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[54] **FAIL-SAFE FUEL CUTOFF DEVICE**
19 Claims, 3 Drawing Figs.

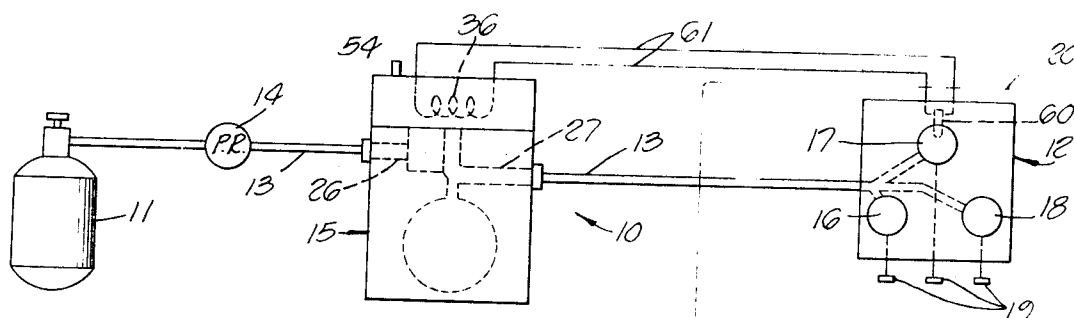
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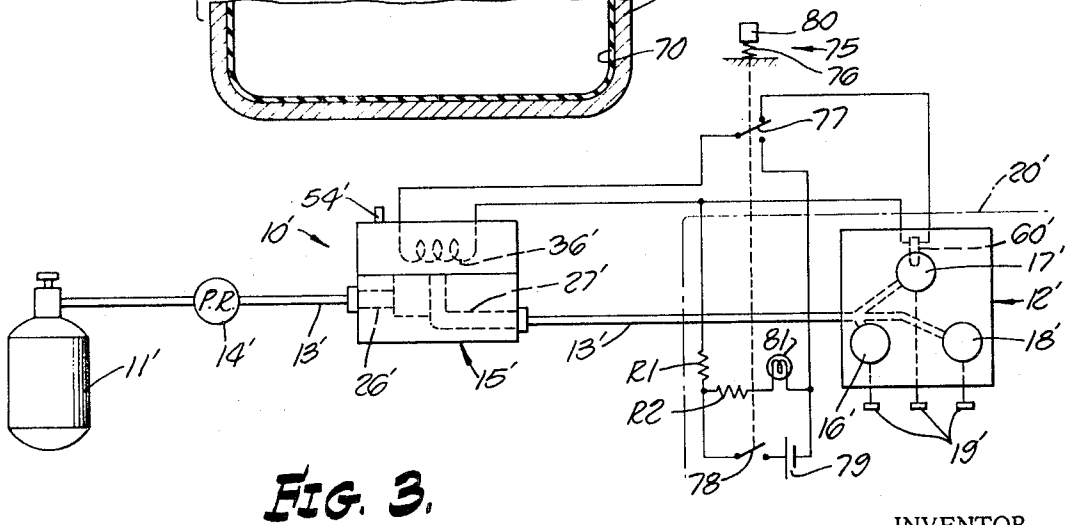
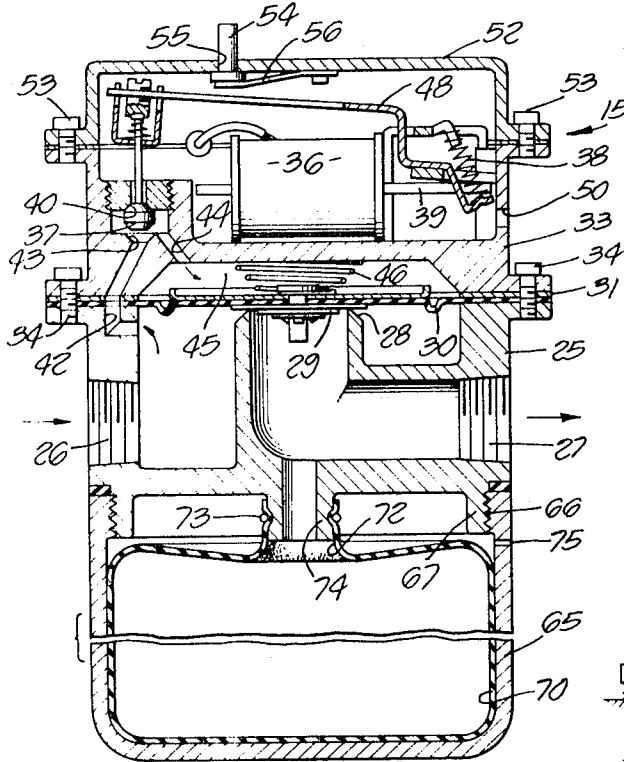
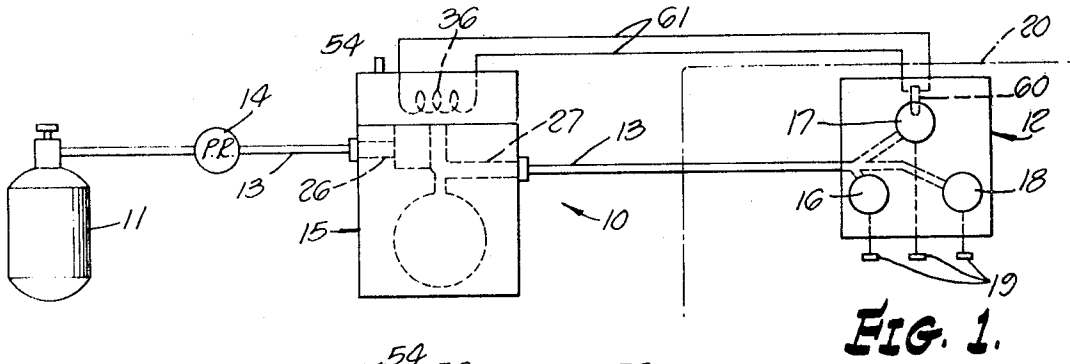
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ABSTRACT: A fail-safe safety fuel cutoff system for heating equipment fueled with pressurized gas, such as LPG, hazardous to life if accidentally escaping into an enclosure. The system utilizes a main cutoff valve of the pilot-controlled type and equipped with an operating solenoid normally energized by a thermocouple having its hot junction exposed to the burner. In one preferred embodiment, a reserve quantity of fuel is automatically stored adequate to operate the burner to energize the thermocouple and open the cutoff valve whereas, in a second embodiment, a secondary power source is utilized initially to hold the main valve open until the thermocouple reaches its operating temperature and assumes control of the cutoff valve. Each embodiment is effective to positively cut off all fuel flow at a point exteriorly of the enclosure following cooling of the thermocouple.





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FAIL-SAFE FUEL CUTOFF DEVICE

This invention relates to safety to off equipment for fuel burners, and more particularly to a fail-safe safety cutoff device affording positive protection for burner equipment designed for use with bottled propane and the like LPG fuels.

Burner and heating equipment designed for use with propane and LPG fuels is particularly hazardous in the event of leakage into occupied enclosures. Because of these hazards, local laws and safe operating procedures dictate that a master valve be located exteriorly of any occupied enclosure and manually turned off before the occupants retire. Otherwise, not infrequently there is a fatal accident occasioned by the forgetfulness of failure to turn off the master valve.

Various proposals have been made to safeguard against these hazards but, prior to the present invention, no one of these proposals has been satisfactory from either a reliability or an economic standpoint.

To avoid the foregoing and other shortcomings of prior safety fuel cutoff systems, there is provided by the present invention a highly satisfactory foolproof, fail-safe system readily installed by the novice. These objectives are achieved by the use of a master cutoff assembly designed for fail-safe operation and insertable as a unit in the fuel line exteriorly of an occupied enclosure at a point intermediate the customary pressure regulator and the burner to be served. The only additional connection is an electric service circuit extending between the cutoff device and the heater and including a rugged thermocouple having a hot junction located in heating proximity to the burner. This thermocouple is employed to energize a solenoid controlling a pilot valve for the main valve, and having its fuel inlet in communication only with the inlet side of the master valve.

According to one preferred embodiment, the outlet side of the main valve communicates with the reserve fuel reservoir having a capacity, taken with that of the fuel line itself, barely adequate to operate the burner until the thermocouple comes up to operating temperature. This quantity of fuel is retained trapped in reserve reservoir by the usual manually operated burner control valve. If this valve fails or leaks for any reason only the negligible quantity of reserve fuel can escape into the living quarters.

In an alternate embodiment of the invention, a pushbutton switch located at the burner and conveniently located for operation as the burner control valve is opened, is effective to energize the pilot-controlled valve from an auxiliary source of power. This switch is held manually depressed for the short interval required for the lighted burner to bring the thermocouple up to operating temperature following which the switch is released thereby automatically leaving the thermocouple in control of the pilot valve and effective to close the master valve as soon as the burner employed to heat the thermocouple is turned off.

Both embodiment of the invention are equally foolproof in operation and assure positive cutoff of the main fuel valve upon either intentional or accidental extinguishment of the burner flame, thereby avoiding the need for a trip to the master valve before retiring or at any other time.

Accordingly it is a primary object of the present invention to provide a unique and improved fail-safe safety fuel cutoff system for use with pressurized gaseous fuels.

Another object of the invention is the provision of a simple, rugged, inexpensive, positively acting safety cutoff device insertable in the gaseous fuel line exteriorly of an occupied enclosure and operating automatically to safeguard against the release of a dangerous quantity of fuel into the enclosure.

Another object of the invention is the provision of a fail-safe fuel cutoff system for use with pressurized gas and including means for automatically storing a reserve quantity of fuel adequate only to heat a control thermocouple to its operating temperature effective to open the main valve.

Another object of the invention is the provision of a fail-safe fuel cutoff system including provision for automatically storing a reserve quantity of fuel principally in the cutoff device itself and adequate to heat a thermocouple controlling operation of a main shutoff valve.

Another object of the invention is the provision of a thermocouple-controlled pilot-operated safety cutoff valve equipped with manually controlled auxiliary power for use in holding the pilot valve open until the main thermocouple control is heated to its operating temperature.

These and other more specific objects will appear upon reading the following specification and claims and upon considering in connection therewith the attached drawing to which they relate.

Referring now to the drawing in which a preferred embodiment of the invention is illustrated:

FIG. 1 is a generally diagrammatic view of one preferred embodiment of the invention installed in a typical operating environment;

FIG. 2 is a vertical sectional view on an enlarged scale through the safety fuel cutoff valve; and

FIG. 3 is a diagrammatic view of a second preferred embodiment of the invention utilizing a manually operated auxiliary power supply for the pilot valve.

Referring more particularly, initially, to FIGS. 1 and 2, there is shown a typical embodiment of the invention fail-safe cutoff system designated generally 10. This system includes a typical supply tank 11 for LPG, propane or the like pressurized fuel connected to any suitable heater 12 by way of a fuel distributing conduit 13. This conduit includes a pressure regulating valve 14 and the invention fail-safe cutoff valve 15. The discharge end of fuel conduit 13 is connected to one or more burners 16, 17, 18 each provided with its own manually operated fuel-regulating valve of any suitable construction having control handles 19. Heater 12 is here shown located in an enclosure 20 such as a trailer, camper or other living quarters. To be noted is the fact that the fail-safe cutoff valve 15 is located exteriorly of these living quarters.

Referring now to FIG. 2, there is shown the essential structural details of the unitary fail-safe device 15 having a main housing 25 provided with a fuel inlet 26 and a fuel outlet 27. Outlet passage 27 is generally L-shaped and provided at its inner end with a valve seat 28 normally closed by resilient valve member 29 carried centrally of a flexible diaphragm 30. This diaphragm, its sealing gasket 31 and a cover 33 are held assembled by cap screws 34. The cup-shaped cover 33 encloses a high-efficiency solenoid 36 operatively coupled to a pilot valve 37. This pilot valve and its actuating linkage is of known construction having spring means 38 operatively coupled to the solenoid armature 39 and normally effective, in the deenergized condition of the solenoid, to hold pilot valve 37 seated against seat 40 as shown in FIG. 2. Under these conditions, pressurized fuel entering inlet 26 flows through passage 42, past valve seat 43, and thence through passage 44 into chamber 45 overlying diaphragm 30. Spring 46 bearing against the diaphragm is then effective to hold valve 29 firmly seated against seat 28. However, when solenoid 36 is energized, its armature 39 pivots operating lever 48 counterclockwise thereby closing pilot valve 37 against seat 43. Gas then present in chamber 45 above the diaphragm is free to exit to the atmosphere via passage 44, past valve seat 40, and to the atmosphere through port 50 in the sidewall of cover member 33.

The upper end of the cup-shaped cover 33 is normally closed by a cover member 53 held in place by assembly screws 53. This cover preferably includes an operating button 54 projecting loosely through an opening 55 in the cover and normally held in its extended position by leaf spring 56. Button 54 overlies lever 48 and, when manually depressed, is effective to pivot the pilot valve supporting lever 48 counterclockwise to vent gas from chamber 45 overlying diaphragm 30.

An important feature of the first preferred embodiment comprises means for storing a limited reserve supply of fuel on the downstream side of valve seat 28 adequate to operate burner 17 long enough to bring the hot junction of thermocouple 60 up to its operating temperature. The cold junctions of this thermocouple are connected to solenoid 36 by heavy leads 61 and the power generated by the thermocouple is adequate to energize the high-efficiency solenoid 36 to hold

pilot valve 37 seated against seat 43 so long as burner 17 is operating. It will be understood that the means for storing the reserve supply of fuel adequate for these purposes may be located at any point between valve seat 28 and burner 17, for example, in an enlarged portion of fuel conduit 13 downstream from the valve outlet passage 27.

However, there are distinct advantages in locating the reserve fuel supply chamber within the housing for the master cutoff valve 15. To this end, there is removably attached to the lower side of housing 25 a cup-shaped protective guard 65 having threads 66 for holding the same separably assembled to a threaded flange 67 integral with housing 25. Housed within cup 65 is a resilient diaphragm such as a balloon 70 of thick-walled highly resilient elastomeric material having an inlet neck 72 held assembled by a retainer clamp 73 to a tubular member 74 communicating with the valve outlet passage 27. Housing 65 includes one or more atmospheric vents 75 permitting air to enter and leave housing 65 as balloon 70 expands and contracts. As shown in FIG. 2, the fuel supply system is closed and each of the fuel valves 19 is in a fully cut off condition. Under these circumstances, balloon 70 is fully charged with its walls expanded against the interior surfaces of housing 65. The operation of the first described embodiment will be quite apparent from the foregoing description. Initially and when first installed, it is necessary to manually open pilot valve 37 in order to charge the reserve reservoir with fuel. This is accomplished by depressing button 54 thereby pivoting lever 48 downwardly and allowing the fuel present in chamber 45 above diaphragm 30 to escape to the atmosphere via port 50. The line pressure on the lower side of the diaphragm, as 2 to 3 p.s.i. in a typical case, then opens valve 29 allowing the fuel to fill the reservoir and the conduit leading therefrom to burner 17. Once this has been accomplished button 54 is released and need not thereafter be operated except for the purpose just described.

The operator then proceeds to use heater 12 by first turning on the valve 19 controlling the flow of fuel to burner 17 and lighting this burner. The hot junction of thermocouple 60 is quickly heated by the burner and generates the requisite energy to activate solenoid 36 and seat pilot valve 37 against seat 43 thereby venting the fuel from chamber 45 to the atmosphere in the manner described above. This operation occurs before exhausting the small quantity of reserve fuel stored in the contracting balloon 70. As soon as valve 29 opens, the balloon is immediately recharged to its full capacity and is maintained charged in readiness to reheat the thermocouple for a subsequent starting cycle. It will therefore be appreciated that the operator initiates operation of heater 12 repeatedly and whenever desired merely by opening the manual valve for the burner employed to heat the thermocouple and igniting this burner in the usual way. So long as the heater is in use the operator always utilized burner 17 and any one of the other burners 16 and 18. Thereafter if he has need for less than all of the burners he always discontinues using burners 6 and 18 before cutting off burner 17 since heat from this burner is required to maintain the safety cutoff valve open.

Whenever burner 17 is cut off, solenoid 36 becomes deenergized due to the quick cooling of the thermocouple and then operates spring 38 and lever 48 whereupon pilot valve 37 closes upwardly against seat 40 allowing pressurized gas to flow into chamber 45 and spring 46 to close valve 29. Should any portion of the fuel conduits valves, the reserve fuel chamber itself, or burners downstream from outlet port 27, develop a leak, only the small amount of fuel held in reserve by balloon 70 can escape. This small amount is insufficient to be hazardous.

The second preferred embodiment of the invention illustrated in FIG. 3, and designated generally 10', is quite similar to the first described embodiment. It differs essentially in the elimination of the reserve fuel supply chamber and in the use of a manually controlled auxiliary power supply for holding the pilot valve in a position to open the main valve and supply

fuel to burner 17' until the thermocouple reaches its operating temperature.

It will be understood that the main field cutoff valve 15' may differ from valve 15 only in the omission of the reserve fuel storage chamber and the supply passage 74 leading thereinto. In lieu of the reserve fuel storage chamber, the FIG. 3 embodiment includes a double-pole single-throw switch 75 normally biased by spring 76 to the position shown. In that position blade 77 closes a circuit between thermocouple 60' and solenoid coil 36' whereas switch blade 78 is open to disconnect the auxiliary power source or battery 79 from the solenoid coil. However, when control button 80 for switch 75 is depressed, blade 77 is closed to its alternate position and blade 78 is likewise closed to energize the solenoid coil thereby bleeding gas from the chamber above the valve-operating diaphragm allowing the latter to open and supply fuel to the burners. Resistors R1 and R2 limit the current flow to the solenoid and to a pilot lamp 81 respectively. The pilot provides a visual indication to the operator that the pilot valve is energized and that fuel is being supplied to heater 12'. The operator then proceeds to open the valve to burner 17' and ignites this burner in the customary manner. Button 80 is held depressed to maintain valve 15' open until the burner has heated the hot terminal of thermocouple 60' whereupon button 80 is released and automatically shifts to its alternate or normal position under the influence of spring 76 thereby deactivating the battery circuit and closing switch blade 77 so that the power developed by the thermocouple is utilized to energize the solenoid and maintain the safety fuel cutoff valve 15' open so long as the thermocouple is heated.

While the particular fail-safe fuel cutoff device herein shown and disclosed in detail is fully capable of attaining the objects and providing the advantages hereinbefore stated, it is to be understood that it is merely illustrative of the presently preferred embodiment of the invention, and that no limitations are intended to the details of construction or design herein shown other than as defined in the appended claims.

I claim:

1. In a fail-safe fuel supply system for a manually controlled main burner located in an enclosure and supplied with gaseous fuel through a fuel conductor from a pressure-regulated main supply exteriorly of the enclosure, that improvement which comprises: normally closed automatic safety cutoff means controlling said fuel supply to said burner and including pilot valve means effective when energized to effect the opening of main valve means controlling the flow of fuel to said burner, thermally responsive means positioned to be heated solely by said burner and effective when heated by gas supplied to said burner to energize said pilot valve means to open said main valve means, and means including manually operated means for supplying gaseous fuel to said main burner temporarily from gas trapped between said cutoff means and manually operated means and in sufficient quantity to bring said thermally responsive means to a temperature adequate to energize said pilot valve means.

2. A fail-safe fuel supply system as defined in claim 1 characterized in that said manually controlled means includes means for energizing said pilot valve means for a brief interval from a separate power source and for thereafter energizing said pilot valve means from said thermally responsive means so long as the same remains heated from said burner.

3. A fail-safe fuel supply system as defined in claim 1 characterized in that said manually controlled means includes switch-controlled auxiliary power means manually operable to energize said pilot valve means while said thermally responsive means is being heated by said burner.

4. A fail-safe fuel supply system as defined in claim 3 characterized in that said manually controlled means for said auxiliary power means includes means for automatically deactivating the connection to said auxiliary power means and for energizing said pilot valve means from said thermally responsive means.

5. A fail-safe fuel supply system as defined in claim 3 characterized in that manually controlled means comprise double-pole single-throw switch means normally spring biased to a position deactivating said auxiliary power means and connecting said thermally responsive means in circuit with said pilot valve means.

6. A fail-safe fuel supply system as defined in claim 5 characterized in the provision of signal means operatively connected with said switch means and effective to provide a distinctive indication when said auxiliary power means is in use to energize said pilot valve means.

7. A fail-safe fuel supply system as defined in claim 1 characterized in that said means for supplying fuel to said burner temporarily to heat said thermally responsive means to a temperature effective to energize said pilot valve means includes reserve fuel storage means of limited capacity located in the fuel connection between said main valve and said burner and automatically charged to capacity as an incident to the opening of said main valve.

8. A fail-safe fuel supply system as defined in claim 7 characterized in that said reserve fuel supply means includes means for maintaining the reserve supply of fuel under pressure as the same is being supplied to and burned at said burner to bring said thermally responsive means up to its operating temperature

9. A fail-safe fuel supply system as defined in claim 7 characterized in that said reserve fuel storage means is a unitary part of said safety cutoff means.

10. A fail-safe fuel supply system as defined in claim 7 characterized in that said safety cutoff means is a unitary assembly having a housing formed with a chamber enclosing said reserve fuel storage means.

11. A fail-safe fuel supply system as defined in claim 7 characterized in that said reserve fuel storage means comprises chamber means enclosing a balloon of resilient material having an inlet sealed to a passage in direct communication with the fuel flow passage extending between said main valve and said burner, said balloon being normally held expanded against the interior of said chamber means by the normal fuel pressure, and the energy stored in said expanded balloon being effective when the fuel therein is being burned at said burner to contract and maintain pressure on the diminishing quantity of reserve fuel therein.

12. A fail-safe fuel cutoff valve comprising a main housing

provided with a diaphragm-supported main valve cooperating with seat means positioned to control the flow of gaseous fuel between an inlet and an outlet passage, solenoid-operated pilot valve means controlling the flow of fuel between said inlet passage and the remote side of the diaphragm and a vent to the atmosphere and operable to hold said main valve in one extreme position thereof when energized and in a second extreme position when deenergized, and resilient balloon means enclosed in said housing and in communication with said outlet passage operable to store a reserve quantity of gaseous fuel therein when said main valve is open.

13. A fail-safe fuel cutoff valve as defined in claim 12 characterized in that a portion of said housing enclosing said resilient balloon is detachable to provide access to said balloon for servicing the same.

14. A fail-safe fuel cutoff valve as defined in claim 12 characterized in the provision of valve-controlled means on the downstream side of said main valve and in communication with said balloon means operable to trap said reserve quantity of fuel in said balloon means when said pilot valve closes said atmospheric vent thereby closing said main valve.

15. A fail-safe fuel supply system as defined in claim 1 characterized in that the capacity of said fuel conductor between said cutoff means and said manually controlled means is adequate when burned at said main burner to activate said thermally responsive means to energize said pilot valve to open said cutoff means.

16. A fail-safe fuel supply system as defined in claim 15 characterized in that said thermally responsive means includes thermocouple means.

17. A fail-safe fuel supply system as defined in claim 1 characterized in the provision of auxiliary means for energizing said pilot valve means temporarily independently of said thermally responsive means while the latter is being heated.

18. A fail-safe fuel supply system as defined in claim 1 characterized in that said fuel supply comprises a tank of liquid petroleum fuel.

19. A fail-safe fuel supply system as defined in claim 1 characterized in that said system is fully self contained and independent of public utility fuel and electrical supplies and in which said thermally responsive means comprises thermocouple means and said fuel supply comprises a tank of liquid petroleum.

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