April 28, 1959 S. W. HETHERINGTON 2,884,009

FLUID FLOW CONTROL VALVE WITH MODULATING ORIFICE

Filed May 16, 1955 2 Sheets-Sheet 1

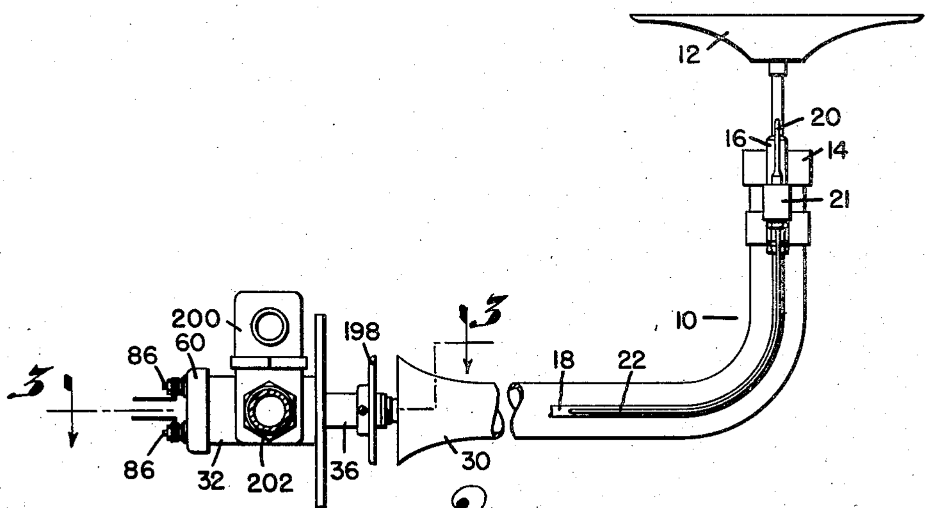

Fig. 1

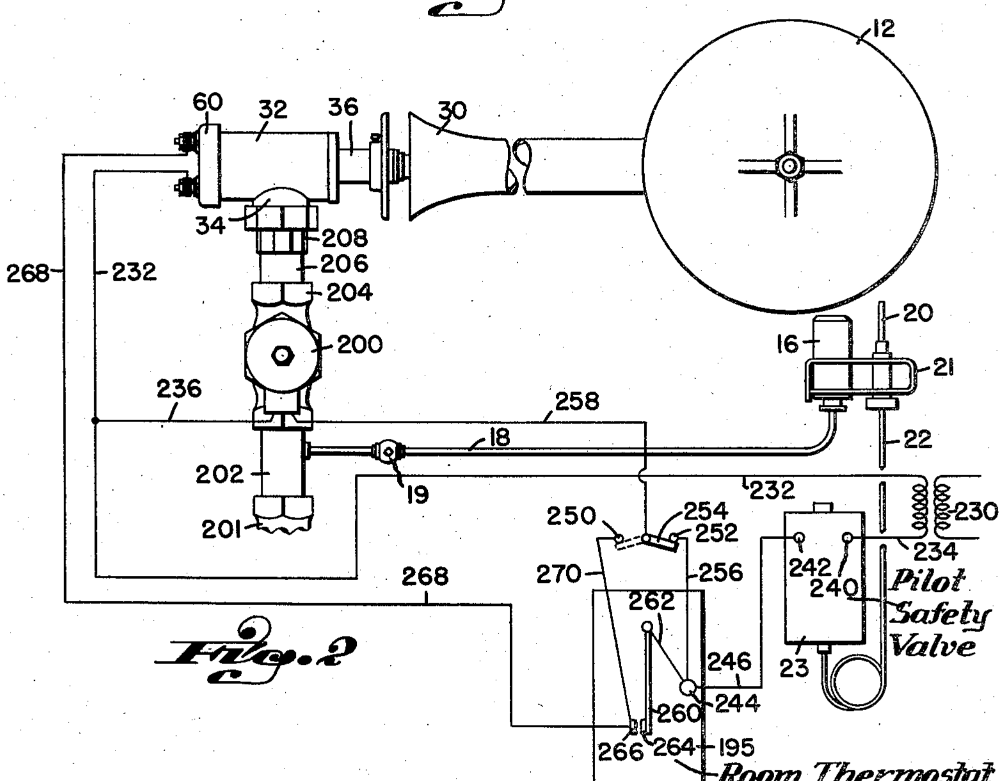

Fig. 2

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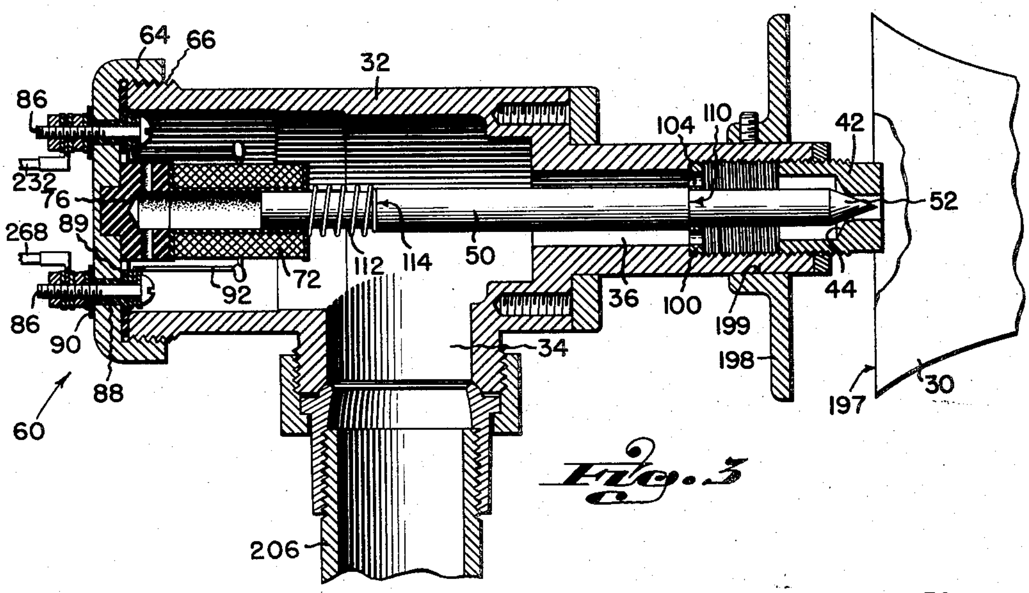

Fig. 3

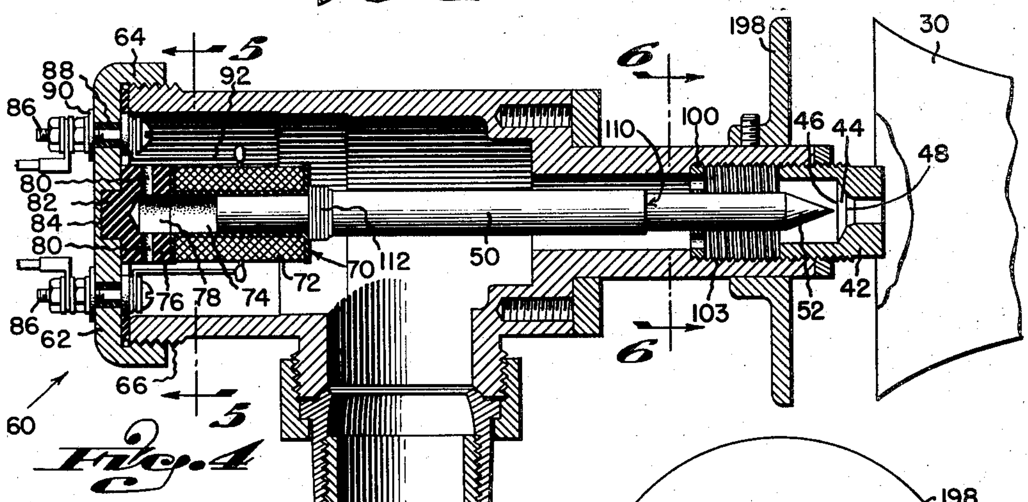

Fig. 4

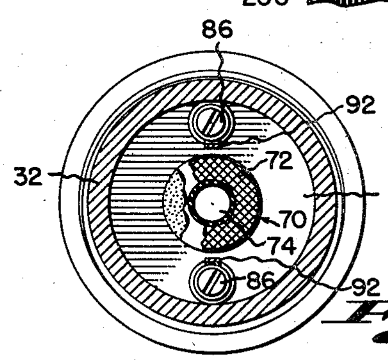

Fig. 5

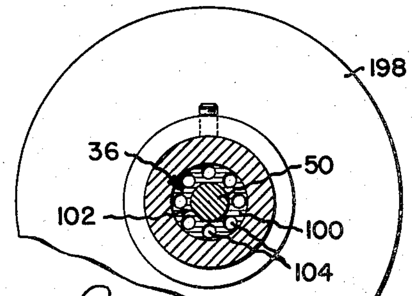

Fig. 6

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2,884,009

Patented Apr. 28, 1959

2,884,009

FLUID FLOW CONTROL VALVE WITH MODULATING ORIFICE

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Application May 16, 1955, Serial No. 508,629

7 Claims. (Cl. 138—46)

This invention relates to valves, and more particularly to a fluid flow control valve having a modulating orifice.

An object of the invention is to provide a fluid flow control valve which may be associated with the venturi of a standard gaseous fuel burner for thereby enabling the standard burner to be selectively operated at either a continuous low fire, or at a high fire.

Another object of the invention is to provide a fluid flow control valve which is so constructed and arranged as to replace, in its entirety, the fuel nozzle usually associated with the venturi of a standard gaseous fuel burner.

Still another object of the invention is to provide a fluid flow control valve having a modulating orifice which is compact, inexpensive, foolproof and easily adjustable to any type of standard gaseous fuel burner, thereby greatly enhancing its utility.

A further object of the invention is to provide a valve having the hereinabove described characteristics and which includes an elongate fuel discharge nozzle, the free outer end of which is provided with an orifice member which is adjustably mounted in the nozzle for enabling an operator to quickly and easily establish the low fire characteristics of the burner with which my valve is associated.

Still another object of the invention is to provide a valve having a modulating orifice secured to and carried by the fuel nozzle, said valve including a metering element in the form of an axially shiftable armature in axial alignment with the orifice member and mounted for axial movement relative thereto, whereby to be disposed in one or the other of two normal positions, viz., in a fully advanced position for establishing a minimum effective fuel opening or passageway through the orifice member, or at a position fully retracted therefrom for establishing a maximum effective opening through the orifice member.

Another object of the invention is to provide a valve with a modulating orifice having the hereinabove described characteristics wherein positive mechanical means, such as a spring, are utilized for normally and yieldably urging the metering element to its fully advanced position with respect to the orifice member, and wherein electrical means, in the form of a solenoid housed entirely within the valve housing, are utilized for effecting retraction of the fuel metering element, whereby a power failure will result in the automatic shifting of the metering element toward the orifice member for admitting a minimum amount of fuel to the burner.

A further object of the invention is to provide a valve having the hereinabove characteristics, and in which a spool type solenoid is secured to and carried by a closure cap, said solenoid providing a guide support for one end of the axially shiftable fuel metering armature.

A further object of the invention is to teach a method of converting any standard burner from intermittent on-off operation to continuous operation on either a low or high fire.

Still a further object of the invention is to provide a

valve having a modulating orifice which may be associated with the venturi of a standard gaseous fuel burner whereby to selectively convert the operating characteristics of the burner from the customary on-off cycle to continuous operation at either a high or a low fire. In those instances wherein the weather conditions are such as to render continuous low fire operation of the burner undesirable, by valve may, without structural change, be utilized in the intermittent, that is, on-and-off operation of the burner.

These and other objects are attained by the means described herein and as disclosed in the accompanying drawings, in which:

Fig. 1 is a side elevational view of a typical or standard gaseous fuel burner with a valve having a modulating orifice embodying the teachings of the present invention, operatively associated with the venturi of the burner.

Fig. 2 is a top view of the assembly of Fig. 1 showing, diagrammatically, the various controls and control systems therefor.

Fig. 3 is a sectional view taken on line 3—3 of Fig. 1, with the fuel metering armature in a fully advanced position for producing a minimum effective fuel opening through the orifice member.

Fig. 4 is a view similar to Fig. 3 but wherein the fuel metering armature has been fully retracted for providing a maximum effective fuel opening through the orifice member.

Fig. 5 is a sectional view taken on line 5—5 of Fig. 4.

Fig. 6 is a sectional view taken on line 6—6 of Fig. 4.

With particular reference now to Fig. 1, the numeral **10** denotes generally a so-called standard gaseous fuel burner which includes a target **12** against which the flame from burner head **14** is directed. A pilot burner **16** is provided closely adjacent burner head **14**, said pilot burner being connected by means of piping **18** to a suitable source **202** of gaseous fuel between the magnetic safety cut-off valve **200** and the manual shut-off valve **201**. A manually operable valve **19** is provided for controlling the pilot flame.

As is common practice, a thermocouple **20** is disposed adjacent burner head **14** and pilot burner **16** by means of mounting bracket **21**, said thermocouple being suitably connected through conduit **22** to a conventional pilot safety valve **23**, the purpose of which is to actuate the magnetic safety cut-off valve **200** to turn off the gas supply to the burner in the event that the pilot should go out.

The numeral **30** denotes a venturi which is standard equipment on many types of burners, it being understood that fuel discharged axially into the enlarged open end of the venturi is mixed with air for providing a combustible mixture which is discharged through burner head **14**.

It should be understood that my invention is neither directed to nor concerned with the structural details of the fuel burner, venturi, pilot or the bi-metallic safety element, such items being old in the art, and the representations of these items in the drawings are merely exemplary, not restrictive.

With particular reference now to Figs. 3 and 4, the numeral **32** denotes a valve housing having an inlet port **34** and a combination outlet port and discharge nozzle **36**.

An orifice plate or member **42** is secured to and carried by the discharge or outer end of the nozzle, said member comprising a bushing having, in the preferred embodiment of the invention, a conical port **44** provided therein, said port tapering from a maximum diameter at the inner side **46** of the bushing to a minimum diameter at the outer side **48**, note Fig. 4.

An axially shiftable fuel metering armature **50** is mounted interiorly of the housing and in axial alignment with the orifice member. The forward end of the metering armature is provided with a tapered metering tip 52 which is the complement of the taper 44 through the orifice member.

The numeral 60 denotes a closure cap for that end of the housing remote from outlet port 36, said cap including an end wall 62 and internally threaded side walls 64 which engage threaded portion 66 of the housing.

A spool solenoid 70 including coil 72 and an axial bore 74 is permanently secured to a bushing 76 of insulating material having a blind bore 78 therein and a pair of diametric ports 80 in open communication with the bottom of bore 78. The bushing may include a rearwardly projecting portion 82 dimensioned to be snugly received within axial socket 84 in the inner face of cap 60. The bushing may be fixedly secured to the closure cap by means of a suitable adhesive, or the like, whereby the solenoid, per se, will be mounted interiorly of the housing with its bore in axial alignment with outlet port 36.

The numerals 86 denote a pair of terminal posts which extend through end wall 62 of the cap to which they are sealed by means of a suitable insulator type sleeve 88 which includes flange 89 and washer 90, for providing a gas and fluid tight fit. Bus wires 92 connect the terminal posts in series circuit with coil 72.

The numeral 100 denotes a guide member which is provided with an axial bore 102 and a plurality of apertures 104, said member being threaded to be received within the threaded portion 103 of the outlet port.

The fuel metering aperture is received in spanning relationship with the bores of the solenoid spool and guide member, whereby it will be disposed in precise axial alignment with the valve housing.

An abutment 110 is provided on the armature to abuttingly engage that face of the guide member adjacent the solenoid for determining the fully advanced position of the armature with respect to the orifice member 42. The armature is normally and yieldably maintained in the fully advanced position of Fig. 3 by means of spring 112 located between the free outer end of the solenoid spool and an abutment 114 provided on the armature.

The armature will be shifted to the fully retracted position of Fig. 4 upon energization of the solenoid, thereby permitting a full flow of fuel to pass to and through orifice member 42.

It has been noted that the provision of ports 80 in bushing 76 permits the gas within bores 74 and 78 to be dissipated, incident to movement of the armature to the left, at a rate whereby the action of the solenoid will be cushioned, thereby eliminating any undesirable noise incident to actuation of the device.

In the preferred embodiment of the invention, the discharge nozzle is adapted to receive the internal bore 199 of a substantially circular primary air shutter 198 mounted for axial movement along the nozzle and relative to venturi 30. It will be noted that the relative spacing between shutter 198 and the intake end 197 of the venturi determines the amount of primary air which is mixed with the fuel discharged into the venturi via orifice member 42.

The numeral 200 denotes a commercial magnetic safety cut-off valve which, by law, must be placed between the fuel supply line 202 and the burner. The present invention is neither directed to nor concerned with the structural details of the magnetic safety cut-off valve, said devices being old and well known to the art.

The discharge side 204 of the safety cut-off valve is connected to inlet port 34 of the housing 32, by means of bushing 206 and nipple 208.

In actual practice the orifice member 42 is disposed within and relative to nozzle 36 with the metering element 50 in the fully advanced position of Fig. 3 for thereby establishing the minimum effective fuel opening through the orifice member for providing a continuous low fire of desired intensity at burner head 14.

The pilot light is then ignited, and as soon as the thermocouple 20 has reached a predetermined temperature the pilot safety valve 23 will be actuated for completing an electrical circuit to the magnetic safety cut-off valve 200, which will then be opened for permitting a flow of fuel through valve 200 into housing 32, thence through orifice member 42 into venturi 30. This fuel, when suitably mixed with air, will burn at burner head 14.

Energization of solenoid coil 72 will result in rapid translation of the metering element 50 to the left, to a fully retracted position, for thereby providing a maximum effective fuel opening through the orifice member, note Fig. 4. When the metering element is thus positioned, the flame at port 14 will be at maximum height for providing a high fire. The primary air shutter 198 may then be adjusted whereby the desired ratio of air to fuel is obtained for efficient combustion at the burner.

It should be understood that the operating characteristics and cycle of solenoid 72 may be controlled by a standard and conventional room thermostat denoted generally by the numeral 195, it being further noted that a temperature drop will result in an electric circuit being closed through the thermostat to the solenoid 72 which, when energized, will retract the metering element 50 for thereby establishing a high fire at the burner. After the room temperature has risen whereby to satisfy the thermostat, the circuit to the solenoid will be interrupted, thereby permitting the metering element to be moved to the right, to the position illustrated in Fig. 3 for reducing the burner flame to a predetermined low fire.

It has been found that by continuously maintaining the burner at a predetermined low fire when not being operated at a high fire, the cooling effect which would otherwise occur in the rooms to be heated is greatly reduced, since the low fire will continually and effectively provide a certain amount of heat to the rooms while maintaining the air ducts, furnace jacket and other portions of the heating system in a warm condition. Therefore, the heating effect which occurs when the metering element is retracted for a high fire in the burner will be quite prompt, since it will be unnecessary to first re-heat the various items comprising the heating system and the air in the rooms to be heated, as is the case in those instances wherein the burner operated on a full on or full off cycle.

By means of my system "cold 70" is effectively eliminated. Reference is hereby made to the February 1953 issue of House Beautiful, copyright 1953 by The Hearst Corporation, pages 93–95 and 121–123, for a full and lucid description of "cold 70."

With particular reference now to Fig. 2, it will be noted that the numeral 230 denotes generally a transformer for supplying suitable voltage to conductors 232 and 234. Conductor 232 is connected to one side of solenoid coil 72 and to one side, by means of conductor 236, of the solenoid of the magnetic safety cut-off valve 200. Conductor 234 is connected to one side 240 of the electrical circuit of pilot safety valve 23, the other side 242 of said circuit being connected to terminal 244 of the thermostat 195 via conductor 246.

In the preferred embodiment of the invention I provide a single pole, double throw switch including contacts 250 and 252 and a switch arm 254. Contact 252 is connected in series with terminal 244 through conductor 256, whereas switch arm 254 is connected to the other side of the solenoid of the magnetic safety cut-off valve 200 through conductor 258. Terminal 244 is likewise electrically connected to bi-metallic arm 260 through conductor 262, the bi-metallic conductor being provided with a contact point 264 movable into and out of engagement with fixed contact point 266 electrically connected by conductor 268 to the other side of solenoid 72. The fixed contact point 266 is likewise connected to switch contact 250 through conductor 270.

From the foregoing it will be noted that during those periods of time when switch arm 254 is in series circuit with contact 252, an electrical circuit will be completed through a pilot safety valve 23 to the safety cut-off valve 200, thereby maintaining valve 200 in a full open position so long as the thermocouple 20 is suitably heated.

Contacting of contact points 264 and 266 will complete an electrical circuit to solenoid 72, thereby retracting the metering element 50 for automatically increasing the low fire at the burner head to a high fire.

During those periods of time when it would be uncomfortable to continually operate the burner at a minimum or low fire, switch arm 254 may be shifted to engage contact 250, thereby breaking the electrical contact to the safety cut-off valve 200 except during those periods of time when thermostat contact point 264 engages fixed contact point 266. When the thermostat circuit is thus closed, the safety cut-off valve 200 will be energized for establishing a flow of fuel through pipe 202 into valve 32, and at the same time solenoid 72 will be energized. In this manner I am able to convert the system from continuous operation on either a high or low fire to intermittent operation between on and off conditions, it being understood that pilot 16 will be continuously burned whereby to ignite the fuel discharged through the burner head 14 during the "on" periods.

It should, of course, be understood that my modulating orifice valve may likewise be associated with the fuel supply line for standard or commercially available burners of the type which do not include a venturi in the fuel supply line to the burner. In these instances my modulating orifice valve will serve to control the continuous flow of fuel to the burner at either a predetermined maximum or a predetermined and continuous minimum rate.

In conclusion it will be noted that I have thus provided a simple, inexpensive, yet highly efficient device wherein the solenoid, per se, is located interiorly of the valve housing, the inlet port of which is disposed between the solenoid and outlet port, thereby clearly distinguishing from the structural details of the valves disclosed in the following U.S. patents: Armentraut No. 2,301,355; Walker No. 1,999,221; Borst No. 2,494,737 and Doble No. 1,617,677.

It should be understood that various changes and modifications may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed is:

1. A device for supplying at full supply pressure, a maximum and a minimum rate of flow of a gaseous medium, comprising a housing having inlet and discharge ports, an orifice plate mounted in the discharge port, said orifice plate having a discharge orifice, a flow rate selecting member slidably mounted in said housing and having a tapered end disposed in flow selecting relation to said orifice, the opposite end of said selecting member being magnetic, means for limiting motion of said selecting member towards the orifice for minimum flow rate, means normally urging the selector member to minimum flow rate position, a solenoid in said housing disposed in magnetic relation to the magnetic end of said selecting member, which when energized actuates the flow selector to maximum flow position.

2. A device as in claim 1 in which means are provided for adjusting the orifice plate in a direction axially of the selector whereby the minimum flow rate can be preset to selected values.

3. A fluid flow control valve comprising an elongate housing, a hollow solenoid coil interiorly of the housing at one end thereof and an outlet port at the other end thereof, an apertured guide in said outlet port, an axially shiftable fuel metering solenoid armature in spanning, supported relationship with the interior of the solenoid coil and said guide, an orifice plate in the discharge end of the outlet port, said armature movable in said housing relative to said orifice plate to vary the fluid flow therethrough, said armature including in abutment engageable with the solenoid-adjacent face of said guide for limiting its axial travel toward the orifice plate, spring means normally and yieldably urging the fuel metering armature toward the orifice plate, said housing including a fuel inlet port intermediate its length, and terminals externally of the housing in series circuit with the solenoid coil, said armature shiftable away from said orifice plate incident to energization of said solenoid.

4. A fluid flow control valve comprising an elongate housing, a closure cap secured to and carried by an end of the housing and an outlet port at the other end thereof, a solenoid spool having an axial bore therethrough, means securing said spool to the inner face of the closure cap, an orifice plate in the discharge end of the outlet port, a guide member in said outlet port having an axial bore and a plurality of apertures therethrough, a fuel metering magnetic armature coaxial of said orifice plate and axially movable in said housing relative to said orifice plate to vary the fluid flow therethrough, said armature in spanning, supported relationship with the bores of the solenoid spool and guide member, an abutment on said armature engageable with that side of the guide member adjacent the solenoid spool, spring means normally and yieldably urging the fuel metering armature into abutting relationship with said guide member, a solenoid coil externally of said spool, and electrical terminals externally of the closure cap in series circuit with said coil, said housing having a fuel inlet port between said closure cap and outlet port.

5. A fluid flow control valve comprising an elongate housing, a closure cap secured to and carried by an end of the housing and an outlet port at the other end thereof, a solenoid spool having an axial bore therethrough, an insulated bushing having a blind axial bore therein, means securing said spool to the bushing with the bores in axial alignment, means securing that end of the bushing remote from the spool to the inner face of the closure cap, a guide member in said outlet port having an axial bore and a plurality of apertures therethrough, an orifice plate in the discharge end of the outlet port, an axially shiftable fuel metering magnetic armature in spanning, supported relationship with the bores of the bushing, solenoid spool and guide member, an abutment on said armature engageable with that side of the guide member adjacent the solenoid spool, spring means normally and yieldably urging the fuel metering armature toward the orifice plate and into abutting relationship with said guide member, a solenoid coil on said spool, and individually insulated electrical terminals externally of the closure cap in series circuit with said coil, said housing having a fuel inlet port between said closure cap and outlet port.

6. A fluid flow control valve as described in claim 5 wherein a pair of axially aligned ports are provided through the bushing adjacent and in open communication with the bottom of the blind bore therein.

7. A fluid flow control valve as described in claim 5 wherein the spring means is disposed between the outer end of the solenoid spool and an abutment on the armature.

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