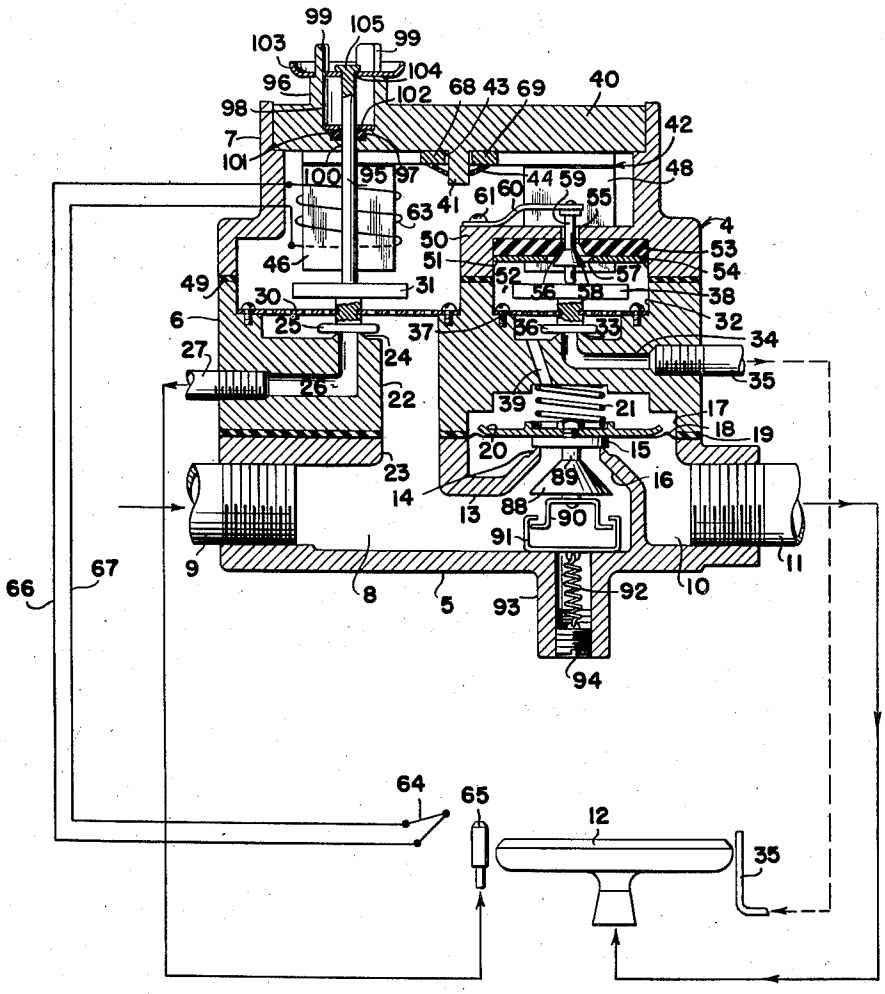
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FUEL FLOW CONTROL DEVICE

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FIG. 1.



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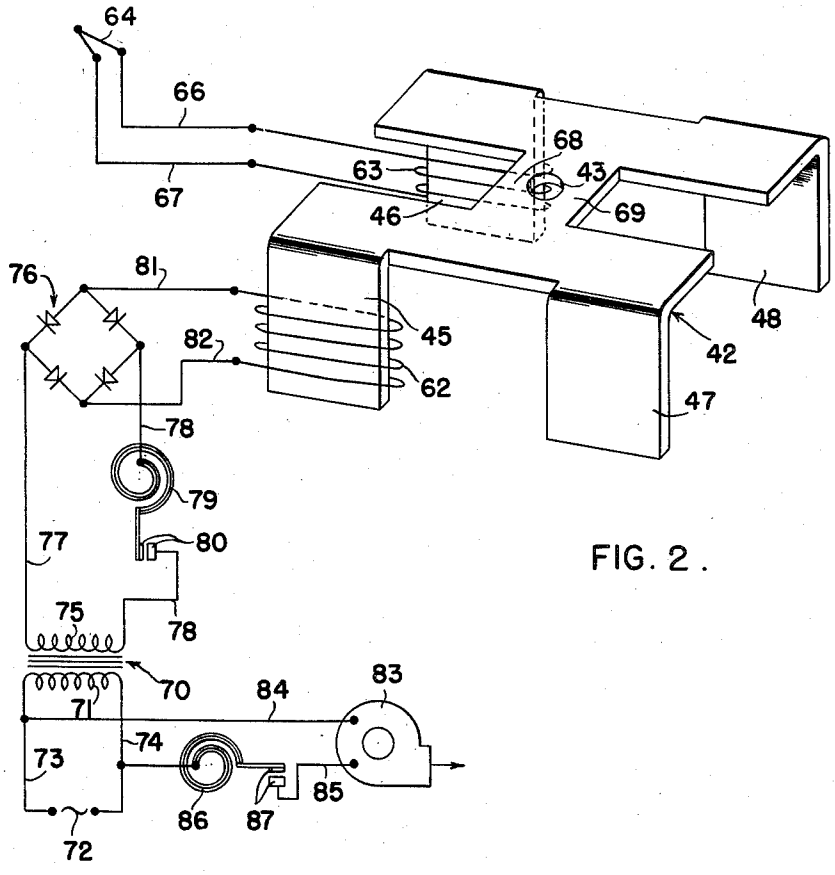
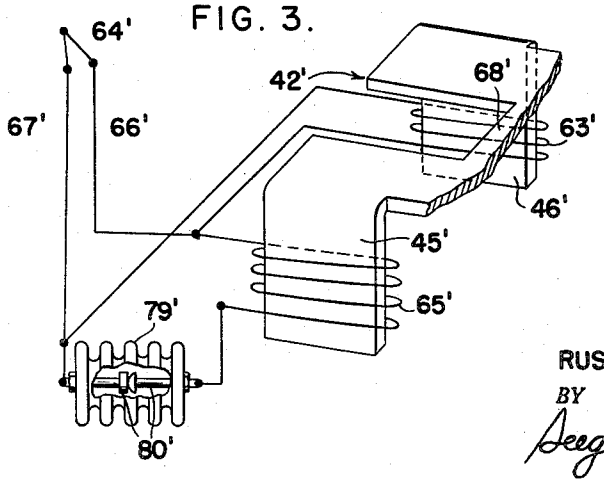


FIG. 2.

FIG. 3.



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FUEL FLOW CONTROL DEVICE

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Application April 23, 1956, Serial No. 580,112

15 Claims. (Cl. 158—129)

This invention relates to improvements in electromagnetic fuel control devices and is an improvement on the safety shut-off and automatic control device for gaseous fuel burners disclosed in my copending application, Serial No. 427,701, now Patent No. 2,742,915, dated April 24, 1956, and assigned to the assignee of the present invention.

In the control of fuel flow to fluid fuel burning apparatus having main and pilot burners, it is desirable to provide a valve which permits fuel flow to the pilot burner as long as a flame is present thereat and also a valve which may be cycled between open and closed positions to permit or prevent fuel flow to the main burner in accordance with the demands of a thermostat as long as a flame is present at the pilot burner, both of said valves being closed in response to pilot burner outage to afford 100 percent shut off of the fuel.

It is a general object of the present invention to provide an improved fuel control device having main and pilot fuel valves and having an electromagnetic operator for said valves including a pair of energizing windings and a pair of armatures, there being means responsive to the presence of a flame at the pilot burner for energizing one of said windings to effect holding of one of said armatures in attracted position when moved thereto and thereby disposition of the pilot fuel valve in open position, energization of the other of said windings when said first armature is in attracted position being effective to actuate the other of said armatures to attracted position and thereby the main fuel valve to open position.

Another object of the invention is to provide an improved fuel control device of the aforementioned character wherein energization of the second winding alone is insufficient to attract or hold either of the armatures in attracted position so that on outage of the pilot burner, both of the armatures drop out to afford 100 percent shut off of the fuel.

Another object of the invention is to provide an improved fuel control device of the class described the operator of which includes an electromagnet frame having a separate pair of pole pieces cooperable with each of the armatures, energization of the first winding affording flux flow through said first armature and the pole pieces cooperable therewith to provide attractive force sufficient to hold the first armature in attracted position when moved thereto against a bias, energization of the second winding while the first armature is in attracted position affording with the flux from the first winding a flux density more than sufficient to saturate a portion of said frame, wherefore flux is shunted from said saturated portion through the other pair of pole pieces to link the second armature and actuate the latter to attracted position against a bias.

A further object of the invention is to provide an improved control device of the class described wherein both of the energizing windings are connected for energization by a thermoelectric generator subject to the heat of burning fuel at the pilot burner, energization of the second winding and thereby cycling of the main fuel valve being under the control of a thermostat.

Still another object of the invention is to provide an improved fuel control device of the aforementioned character wherein the first energizing winding is connected for energization by a thermoelectric generator subject to the heat of burning fuel at the pilot burner, and the second energizing winding is energized by current from a line power source, for example through a step down transformer, a full wave rectifier, and a thermostat, said operator affording an interlock between the thermoelectric and line powered circuits preventing opening of the main fuel valve in the event of either pilot burner outage or line power failure.

Still another object of the invention is to provide an improved fuel control device of the class described wherein the main fuel valve is of the fluid pressure operated type having bleed ports controlled by the second armature, and wherein there is pressure regulating means operatively connected to said main fuel valve for movement therewith and operable to maintain the pressure of the fuel delivered to the main burner within predetermined limits in spite of substantial fluctuations in the pressure of the fuel supplied to the improved control.

Other objects and advantages of the invention will become apparent as the description proceeds, reference being had to the accompanying drawings illustrating two forms of the invention and wherein like characters of reference indicate the same parts in all of the views. In the drawings:

Figure 1 is a vertical sectional view taken through the improved control device with the fuel and certain of the electrical connections thereto shown diagrammatically;

Figure 2 is a diagrammatic view showing the electrical circuit of the improved control device; and

Figure 3 is a fragmentary diagrammatic view of another form of electrical circuit for the improved control device.

Referring more particularly to Figure 1 of the drawing, the illustrated form of the improved control device comprises a control body 4 which may be made up of superimposed body parts 5, 6 and 7, the body part 5 being formed with an inlet chamber 8 for receiving a fuel supply conduit 9 and also being formed with a fuel outlet chamber 10 from which fuel may be delivered, for example through a conduit 11, to a main burner 12. The body part 5 is formed with a partition 13 separating the inlet chamber 8 from the outlet chamber 10 and formed with a main valve port surrounded by an annular valve seat 14 for cooperation with a main fuel valve member 15. The partition 13 may also be formed with a conical surface 16 for a purpose to be more fully described hereinafter.

The body part 6 is formed with a chamber 17, and a diaphragm 18, which is marginally clamped by the body parts 5 and 6, forms a chamber 17 with the recess 17*a*. A seal between the body parts 5 and 6 and diaphragm 18 is effected by means of a gasket 19. The diaphragm 18 is centrally clamped between the valve member 15 and a back-up plate 20, and the valve member 15 may, if desired, be biased toward the seat 14 by means of a compression spring 21.

The body part 6 is formed with a passageway 22 therethrough which communicates at its lower end with a branch passage 23 formed in the body part 5 and intersecting the inlet chamber 8 as shown. The body part 6 is also formed with an annular valve seat 24 surrounding a pilot fuel outlet passage 26 which may supply fuel, for example through a conduit 27 to a pilot burner 65 disposed in coacting relation with the main burner 12. The pilot fuel valve member 25 cooperates with the seat 24 to control the flow of fuel to the pilot burner 65, and is carried by a spiral biasing spring 30 which biases said valve member toward the seat 24, said spring also

carrying a magnetic member in the form of a magnetically permeable armature 31.

The body part 6 is also formed with a recess 32 formed with an annular valve seat 33 surrounding a bleed port or passage 34 which may communicate with a bleed conduit 35 extending to a position adjacent the main burner 12 as shown. A bleed port valve 36 cooperates with the valve seat 33 and is carried by a spiral spring 37 which biases said valve toward said seat. Also carried by the spiral spring 37 is a magnetic control member in the form of a magnetically permeable armature 38. A passage 39 affords communication between the recess 32 and the chamber 17 as shown.

The body part 7 is provided with the cover member 40 having a centrally disposed depending lug 41. A magnetic member in the form of an electromagnet frame 42, shown most clearly in Figure 2, is generally H-shaped in plan view and has a cross bar portion formed with an aperture 43 separating portions 68 and 69 of reduced cross section. As shown in Figure 1, the depending lug 41 projects through the aperture 43 in the frame 42, and said frame is held in abutting relation with the underside of the cover member 40 by means of a friction clip 44 which engages both the lug 41 and the portions 68 and 69 of the frame 42.

As shown in Figure 2, each of the arms of the electromagnet frame 42 is provided with a depending leg or pole piece, said legs or pole pieces being indicated by the numerals 45, 46, 47 and 48. The body part 7 is sealingly connected to the body part 6, as by gasket 49, and the body part 7 is formed with a partition 50 defining a recess 51 with which the recess 32 forms a chamber 52. The partition 50 is formed with a pair of slots (not shown) through which the depending legs or pole pieces 47 and 48 of the electromagnet frame 42 project into the chamber 52. A sealing gasket 53, for example of rubber, is disposed within the recess 51 and is formed with slots (not shown) to snugly receive the depending legs 47 and 48, and a clamping plate 54 of non-magnetic material is also disposed within a recess 51 and is formed with slots (not shown) to receive the depending legs 47 and 48. The clamping plate 54 is staked in operative position clamping the sealing gasket 53 between said plate and the partition 50 to form a gas tight seal around the legs 47 and 48.

The partition 50 is formed with an opening 55 intermediate the legs 47 and 48, and the gasket 53 is formed with a coaxial tapered opening 56, the clamping plate 54 also being formed with a coaxial opening 57. A frusto-conical valve member 58 is movable into and out of seating engagement with the conical opening 56 and forms with the bleed port valve 36 and armature 38 pilot valve means controlling the pressure to which the diaphragm 18 is subjected and thereby controlling the main fuel valve 15. The valve member 58 is provided with a stem portion 59 extending loosely through the aperture 55 and having a connection with one end of a leaf spring 60, the other end of said spring being anchored to the partition 50 as by a screw 61. The leaf spring 60 biases the valve member 58 downwardly toward flow-permitting position with respect to the opening 56 and also tends to bias the lower end of the stem 59 into engagement with the armature 38 as shown.

The lower ends of the electromagnet frame legs 45 and 46 terminate in coplanar pole faces, and the armature 31 is movable from the retracted position shown in Figure 1 to an attracted position in engagement with the pole faces of said frame legs. Similarly, the lower ends of the legs 47 and 48 terminate in coplanar pole faces, and the armature 38 is movable from the retracted position shown into engagement with said pole faces. As the armature 38 moves toward attracted position, such movement effects seating of the valve member 58 within the opening 56, and simultaneously lifts the bleed port valve 36 off the annular seat 33.

Means is provided tending when energized to establish magnetic flux flow through the legs 45 and 46 at a first density level and also at a predetermined higher density level, said means taking the form of a flux generating winding 62 wound on the frame leg 45, and a flux generating winding 63 wound on the frame leg 46. A thermoelectric generator 64, which may take the form of a thermocouple, is disposed with its hot junction or junctions subject to the heat of burning fuel at the pilot burner 65 and has its terminals connected in circuit with the winding 63 as by conductors 66 and 67.

Means is provided for energizing the winding 62 from a line powered source, said means comprising a step down transformer 70, the primary winding 71 of which may be connected in circuit with an alternating current source 72, as by conductors 73 and 74. One end of the secondary winding 75 of the transformer 70 is connected in circuit with one input terminal of a full wave rectifier 76 by means of a conductor 77, and the other end of said winding is connected in circuit with the other input terminal of the rectifier 76 by a conductor 78. A thermostat 79 is interposed in the conductor 78 and has coating contacts 80. The winding 62 is connected in circuit with the output terminals of the rectifier 76, as by conductors 81 and 82.

The numeral 83 indicates a blower, for example a fresh air circulating blower which is connected in circuit with the source 72, as by conductors 84 and 85 connected respectively in circuit with the conductors 73 and 74. The conductor 85 has a thermostat 86 interposed therein, said thermostat having coacting contacts 87. The thermostat 79 is a room thermostat, whereas the thermostat 86 may be of the type commonly referred to as a fan switch, the latter sensing temperatures within the bonnet of a furnace (not shown) of which the main burner 12 forms a part.

Means may be provided for maintaining the pressure of the fuel supplied to the main burner 12 within predetermined limits in spite of substantial fluctuations of the pressure of the fuel supplied to the inlet chamber 8. In the illustrated form of the invention, the aforementioned pressure regulating means comprising a frusto-conical flow restricting member 88 carried by a stem 89 fixed to and depending from the main burner valve 15 as shown. The lower end of the stem 89 carries a generally U-shaped bracket 90 having outturned ears as shown. A generally U-shaped bracket 91 having inturned ears overlapping the ears of the bracket 90 is biased against the inner wall of the inlet chamber 8 by a spring 92. Spring 92 is disposed within a tubular extension 93 formed on the body part 5 and has its inner end attached to the bracket 91 and its outer end anchored to a set screw 94 threaded into the outer end of the tubular extension 93 as shown.

At the normally open position of the main valve member 15, the flow restricting member 88 exerts no substantial restriction on the flow of fuel past the valve member 15 and the outturned ears of the bracket 90 just engage the inturned ears of the bracket 91. Any abnormal increase in the pressure within the inlet chamber 8 acts against the underside of the diaphragm 18 and tends to open the valve 15 farther. However, as the valve 15 moves farther open, the flow restricting member 88 moves toward the conical surface 16 to restrict the amount of fuel which can flow past the valve 15 and to thereby reduce the pressure within the outlet chamber 10. Such flow restricting movement of the member 88 is against the bias of the spring 92, since the outturned ears of the bracket 90 engaging the inturned ears of the bracket 91 tend to lift the bracket 91 along with the member 88 as the valve member 15 is lifted beyond its normally open position.

Means is provided for manually resetting the armature 31 to attracted position with respect to the pole faces of the pole pieces 45 and 46, said means comprising an

elongated reset stem 95 fixed at its inner end to the armature 31. The cover member 40 is formed with a tubular extension 96 provided with a bore 97 and a counterbore 98 and having its outer end formed with a plurality of spaced axially extending guiding lugs 99. The cover member 40 is also formed with a bore 100 coaxial with the bores 97 and 98 and through which the reset stem 95 axially slidably extends. An O-ring seal 101 is disposed within the bore 97 and is retained therein by a washer 102, said seal being made of resilient material to prevent the escape of fuel around the reset stem 95.

A manually engageable disc 103 is formed with apertures to slidably receive the guiding lugs 99 and may be formed with an upturned periphery, said disc being urged by gravity into engagement with the outer end of the tubular extension 96 as shown. The disc 103 is formed with a central aperture 104 through which the stem 95 also slidably projects, said stem being formed at its outer end with a head 105 of larger diameter than the aperture 104. It will be observed that the armature 31 may be lifted to attracted position with respect to the pole faces of the legs 45 and 46 of the frame 42 against the bias of the spiral spring 30 by manually lifting the disc 103.

The operation of the improved control device will now be described. When the parts of the device are disposed as shown in Figure 1, all fuel flow to the main and pilot burners is shut off, the armatures 31 and 38 being biased to retracted positions by the springs 30 and 37 respectively which also bias the pilot fuel valve 25 and the bleed port valve 36 toward closed position. With the armature 38 in retracted position, the spring 60 biases the valve member 58 toward the open position shown, permitting line pressure of the fuel to pressurize both the chamber 52 and the chamber 17 through the passageways 23, 22, 55 and 39. With the upper side of the diaphragm 18 exposed to line pressure, the main burner valve 15 is biased to the closed position shown.

To place the improved control device into operation, the disc 103 is lifted manually to reset the armature 31 to attracted position with respect to the legs 45 and 46 of frame 42 and to open the pilot valve member 25 to permit fuel flow to the pilot burner 65. The fuel emitted from the pilot burner 65 is then ignited by any suitable means, whereupon the hot junction of the thermoelectric generator 65 is heated by the heat of burning fuel at said pilot burner to energize the winding 63. The flux generated by the energized winding 63 flows through the low reluctance flux path afforded by legs 45 and 46, frame portions 68 and 69, and armature 31 at a first density of a level exerting sufficient attractive force to hold said armature in attracted position so that the disc 103 may be released for return by gravity to the position shown. The armature 31 will remain in attracted position and the pilot fuel valve 25 in open position as long as fuel continues to be burned at the pilot burner 65.

When the room thermostat 79 calls for heat, the contacts thereof close to supply a reduced voltage, for example 24 volts, of rectified current to the winding 62. The flux generated by the energized winding 62 aids that generated by the winding 63, and the combined flux attains a second higher density level which is more than that which can be accommodated by the restricted cross section portions 68 and 69 of the frame 42, whereupon said portions become saturated and the excess flux is diverted from the aforementioned low reluctance path and flows through the frame legs 47 and 48 to link the armature or control member 38 and actuate the latter to attraced position. Attractive movement of the armature 38 closes the valve member 58 and opens the bleed port valve member 36 to vent the chamber 17 to the atmosphere through the passage 39, chamber 52, bleed port 34 and bleed conduit 35. As a result, line fuel pressure acting on the underside of the valve member 15 is sufficient to lift said valve against the bias of the spring 21, where the latter is used, to permit fuel flow to the main burner 12. The fuel emitted from the main burner 12 is ignited by the flame of the pilot burner 65 and the system is thus in complete operation.

Thereafter, the main valve 15 can be cycled between open and closed positions by attractive and retractive movement of the armature 38 under the control of the thermostat 79 as long as the generator 64 continues to be heated by the flame of the pilot burner. Energization of the winding 62 alone, however, does not supply sufficient flux to hold either of the armatures 31 and 38 in attracted position, so that in the event of outage of the pilot burner 65, cooling of the generator 64 and deenergization of the winding 63 effects drop out of the armature 31 and also of the armature 38 if the latter is in attracted position at the time. This, of course, shuts off all fuel flow to both the main and the pilot burners.

The improved control affords a magnetic interlock which prevents opening of the main fuel valve 15 immediately upon failure of the source 72 as well as on outage of the pilot burner 65. The prevention of opening of the main burner valve 15 when the source 72 has failed, prevents overheating which might occur if the main valve were opened thermoelectrically and independently of the line powered circuit. Opening of the main valve, at such a time would generate heat which could not be dissipated by the fresh air circulating blower 83 because of the line power failure.

Figure 3 illustrates a modified form of electrical circuit for the improved control device wherein the winding 62′ as well as the winding 63′ is energized by current from a thermoelectric generator 64′, and the line powered source means of Figure 2 is omitted. The parts indicated by primed reference characters in Figure 3 are similar to those in Figures 1 and 2 indicated by the same reference characters unprimed. In Figure 3 the conductor 66′ is connected to one end of each of the windings 62′ and 63′, the other end of the winding 63′ being connected directly to the conductor 67′ as shown, and the other end of the winding 62′ being connected to the conductor 67′ through a thermostat 79′ having coacting low resistance contacts 80′. The thermostat 79′ may comprise an hermetically sealed expansible and contractible bellows having a temperature responsive expansible and contractible volatile fluid fill therein which does not deleteriously effect the low resistance character of the contacts 80′.

The operation of the improved control device embodying the electrical circuit shown in Figure 3 is similar to its operation with the circuit shown in Figure 2. The energy continuously supplied to the winding 63′ by the generator 64′ when the latter is heated is sufficient to hold an armature 31 in attracted position when moved thereto by the manual reset means and thereby to hold the pilot valve 25 in open position. Energization of the winding 62′ upon circuit-making engagement of the contacts 80′ affords magnetic flux which aids that generated by the winding 63′ to effect saturation of the reduced cross section portions of the frame 42′ and pull in of the armature 38 with resultant opening of the main burner fuel valve 15. Thus, the main burner fuel valve may be cycled under the control of the thermostat 79′ as long as the generator 64′ continues to be heated by the heat of burning fluel at the pilot burner. In the event of pilot burner outage both of the windings 62′ and 63′ are deenergized by cooling of the generator 64′, and both of the armatures are thereupon dropped out to effect 100 percent shut off of the fuel, even though the thermostat 79′ may be calling for heat at the time.

Various other changes and modifications may be made in the improved control device without departing from the spirit of the invention, and all of such changes are contemplated as may come within the scope of the appended claims.

What is claimed as the invention is:

1. A fluid flow control device comprising a control body having an inlet passage and first and second outlet passages, a first flow controlling member having flow-permitting and flow-preventing positions only with respect to fluid flow from said inlet to said first outlet passage, a second flow controlling member having flow-permitting and flow-preventing positions with respect to fluid flow from said inlet to said second outlet passage, fluid pressure operated means for actuating said second flow controlling member, means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, said magnetic members being operatively associated with said first flow controlling member to effect disposition thereof in one controlling position when said members are in attracted relation and in another controlling position when said members are in separated relation, means tending to establish magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias and through the same path at a predetermined higher density level, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, and pilot valve means for controlling said actuating means including a magnetic control member positioned to be linked by said shunted flux and to be actuated thereby from a first to a second controlling position for actuation of said second flow-controlling member to one of its flow controlling positions.

2. A fluid flow control device comprising a control body having an inlet passage, first and second outlet passages, and a vent passage, a first flow controlling member having flow-permitting and flow-preventing positions only with respect to fluid flow from said inlet to said first outlet passage, a second flow controlling member having flow-permitting and flow-preventing positions with respect to fluid flow from said inlet to said second outlet passage, fluid pressure operated means for actuating said second flow controlling member comprising a pressure chamber in said valve body having a movable wall portion operatively connected to said second flow controlling member for movement therewith, means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, said magnetic members being operatively associated with said first flow controlling member to effect disposition thereof in one controlling position when said members are in attracted relation and in another controlling position when said members are in separated relation, means tending to establish magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias and through the same path at a predetermined higher density level, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, and pilot valve means movable to controlling positions affording alternative communication between said pressure chamber and inlet passage and said pressure chamber and vent passage to thereby control said actuating means, said pilot valve means including a magnetic control member positioned to be linked by said shunted flux and to be actuated thereby from a first to a second controlling position for actuation of said second flow-controlling member to one of its flow controlling positions.

3. A fluid flow control device comprising a control body having an inlet passage and first and second outlet passages, a first flow controlling member having flow-permitting and flow-preventing positions with respect to fluid flow from said inlet to said first outlet passage, a second flow controlling member having flow-permitting and flow-preventing positions with respect to fluid flow from said inlet to said second outlet passage, fluid pressure operated means for actuating said second flow controlling member, means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, said magnetic members being operatively associated with said first flow controlling member to effect disposition thereof in one controlling position when said members are in attracted relation and in another controlling position when said members are in separated relation, means tending to establish magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias and through the same path at a predetermined higher density level, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, pilot valve means for controlling said actuating means including a magnetic control member positioned to be linked by said shunted flux and to be actuated thereby from a first to a second controlling position for actuation of said second flow-controlling member to one of its flow controlling positions, and pressure regulating means operatively connected to said second flow controlling member for actuation thereby operable to maintain the pressure of the fluid in said second outlet passage within predetermined limits in spite of substantial fluctuations in the fluid pressure in said inlet passage.

4. An electromagnetic control device, comprising means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, means tending to establish magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias and through the same path at a predetermined higher density level, the flux flow effecting the change from said first to said higher density level being insufficient in magnitude by itself to hold said magnetic members in attracted relation against said bias, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore, on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, and a magnetic control member biased toward a first controlling position in which it can be linked by said shunted flux, said control member being movable against said bias toward a second controlling position in which it is held by said shunted flux when moved thereto.

5. An electromagnetic control device, comprising means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, means tending to establish magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation

against said bias and through the same path at a predetermined higher density level, the flux flow effecting the change from said first to said higher density level being insufficient in magnitude by itself to hold said magnetic members in attracted relation against said bias, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, and a magnetic control member positioned to be linked by said shunted flux and to be actuated thereby from a first to a second controlling position.

6. An electromagnetic control device, comprising means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, first flux generating means for establishing magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias, second flux generating means operable with said first flux generating means to establish flux flow through the same path at a predetermined higher density level, the flux flow afforded by said second flux generating means being insufficient in magnitude by itself to hold said magnetic members in attracted relation against said bias, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, and a magnetic control member biased toward a first controlling position in which it can be linked by said shunted flux, said control member being movable against said bias toward a second controlling position in which it is held by said shunted flux when moved thereto.

7. An electromagnetic control device, comprising means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated realtion, first flux generating means for establishing magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias, second flux generating means operable with said first flux generating means to establish flux flow through the same path at a predetermined higher density level, the flux flow afforded by said second flux generating means being insufficient in magnitude by itself to hold said magnetic members in attracted relation against said bias, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, a magnetic control member biased toward a first controlling position in which it can be linked by said shunted flux, said control member being movable against said bias toward a second controlling position in which it is held by said shunted flux when moved thereto, and a condition responsive circuit controlling device in circuit with said second flux generating means for controlling the operation thereof and thereby of said control member.

8. An electromagnetic control device, comprising means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, first flux generating means for establishing magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias, thermoelectric generator means for energizing said first flux-generating means, second flux generating means operable with said first flux generating means to establish flux flow through the same path at a predetermined higher density level, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, a source of alternating current, a rectifier connected in circuit with said source and said second flux generating means for energizing the latter with rectified current from said source, and a magnetic control member biased toward a first controlling position in which it can be linked by said shunted flux, said control member being movable against said bias toward a second controlling position in which it is held by said shunted flux when moved thereto.

9. An electromagnetic control device, comprising means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, first flux generating means for establishing magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias, thermoelectric generator means for energizing said first flux-generating means, second flux generating means operable with said first flux generating means to establish flux flow through the same path at a predetermined higher density level, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, a source of alternating current, a rectifier connected in circuit with said source and said second flux generating means for energizing the latter with rectified current from said source, a magnetic control member biased toward a first controlling position in which it can be linked by said shunted flux, said control member being movable against said bias toward a second controlling position in which it is held by said shunted flux when moved thereto, and a thermostat in circuit with said rectifier and said second flux generating means for controlling the energization of the latter and thereby the actuation of said control member.

10. An electromagnetic control device for controlling the flow of fuel to fluid fuel burning apparatus having main and ignition burners, comprising a control body having an inlet, an ignition burner fuel outlet and a main burner fuel outlet, ignition fuel control means for controlling only the flow of fuel to said ignition fuel outlet comprising a first control member having flow-permitting and flow-preventing positions, means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, said magnetic members being operatively associated with said first flow controlling member to effect disposition thereof in flow-permitting position when said members are in attracted relation and in flow-preventing position when said members are in separated relation, means tending to establish magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias and through the same path at a predetermined higher density level, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density

level, wherefore on flux flow through said flux path at said higher density level flux is shunted from said flux path adjacent said saturable portion, and main fuel control means for controlling the flow of fuel to said main fuel outlet comprising a magnetic second control member biased toward a flow-preventing position in which it can be linked by said shunted flux and movable against said bias toward a flow-permitting position in which it is held by said shunted flux when moved thereto.

11. An electromagnetic control device for controlling the flow of fuel to fluid fuel burning apparatus having main and ignition burners, comprising a control body having an inlet, an ignition burner fuel outlet and a main burner fuel outlet, an ignition fuel valve controlling only the flow of fuel through said ignition fuel outlet, a main fuel valve controlling the flow of fuel through said main fuel outlet, fluid pressure operated actuating means for said main fuel valve, means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, said magnetic members being operatively associated with said ignition fuel valve to effect disposition thereof in open position when said members are in attracted relation and in closed position when said members are in separated relation, means tending to establish magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias and through the same path at a predetermined higher density level, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, and pilot valve means for controlling said actuating means including a magnetic control member biased toward a first controlling position in which it can be linked by said shunted flux and in which it effects closure of said main fuel valve, said control member being movable against said bias toward a second controlling position in which it is held by said shunted flux when moved thereto and in which it effects opening of said main fuel valve.

12. An electromagnetic control device for controlling the flow of fuel to fluid fuel burning apparatus having main and ignition burners, comprising a control body having an inlet, an ignition burner fuel outlet and a main burner fuel outlet, an ignition fuel valve controlling the flow of fuel through said ignition fuel outlet, a main fuel valve controlling the flow of fuel through said main fuel outlet, fluid pressure operated actuating means for said main fuel valve, means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said members toward separated relation, said magnetic members being operatively associated with said ignition fuel valve to effect disposition thereof in open position when said magnetic members are in attracted relation and in closed position when said members are in separated relation, means tending to establish magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias and through the same path at a predetermined higher density level, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, pilot valve means for controlling said actuating means including a magnetic control member biased toward a first controlling position in which it can be linked by said shunted flux and in which it effects closure of said main fuel valve, said control member being movable against said bias toward a second controlling position in which it is held by said shunted flux when moved thereto and in which it effects opening of said main fuel valve, and pressure regulating means in said control body operatively connected to said main fuel valve for actuation thereby and operable to maintain the pressure of the fuel in said main fuel outlet within predetermined limits in spite of substantial fluctuations in the pressure of the fuel in said inlet.

13. An electromagnetic control device, comprising: Means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, a first control member operatively associated with said magnetic members and movable to a first position in which it is disposed when said members are separated and to a second position in which it is disposed when said members are in attracted relation, first flux generating means operable when energized to establish magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias, a first source of electric energy for energizing said first flux generating means, second flux generating means which when energized is operable with said first flux generating means to establish flux flow through the same path at a predetermined higher density level, said low reluctance flux path means including a portion having a cross-sectional area of a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, and a magnetic second control member biased toward a first controlling position in which it can be linked by said shunted flux, said control member being movable against said bias toward a second controlling position in which it is held by said shunted flux when moved thereto, the flux flow afforded by said second flux generating means being insufficient by itself to hold said magnetic members in attracted relation against said bias, wherefore in the event of failure of said first source said magnetic members separate under their bias to effect movement of both of said control members to their first positions even though said second flux generating means may be energized at the time.

14. An electromagnetic control device for controlling the flow of fuel to fluid fuel burning apparatus having main and ignition burner, comprising: a control body having an inlet, an ignition burner fuel outlet and a main burner fuel outlet, an ignition fuel valve controlling the flow of fuel through said ignition fuel outlet, a main fuel valve controlling the flow of fuel through said main fuel outlet, fluid pressure operated actuating means for said main fuel valve, means including cooperating magnetic members having attracted relation providing a low reluctance flux path, means biasing said magnetic members toward separated relation, said magnetic members being operatively associated with said ignition fuel valve to effect disposition thereof in open position when said magnetic members are in attracted relation and in closed position when said members are in separated relation, first flux generating means operable when energized to establish magnetic flux flow through said flux path at a first density level sufficient to hold said magnetic members in attracted relation against said bias, thermoelectric generator means subject to the heat of burning fuel at said ignition burner for energizing said first flux generating means, second flux generating means which when energized is operable with said first flux generating means to establish flux flow through the same path at a predetermined higher density level, a source of electrical energy for energizing said second flux generating means, said low reluctance flux path means including a portion having a cross-sectional area of

a size permitting flux flow therethrough at said first density level and saturable by flux flow therethrough at less than said predetermined higher density level, wherefore on flux flow through said flux path means at said higher density level flux is shunted from said flux path adjacent said saturable portion, and pilot valve means for controlling said actuating means including a magnetic control member biased toward a first controlling position in which it can be linked by said shunted flux and in which it effects closure of said main fuel valve, said control member being movable against said bias toward a second controlling position in which it is held by said shunted flux when moved thereto and in which it effects opening of said main fuel valve, the flux flow afforded by said second flux generating means when energized being insufficient by itself to hold said magnetic members in attracted relation against their bias, wherefore in the event of pilot burner outage said members separate to effect closure of both the ignition and main fuel valves even though said second flux generating means may be energized at the time.

15. A fuel control device for controlling the flow of fuel to fluid fuel burning apparatus having main and pilot burners comprising main and pilot burner fuel valves, an electromagnetic operator for said valves including first and second flux generating windings and first and second movable magnetic members each biased toward retracted positions and movable to attracted positions, said movable members being operatively associated with said pilot and main fuel valves respectively to effect disposition of

said valves in open position when said members are in attracted position and in closed position when said members are in retracted position, flame sensitive first electric energy source means in circuit with said first flux generating winding for energizing the latter in response to the presence of a flame at said pilot burner, said energization causing said first winding to generate sufficient flux to hold said first magnetic member in attracted position and said pilot valve in open position when moved thereto against said bias, second electric energy source means connected to energize said second flux generating winding, energization of said second winding while said first magnetic member is in attracted position only effecting actuation of said second magnetic member to its attracted position against said bias and thereby said main fuel valve toward its open position, energization of said second winding only being insufficient to hold either of said magnetic members in attracted position against said bias, whereby said control device affords an interlock between said first and second energy source means preventing said main fuel valve from being opened in the absence of a flame at said pilot burner or if said second energy source means has failed.

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