Sept. 20, 1960 C. E. HAJNY 2,953,198

FUEL CONTROL APPARATUS

Filed Aug. 23, 1956 2 Sheets-Sheet 1

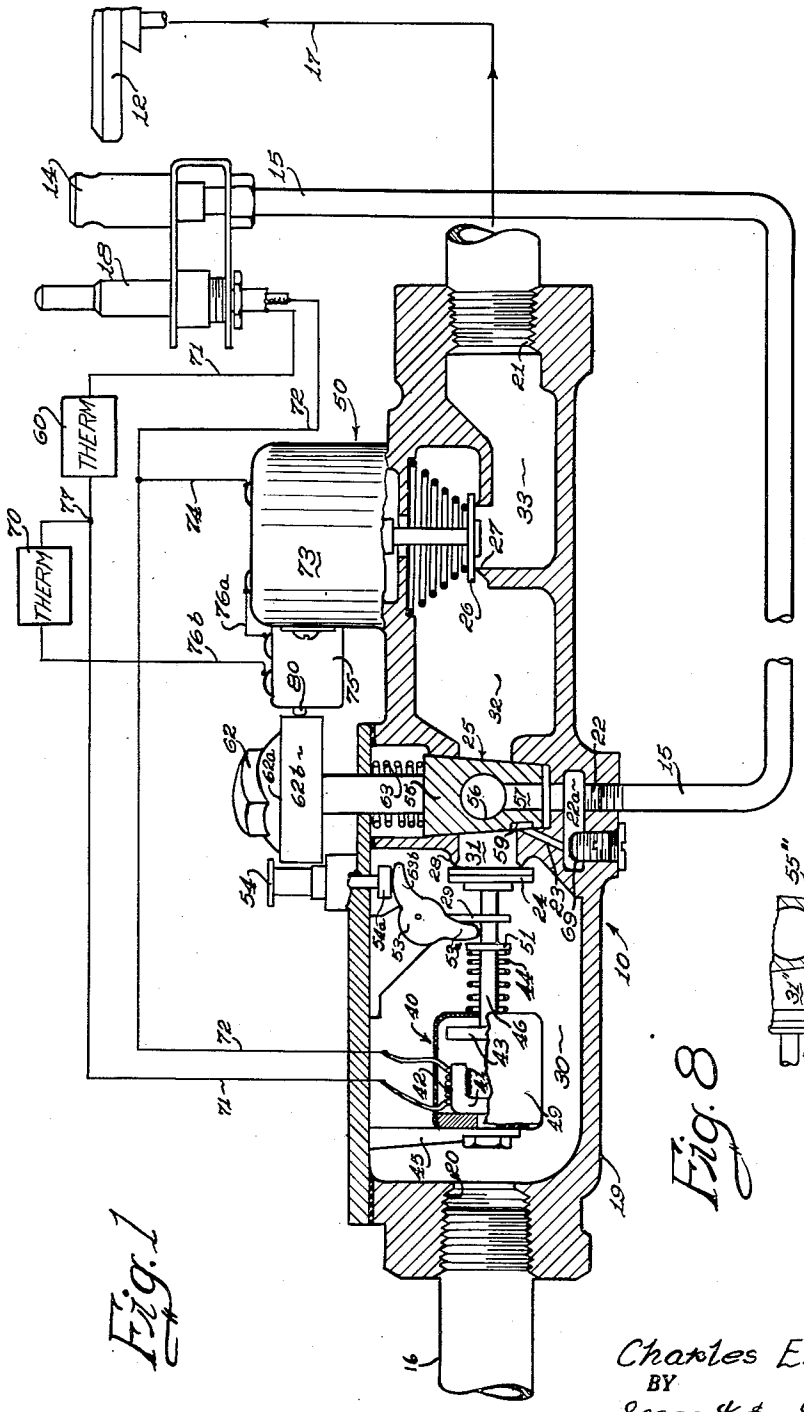

Fig. 1

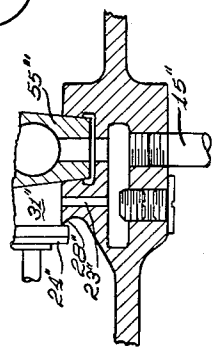

Fig. 8

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FUEL CONTROL APPARATUS

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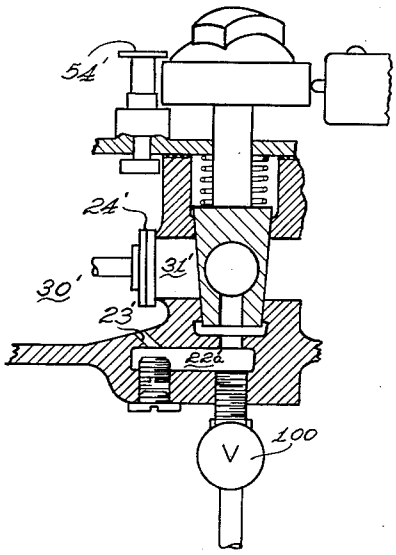

Fig. 2

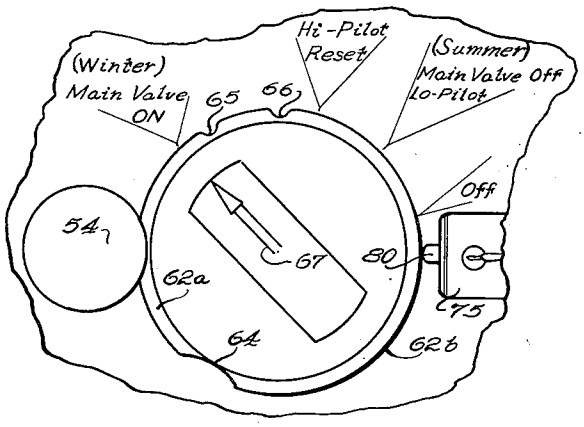

Fig. 3

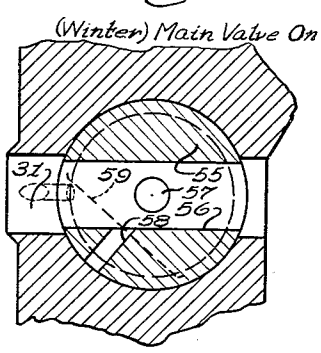

Fig. 4

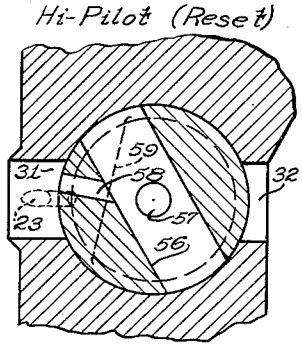

Fig. 5

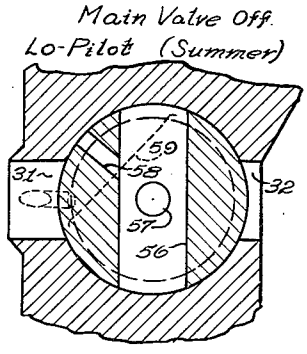

Fig. 6

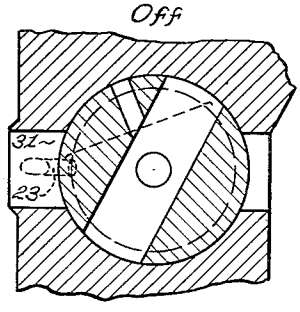

Fig. 7

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FUEL CONTROL APPARATUS

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Filed Aug. 23, 1956, Ser. No. 605,731

10 Claims. (Cl. 158—131)

This invention relates in general to an apparatus for the control of gaseous fuel and more particularly to apparatus for controlling the flow of gaseous fuel to main and pilot burners of fluid fuel burning apparatus in a manner to afford improved efficiency.

In modern control of gaseous fuel flow, many types of so called "self-powered" or "self-generating" systems are available to control the fuel flow to gaseous fuel burners. One type of power source for the self-generating systems is a thermoelectric generator which may be heated by a pilot burner to supply electric energy for controlling various combinations of safety shut-off valves and main burner valves. The problem of keeping pilot gas consumption low has become increasingly difficult due to larger and larger power requirements in self-generating systems requiring larger output generators, which in turn require substantial generation of heat to supply the necessary power. This high heat is particularly objectionable, for example, in the summer time situation in domestic furnaces where only pilot gas is flowing, and the high B.t.u. consumption necessary to heat the large generators for operating the self-generating systems during operating cycles may be much more expensive to maintain than desirable during such a standby situation.

There are a number of applications wherein the B.t.u. consumption (as determined by pilot size) is relatively unimportant during operating cycles, but where it is greatly desirable to reduce the B.t.u. consumption of the pilot burner during long standby periods. As an example, in a furnace for domestic heating applications, the size of the pilot flame may have to be relatively large in winter but as aforestated, preferably should be relatively small in summer for reasons of economy. There are many advantages in the pilot being large in winter, and in many applications a large pilot is a necessity at all times that the main burner is to be ignited because of the strong secondary air currents created by combustion of the main burner which would tend to snuff a small pilot. On the other hand, in most domestic heating systems it is greatly desired that a constant burning pilot should remain ignited all through the summer to prevent rust and corrosion of the parts within the heating chamber, to afford a constant check on the workability of the controls of the furance, and to be instantly ready for use without the necessity of a service call to light the pilot.

Water heaters, commercial and industrial furnaces, etc. also may be advantageously supplied with low consumption standby pilots similar to those aforedescribed for domestic furnaces. A domestic cooking range presents an added problem in that it is normally in standby situation with the main burner off. For example, the percentage of total time of operation of the main burner in a range is generally very low, yet instant ignition is required by the housewife.

In ranges particularly and in the other applications too, heretofore, the limiting factor for the minimum flow rate of fuel supplied to the pilot burner has often been determined by the flow rate that will support ignition of the

main burner without snuffing out of the pilot. This flow rate is often considerably greater than the amount of fuel flow that will support a stable flame at the pilot burner when the main burner is not ignited. It is desirable to maintain the apparatus on a low flow standby pilot with the aforementioned lowest flow rate for reasons of economy. Such a low flow rate pilot system that utilizes a flow rate affording a low consumption flame that is insufficient to ignite the main burner is safe only if an interlock is provided that affords a higher amount of pilot flame for and during ignition of the main burner. A system incorporating the above concepts would afford a greater economy than heretofore possible.

It is a general object of this invention to provide an apparatus affording an increased efficiency by providing a relatively large constant ignition flame at any general operating period and which provides a low B.t.u. consumption flame in standby settings for periods of non-use.

Another object of the invention is to provide an apparatus of the aforementioned general characteristics wherein fuel may flow to a main burner only when an ignition burner is in a high flame position, thus preventing attempted ignition of the main burner by a low consumption flame that is too small to support ignition of said main burner.

A further object of the invention is to provide an apparatus as above characterized having main and pilot burners, main burner flow control means having flow-permitting and flow-preventing positions, flow control means for said pilot burner, the latter flow control means having a flow-preventing position and high and low flow-permitting positions, and interlock means associated with both said flow control means preventing the movement of the main burner flow control means to its flow-permitting position when the pilot burner flow control means is in said low flow-permitting position to thereby provide a safe and economical heating apparatus.

A further object of the invention is to provide an apparatus as above described having generating means responsive to a flame at the pilot burner, safety shut-off means and main burner flow control means both energizable by said generating means, said generating means delivering different levels of electrical energy responsive to the various heat levels of the pilot burner as determined by the position of said pilot burner flow control means, said generating means affording sufficient electrical energy to energize both said safety shut-off means and said main burner flow control means when said pilot burner flow control means is in said high flow-permitting position, said generating means delivering insufficient energy to energize both said safety shut-off and main burner flow control means when said pilot burner flow control means is in said low flow-permitting position, and electrical interlock means preventing energization of the main burner flow control means and permitting continued energization of the safety shut-off means when the generating means affords insufficient energy to energize both the main burner flow control and safety shut-off means, thereby affording safety shut-off control as long as the pilot burner remains ignited.

A further object of this invention is to provide the apparatus as aforementioned with reset means for resetting the safety shut-off means to a flow-permitting position and interlock means for cooperation with the safety shut-off means and the pilot burner flow control means, said interlock means preventing resetting of the safety shut-off means except when the pilot burner flow control means is in its high flow-permitting position to thereby afford sufficient fuel for initial ignition of said pilot burner, and following ignition, permitting movement of the pilot burner flow control means to a low or reduced flow-permitting position providing sufficient fuel to main-

tain a stable flame but insufficient for said initial ignition of the burner.

A further object of this invention is to provide apparatus as above described having a plug valve therein that affords flow interruption means for prevention of fuel flow to the main burner during the reset operation of the safety shut-off means and also simultaneously permits the high ignition fuel flow to the pilot burner.

A further specific object of this invention is to provide an apparatus of the above type wherein the safety shut-off means is operable to prevent all fuel flow to both the main and pilot burners upon pilot outage irrespective of whether the pilot burner flow control means is positioned in its high flow-permitting or its low flow-permitting positions.

Another object of the invention is to provide a device as above characterized having thermoelectrically powered safety shut-off and main burner valves with a high limit switch connected in circuit with both said valves to cause both valves to become deenergized to thereby prevent fuel flow upon the occurrence of an abnormal situation, said arrangement protecting against a hung or leaky safety shut-off valve.

Still another object of the invention is to provide an apparatus which is compact, extremely sturdy for long field life, easy fabricated and assembled, and is otherwise well adapted for the purposes for which it was designed.

The novel features that are characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof will best be understood by the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Figure 1 is a view partially in section of the improved control apparatus embodied in the fuel control system, portions of the apparatus and of the system being shown semi-diagrammatically;

Figure 2 is a fragmentary sectional view of an alternative form of the fuel control apparatus;

Figure 3 is a fragmentary portion of a top plan view of the fuel control device depicted in Figure 1;

Figure 4 is a fragmentary sectional view of the plug valve shown in Figure 1 in the winter position;

Figure 5 is a view similar to Figure 4 showing the plug valve in the high pilot and reset position;

Figure 6 is a view similar to Figures 4 and 5 showing the plug valve in the summer or standby low pilot position;

Figure 7 is a view similar to Figures 4, 5 and 6, showing the plug valve in the 100% off position; and

Figure 8 is a fragmentary sectional view of another alternative form of the fuel control apparatus.

While a specific control system is shown and described in connection with a pilot burner and main burner for burning gaseous fuel in a domestic furnace, it is to be understood that the invention is not limited to this use, but it is adapted for use equally well wherein it is desired and/or required that there be a relatively large constant burning ignition flame during operating cycles and in which a small constant burning flame is desired during standby periods.

Referring now to Figure 1, the new flow control apparatus **10** is adapted to control the flow of fluid fuel to a main burner **12** and a pilot burner **14**. The apparatus **10** is connected between a suitable source of fuel (not shown) and the burners **12** and **14**, there being a fuel supply line **16** leading from the fuel source to an inlet **20** of the device. Separate control of the main and pilot burners is provided by the control device **10** and separate supply pipes are provided to said burners from the device such as a supply line **15** leading from a pilot outlet **22** to the pilot burner **14** and supply line **17** leading from a main burner outlet **21** to the main burner **12**.

The control apparatus shown in Figure 1 is of the "self-powered" type and to that end the pilot burner **14**, when ignited, is adapted to impinge a flame upon a suitable thermoelectric generator **18** which when heated supplies energizing power through suitable circuitry for operating the safety shut-off means **40** and main burner flow control means **50** within the control device **10** in a manner as shall be more fully explained later. The self-powered system includes a suitable high limit theremostat **60** and a cycling thermostat **70** interposed in the circuitry between the generator **18** and the electrical components in the device **10** for purposes appearing hereinafter.

The major components within the device **10** comprise the safety shut-off means **40**, the plug valve means **25** and the main burner flow control means **50**. The control device **10** may be formed with an outer casing **19** surrounding a plurality of chambers **30**, **31**, **32**, **33**, the inlet **20** leading into chamber **30**, the main burner outlet **21** leading from chamber **33**, and the pilot outlet **22** leading from chamber **31** through suitable passageways such as **23** and **57** to be more fully explained. The major components are disposed within the casing **19** and may be serially arranged in the fuel flow, the safety shut-off means **40** being disposed within the chamber **30** to control the fuel flow therethrough as by a valve **24** cooperating with an annular seat **28** disposed on the outlet side of said chamber. Posterior of the safety shut-off valve **24** and within the chamber **31** is the plug valve means **25** to be more fully described and which is adapted to manually control the flow of fuel to both the main and pilot burner outlets **21** and **22**. Downstream of the plug valve means **25** and disposed within chamber **32** is the thermoelectrically powered main burner flow control means **50** comprising a valve **26** which coacts with a seat **27** to control the flow of fluid fuel to chamber **33** and outlet **21** leading to the main burner **12**.

Referring back to the safety shut-off means **40**, the safety shut-off valve **24** may be controlled by a condition responsive operator means disposed within chamber **30** and comprises a generally U-shaped magnet core **41** disposed within and fixedly mounted with respect to a generally tubular casing **49** which in turn is mounted on a suitable depending bracket **45** attached to the interior of casing **19**. An energizing coil **42** may be disposed on core **41** which when energized is adapted to hold armature **43** in attracted relation when the latter is moved thereto. Means for energizing the coil **42** is provided by the thermoelectric generator **18** which is connected thereto by a pair of suitable conductors **71** and **72**.

The safety shut-off valve member **24** is connected to the armature **43** for movement therewith by a suitable armature stem **46**. A suitable depending guide bearing **29** is fixedly fastened to the interior of casing **19** to guide the armature stem **46** which is mounted for movement therein. Intermediate the ends of stem **46** and attached thereto is an upstanding annular lug **51**. Interposed between lug **51** and the end surface of casing **49** is a biasing spring **44** which is disposed surroundingly to stem **46** to bias the armature **43** away from magnet **41** and valve **24** toward seat **28**. It is to be noted that the distance between the armature **43** and magnet **41** is so great when the magnet **41** and armature **43** are in a separated relation, that even when the magnet **41** is energized it has insufficient attractive force to move armature **43** from its retracted position.

Means for resetting armature **43** toward attractive relation with magnet **41** is provided by a bell crank lever **53** and reset button **54**. The bell crank lever **53** may be pivotally mounted on the depending guide **29** and is formed with suitable extending lever arms **53***a* and **53***b*, the former engaging armature stem lug **51** and the latter engaging a reset stem **54***a*. Thus, upon depression of reset button **54** the end of reset stem **54***a* engages lever

arm 53*b* to move the latter in a clockwise direction to in turn cause movement of armature 43 toward engagement with the magnet 41. The reset button 54 and stem 54*a* may be biased upwardly by a suitable spring (not shown), and thus will return to the position shown in Figure 1 upon completion of the resetting operation.

The plug valve means 25 is positioned to control the fuel flow only when the safety shut-off means 40 is cocked and energized and comprises a tapered rotatable plug 55 biased into a suitable complementary bored seat by a spring 63. The axis of the plug 55 and its seat is here shown transverse the axis of the bore forming chamber 31 and a part of chamber 32. The plug 55 may be formed with a relatively large diametric bore 56 transverse its axis for controlling registry with chambers 31 and 32. The lower portion of the plug may be formed with a relatively smaller coaxial bore 57 which communicates transverse bore 56 with a pilot outlet chamber 22*a*. A relatively small radial bore 58 (as best shown in Figures 4 to 7) is also formed transverse the axis of the plug to intersect bore 56 and provide an alternate passageway between chamber 31 and pilot outlet chamber 22*a* when the plug bore 56 is not in registry with chambers 31 and 32. Thus in the plug position shown in Figure 5, pilot gas may flow from chamber 31 to the pilot burner 14 through bores 58, 56, 57 and into supply pipe 15 even though flow of main gas is prevented by plug 55.

A low flow passageway for pilot gas is provided by a chordal slot or cut 59 which may be formed in the lower portion of plug 55 below bore 56 to connect chamber 31 to pilot outlet chamber 22*a* through passage 23 when said slot 59 is positioned to register with said passageway 23 and chamber 31. Metering means 69 may be disposed within pilot outlet chamber 22*a* for coaction with the end of passageway 23 to adjust the amount of fuel flowing through said passageway to control the low B.t.u. consumption position.

Means for manually rotating plug 55 is provided by an axially extending plug stem which projects outwardly of the casing 19 and terminates in a handle 62. The plug handle 62 may be formed with indicating means here shown as an arrow 67 which is adapted to register with suitable indicia means here shown formed on the exterior casing 19. A peripheral shoulder 62*a* may be formed on the plug handle 62 to define a surface for coaction with the reset button 54 the lip of which extends over said shoulder as best shown in Figure 3. A cylindrical peripheral surface 62*b* of the handle may be formed with a series of indentations 64, 65 and 66, indentation 64 permitting downwardly movement of button 54 when said indentation is aligned therewith. It is to be noted that indentations 65 and 66 (to be more fully explained) are smaller than indentation 64 and smaller than the amount of overlap of reset button 54 relative to shoulder 62*a* and hence reset movement of button 54 is prevented in all positions of the plug except when the button 54 and indentation 64 are aligned.

The main burner flow control means 50 controls the fuel flow to the main burner 12 only when the safety shut-off means is cocked and energized and the plug valve 55 is positioned so that bore 56 is in registry with chambers 31 and 32. The means for thermostatically controlling the main burner gas flow may be provided by a suitable thermoelectrically powered operator 73 which is preferably of the type that when energized will move valve member 26 to a flow-permitting position, i.e. valve 26 away from seat 27. One terminal of the operator 73 may be connected directly to conductor 72 by conductor 74. The other terminal may be connected to conductor 76*a*, through a switch 75, conductor 76*b*, a suitable cycling thermostat 70 and to the conductor 71 at 77. It is to be noted that the high limit thermostat 60 is connected ahead of connection 77 so as to cause deenergization of both the safety shut-off valve 24 and main burner valve 26 upon occurrence of an abnormal situation.

The switch 75 in the circuit to the main burner operator 73 is here shown attached to the outer housing thereof for coaction with the plug handle 62. The circuit is made and interrupted by a pin 80 which is biased outwardly for coaction with peripheral surface 62*b*. The switch is preferably of the type that is normally closed and moves to a circuit breaking position upon registry with indentations 65 and 66 formed in the plug handle. Stated another way, except when the pin 80 is in registry with indentations 65 and 66, the circuit through switch 75 is closed. Thus it is seen that the circuit through switch 75 is closed when the plug is in the position shown in Figure 4 and open when the plug is in the positions shown in Figures 6 and 7.

The operation of the improved device is as follows:

Starting with the following initial conditions: the safety shut-off valve 24 positioned against seat 28 preventing all fuel flow to both the main and pilot burners, and the thermoelectric generator 18 cold. To start the device in operation, handle 62 is rotated to the reset position as shown in Figure 5, i.e. so that the arrow 67 points to reset. Reset button 54 is now in registry with indentation 64 permitting a downward reciprocatory reset movement of the button, which affords a clockwise movement of bell crank lever 53. Lever arm 53*a* is thereby moved into engagement with lug 51 causing armature 43 to be moved into engagement with magnet 41. Pilot gas is now permitted to flow through intersecting passageway 58, cross bore 56 and downward bore 57, pilot outlet chamber 22 and to supply pipe 15 for the pilot burner 14. Pilot burner gas is also permitted to flow through the low flow chordal slot 59, passageway 23 to pilot outlet chamber 22*a*. This position of the plug thus affords a relatively high flow of fuel for the pilot burner for ignition thereof, however, it is to be noted that no gas may flow to the main burner by virtue of the position of cross bore 56 which is out of registry with passageway 32. It is also to be noted that the peripheral plug handle indentation 66 is now in registry with pin 80 thereby opening switch 75 causing deenergization of operator 73 to thereby afford an alternative method of interrupting the flow to the main burner during reset operation.

Upon ignition of the pilot burner 12, thermoelectric generator 18 becomes heated and supplies sufficient thermoelectric energy to the energizing coil 42 to hold armature 43 in attracted relation to the pole faces of magnet 41 and valve 24 away from seat 28. Reset button 54 may now return to the position shown in Figure 1.

In normal wintertime operation of domestic furnaces when a high pilot flame is both necessary and desired, the plug valve handle 62 may be rotated to position shown as winter (as best shown in Figure 4). This position affords a high fuel flow to the pilot burner 14 since both the high and low passageways are open, i.e. the chordal slot 59 is in registry with chamber 31 and passageway 23, and bore 57 receives fuel through bore 56. With the plug in the winter position, the main burner is under the control of the thermostat controlled thermoelectrically powered operator 73, the switch 75 being closed since pin 80 is held in its circuit closed position by surface 62*b* of the plug handle. Thus the main burner may now be cycled in response to the condition required by cycling thermostat 70.

In summertime or at other times when it is wished to maintain a constant burning pilot at a lower consumption rate, the plug handle 62 is rotated to summer position, i.e. arrow 67 pointed toward summer position. (Plug will be as shown in Figure 6.) With the plug 55 in this position, the chordal slot 59 registers with chamber 31 and passageway 23 to provide a relatively low flow of fuel to the pilot burner 14, the exact amount of said flow being adjusted by the metering means 69. It is to be noted that the summer position of the plug positions cross bore 56 completely out of registry with chambers 31 and 32 thereby preventing all fuel flow to the main burner,

Further, no pilot fuel may flow through bore **57** since neither bore **58** nor **56** registers with chamber **31** and hence the flow to the pilot is determined solely by the metering means **69** controlling the outlet of passage **23**. It is also to be noted that the circuit to operator **73** is open since switch **75** is open due to the registry of pin **80** with indentation **65** in the plug handle.

When the plug handle arrow **67** is aligned with the word "off," a fourth position of the plug (as shown in Figure 7) is provided which shuts off all fuel flow to both the main and pilot burners. Thus both "A" and "B" valve action is provided by the plug allowing a complete shut down of the fuel flow at this point in the system.

The apparatus provides increased economy by virtue of the fact that the pilot burner is operated in a manner to burn a minimum amount of fuel. This reduced consumption is at a level considerably below that of conventional pilot burners and, in fact, is that minimum amount which will maintain a flame as distinguished from the higher rate of flow required for initial ignition of the pilot burner, said higher rate being the minimum rate heretofore utilized. It will be observed that in the improved apparatus, the coaction between the reset button **54** and the shoulder **62***a* of the plug handle affords an interlock which insures that during resetting of the safety shut-off means the higher rate of fuel flow is supplied to the pilot burner for ignition thereof. Once ignited, however, the fuel flow to the pilot burner may be reduced to the aforementioned minimum rate by rotation of the plug valve to the "summer" position. It is to be noted that no gas may flow to the pilot burner at any time unless the safety shut-off means is cocked and energized since the pilot supply is under the control of the safety shut-off means **40**, the latter being responsive to pilot outage. Thus the system shows a very low B.t.u. consumption pilot burner which may safely have a fuel flow in amount below that value which will support ignition, said flame also being a self-regulated flame by virtue of the safety shut-off means **40**.

The electrical interlock afforded by the opening of switch **75** in the main burner operator circuit when the plug **55** is positioned in the low pilot (summer position) makes possible a pilot burner flame that is of very low consumption during standby situations while maintaining the pilot under safety shut-off control. For example, when the plug valve is in either the "winter" position or the "high pilot reset" position, the pilot burner is producing a relatively large flame with consequent high heating value for impingement upon the generator **18** due to the relatively large amount of fuel supplied to the burner **14**. The amount of heat produced by this relatively high pilot flame creates sufficient thermoelectric energy to satisfactorily fulfill the power requirements needed to operate both the safety shut-off operator and the main burner valve operator simultaneously. However, the low pilot position (summer) of the plug restricts the fuel flow to the pilot burner for low consumption purposes and consequently the pilot may produce insufficient flame heat for impingement upon the generator to supply the power requirements necessary to operate both of the thermoelectrically powered valves simultaneously. In this latter type situation of a low heat producing flame at the pilot burner, in the absence of the interlock afforded by switch **75**, the closing of the contacts of room thermostat **70** would cause the circuit through the main burner valve **73** to be energized. This would result in deenergization of the safety shut-off control since there would be insufficient power available from the generator to operate both valves. Thus it is seen that switch **75** prevents a false shut off of the safety shut-off valve due to an inadvertent thermostat setting when the plug is positioned to cause a low consumption pilot flame. A further feature afforded by the electrical interlock switch **75** in the summer low pilot position of the plug is that it provides a secondary prevention of fuel flow to main burner by assuring that valve **26** will remain against seat **27**. It is important that no fuel flow to the main burner when the pilot is burning at a low consumption rate inasmuch as such a rate may provide a flame of insufficient strength to withstand ignition of the main burner and as such would be snuffed out by the main burner ignition.

Figure 2 illustrates an alternative form of control system wherein it is desired that the low flow pilot burner gas not be under the control of the safety shut-off valve. In this alternative system, pilot passageway **23'** is shown leading directly from chamber **30'** to the pilot outlet chamber **22***a'* thereby providing a low pilot fuel flow independent of the safety shut-off valve. With this alternative embodiment, the flame impinging upon the generator at low pilot flow rate need not produce sufficient energy in the generator to operate the safety shut-off valve. A "B" valve **100** is provided in this system to give manual cut off in a manner well understood in the art.

The alternative form of apparatus shown in Figure 8 illustrates a system that is especially adaptable for use in a range or oven control where 100% shut-off of the fuel is desired upon pilot outage but where the plug valve **55''** doesn't shut off all pilot gas, i.e. the low flow passageway is not controlled by the plug. The low pilot passageway **23''** leads directly from chamber **31''** on the downstream side of the safety shut-off valve seat **28''**. In this system high fuel flow for pilot and main burner ignition is provided by means in the plug similar to the means shown in Figure 1 so that the device is both economical and safe. In all other respects the system may be similar to the system shown in Figure 1, if desired.

Although a specific embodiment of the invention has been shown and described it is with full awareness that many further modifications thereof are possible. The invention therefore is not to be restricted except insofar as is necessitated by the prior art and by appended claims.

What is claimed by the invention is:

1. Control apparatus comprising, a main burner, a pilot burner associated with said main burner for ignition of the latter, said pilot burner affording a flame sufficient to safely ignite said main burner when supplied with fuel at a first flow rate and affording a flame insufficient to safely ignite said main burner when supplied with fuel at a second lower flow rate, manually operable fuel control valve means operatively associated with said pilot burner and having a first open position permitting fuel flow to said pilot burner at said first rate and a second open position permitting fuel flow to said pilot burner at said second rate, resettable safety shut-off means operatively associated with said main and pilot burners to shut off fuel supply thereto upon outage of the pilot burner, means for manually resetting said safety shut-off means to fuel flow permitting position for reestablishment of a fuel supply to said burners, and means preventing resetting of said safety shut-off means except when said valve means is in its said first open position to permit flow to said pilot burner at said first flow rate.

2. In combination, main and pilot burners, first electroresponsive control means for controlling the fuel flow to both of said burners, second electroresponsive fuel control means for controlling the fuel flow to said main burner, a source of electrical energy connected in circuit with both said control means and having at least two output levels, a pilot burner operatively associated with said source of energy and having at least two heat output levels for respectively producing said two output levels in said source of energy, the electrical energy from said source at one level being sufficient to activate both of said control means, and the electrical energy from said source at the other level being sufficient to activate only said first control means, means for cycling said second control means when the output of said source is at said one level, means for varying said heat output

level of said pilot burner, said means having a first position affording said burner sufficient heat to safely ignite said main burner and also to produce said one output level in said source, said means having a second position affording said burner insufficient heat to safely ignite said main burner but sufficient to produce said other output level in said source, and switch means mechanically interlocked with said output varying means and having contacts in the energizing circuit for said second control means for interrupting the latter when said output varying means is in its said second position.

3. In combination, fluid fuel burning apparatus having a main burner and a pilot burner operatively associated therewith, a manually operable pilot fuel control valve having a closed position shutting off all pilot fuel flow, having a low pilot position permitting fuel flow to said pilot burner at a rate to produce a flame thereat incapable of safely igniting said main burner, and having a high pilot position permitting fuel flow to said pilot burner at a rate to produce a flame thereat capable of safely igniting said main burner, an electroresponsive main burner fuel valve having an energizing circuit, and switch means mechanically interlocked with said manual valve and having contacts in said energizing circuit for interrupting the latter when said manual valve is in said low pilot position.

4. In combination, main and pilot burners, manually resettable safety shut-off fuel flow control means for at least one of said burners, second fuel flow control means operatively related to said pilot burner and having low and high fuel flow permitting positions with respect thereto operable at said low position to supply sufficient fuel to said pilot burner to support a stable flame thereat but insufficient for initial and sustained ignition thereof, and operable at said high position to supply sufficient fuel to said pilot burner for initial and sustained ignition thereof, and means permitting manual resetting of said resettable safety shut-off control means to fuel flow permitting position only when said second fuel flow control means is in its said high fuel flow permitting position.

5. In combination, main and pilot burners, manually resettable safety shut-off flow control means having flow preventing and flow permitting positions with respect to said main and pilot burners, fuel flow controlling means operatively related to said pilot burner having low and high fuel flow permitting positions with respect thereto operable at said low position to supply sufficient fuel to said pilot burner to support a stable flame thereat but insufficient for initial and sustained ignition thereof, and operable at said high position to supply sufficient fuel to said pilot burner for initial and sustained ignition thereof, and means preventing manual resetting of said resettable safety shut-off control means from flow preventing to flow permitting positions when said fuel flow controlling means is in its said low fuel flow permitting position.

6. In combination, main and pilot burners, resettable safety shut-off control means controlling fuel flow to said pilot burner, fuel flow controlling means operatively related to said pilot burner having a first position operable to supply sufficient fuel to said pilot burner for initial and sustained ignition thereof and a second fuel flow permitting position operable to supply a lesser amount of fuel that is sufficient to support a stable flame at said pilot burner but in amount insufficient for initial and sustained ignition thereof, and manual reset means operable to reset said resettable safety shut-off control means to fuel flow permitting position only when said fuel flow controlling means is in its first position.

7. Control apparatus comprising manually resettable electroresponsive safety shut-off first control means, cycling electroresponsive second control means having a pull-in energization requirement substantially greater than the hold-in energization requirement of said resettable control means, a heat responsive source of energy connected to said first and second control means and having first and second output levels, a fuel burner operatively associated with said source of energy and having at least two heat output levels for respectively producing said two energy output levels in said source of energy, energy from said source at said first output level being of sufficient magnitude to supply said first and second control means with said hold-in and pull-in energization requirements respectively, and energy from said source at said second level being of sufficient magnitude to supply only the hold-in energization requirement of said first control means, and manually operable means controlling all fuel flow to said burner and operable selectively to prevent fuel flow thereto or to vary said fuel flow and thereby vary the heat output level of said burner, said manually operable means being movable to a position causing said burner to produce one level of heat in response to which said first and second control means are respectively supplied with said hold-in and pull-in energization requirements by the output of said source, said manually operable means also being movable to another position causing said burner to produce a second level of heat in response to which only the hold-in energization requirement of said first control means is supplied by the output of said source.

8. Control apparatus comprising manually resettable electroresponsive safety shut-off first control means, cycling electroresponsive second control means having a pull-in energization requirement substantially greater than the hold-in energization requirement of said resettable control means, a heat responsive source of energy connected to said first and second control means and having first and second output levels, a fuel burner operatively associated with said source of energy and having at least two heat output levels for respectively producing said two energy output levels in said source of energy, energy from said source at said first output level being of sufficient magnitude to supply said first and second control means with said hold-in and pull-in energization requirements respectively, and energy from said source at said second level being of sufficient magnitude to supply only the hold-in energization requirement of said first control means, and manually operable means controlling all fuel flow to said burner and operable selectively to prevent fuel flow thereto or to vary said fuel flow and thereby vary the heat output level of said burner, said manually operable means being movable to a position causing said burner to produce one level of heat in response to which said first and second control means are respectively supplied with said hold-in and pull-in energization requirements by the output of said source, said manually operable means also being movable to another position causing said burner to produce a second level of heat in response to which only the hold-in energization requirement of said first control means is supplied by the output of said source, and means mechanically interlocked with said manually operable means for interrupting the circuit between said cycling control means and said source when said manually operable means is in its said other position.

9. Control apparatus comprising, a main burner, a pilot burner associated with said main burner for ignition of the latter, said pilot burner affording a flame sufficient to safely ignite said main burner when supplied with fuel at a first flow rate and affording a flame insufficient to safely ignite main burner when supplied with fuel at a second lower flow rate, manually operable control valve means having an inlet and having a pair of outlets connected to said main and pilot burner respectively, said valve means having a pair of fuel passages communicating between said inlet and the outlet connected to said pilot burner, said valve means having a single valve member controlling all fuel flow from

said inlet to said outlets selectively movable to a closed position shutting off all fuel flow to said burners, and to first, second and third open positions, said first position permitting fuel flow from said inlet to said pilot burner only and through both of said fuel passages to afford pilot fuel flow at said first rate, said second position permitting fuel flow from said inlet to said pilot burner only and through only one of said fuel passages to afford pilot fuel flow at said second rate, and said third position permitting fuel flow from said inlet to said main burner and through both of said fuel passages to afford fuel flow at said first rate to said pilot burner.

10. Control apparatus comprising, a main burner, a pilot burner associated with said main burner for ignition of the latter, said pilot burner affording a flame sufficient to safetly ignite said main burner when supplied with fuel at a first flow rate and affording a flame insufficient to safely ignite said main burner when supplied with fuel at a second lower flow rate, manually operable fuel control valve means having an inlet and having a pair of outlets connected to said main and pilot burners respectively, said valve means having a single valve member controlling all fuel flow from said inlet to said outlets selectively movable to a closed position shutting off all fuel flow to said burners, and to first, second and third open positions, said first position permitting fuel flow from said inlet to said pilot burner only and at said first rate, said second position permitting fuel flow from said inlet to said pilot burner only and at said second rate, and said third position permitting fuel flow from said inlet to said main burner and at said first rate to said pilot burner, resettable safety shut-off means operatively associated with said main and pilot burners to shut off fuel supply thereto upon outage of said pilot burner, means for manually resetting said safety shut-off means to fuel flow permitting position for a reestablishment of a fuel supply to said burners, and means preventing resetting of said safety shut-off means except when said valve means is in said first position so that reestablishment of fuel flow to said pilot burner can be effected only at said first flow rate.

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