a thermoelectric generator, an electromagnet energized by said thermoelectric generator and effective when so energized to hold said safety shut-off valve in open position, and means for actuating said safety shut-off valve to open position by the closing operation of said shut-off means.

20. In a system of the class described, in combination, a constantly burning pilot burner, a main burner remote from said pilot burner, an ignition pilot burner adjacent to said main burner for igniting same, intermediate pilot burner means intermediate said constantly burning pilot burner and said ignition pilot burner for igniting said ignition pilot burner from said constantly burning pilot burner, a fuel supply line,

14

a main burner valve for shutting off the supply of fuel for said main burner, an intermediate pilot burner valve for shutting off the supply of fuel for said intermediate pilot burner means, shut-off means in said fuel supply line, mechanical actuating mechanism operated by closing operation of said shut-off means to open the intermediate pilot burner valve for the intermediate pilot burner means and to close said main burner valve, timing mechanism having a time delay action imposed thereon by the operation of said mechanical actuating mechanism by the opening operation of said shut-off means, said timing mechanism being operatively associated with said main burner valve and said intermediate pilot burner valve and rendered effective by the opening of said shut-off means to open said main burner valve for the main burner and to close the pilot burner valve after a time delay following opening of said shut-off means, a safety shut-off valve biased to closed position shutting off the flow of fuel to said main burner and said intermediate pilot burner means, a thermoelectric generator subject to the heat of said intermediate pilot burner means, an electromagnet energized by said thermoelectric generator and effective when so energized to hold said safety shut-off valve in open position, means actuated by closing operation of said shut-off means for actuating said safety shut-off valve to open position, and means for holding said safety shut-off valve in open position until said thermoelectric generator is energized by the heat of said intermediate pilot burner means, said last means being operated to released position by the time delay mechanism when the time delay mechanism is rendered effective by the opening of said shut-off means.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,096,925	Kruesi	May 19, 1914
1,965,054	Powers	July 3, 1934
2,063,834	Bast et al.	Dec. 8, 1936
2,203,613	Cyr	June 4, 1940
2,290,048	Hildebrecht	July 14, 1942
2,297,718	Ray	Oct. 6, 1942
2,297,854	Alfery	Oct. 6, 1942
2,305,915	Wantz	Dec. 22, 1942
2,313,890	Ray	Mar. 16, 1943
2,318,823	Wantz	May 11, 1943
2,443,892	Caparone	June 22, 1948
2,483,191	Gauger	Sept. 27, 1949
2,510,265	Strobel	June 6, 1950
2,513,257	Strobel	June 27, 1950
2,515,476	Strobel	July 18, 1950
2,557,927	Abrams et al.	June 26, 1951
2,578,194	Matthews	Dec. 11, 1951
2,610,680	Witzel	Sept. 16, 1952