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(54) **Electromagnetic fuel injector.**

(57) An electromagnetic fuel injector having an energizable stator means (10) for controlling the movement of a valve member of a valve assembly (10) to open and close the injector and thereby meter fuel, said valve assembly comprising a valve housing (30, 32) including a valve housing bore (92) terminating with a valve seat (56) which is connected to an exit orifice, a valve assembly (60) including a valve (60) reciprocally located in said valve housing bore, operable to close said exit orifice by sealing said valve seat (56) with a ball valve (60), a swirl chamber (43) for imparting to the fuel flow exhausted from the exit orifice a swirl component that is tangential with respect to the spray axis of the injector, and means (40) for supplying fuel from a pressurized source to said swirl chamber, characterized in that said fuel supply means includes means (70) forming a hollow cylinder (42) of fuel between said source and said swirl chamber, and at least one orifice (52) communicating fuel between said fuel cylinder forming means (70) and said swirl chamber (43).

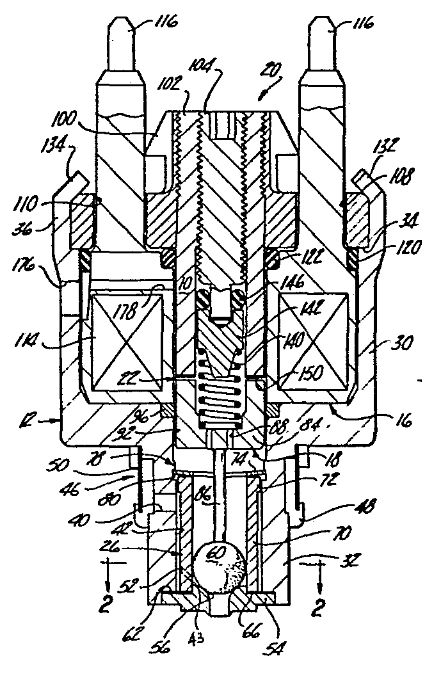

Fig-1

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ELECTROMAGNETIC FUEL INJECTOR

The invention pertains generally to electromagnetic injectors and is more particularly directed to a fast acting, high flow rate injector valve.

This application is related to copending United States Application Serial Number 7 444, filed January 29, 1979. The subject matter of this copending application is incorporated herein by reference.

Electromagnetic fuel injection valves are gaining wide acceptance in the fuel metering art for both multipoint and single point systems where an electronic control apparatus produces a pulse width signal representative of the quantity of fuel to be metered into an internal combustion engine. The injectors operate to open and close pressurized fuel metering orifices leading to the air ingestion paths of the engine by means of a solenoid actuated armature responding to the electronic signal. The quantity of fuel injected can then be precisely tailored to the operating conditions of the engine by controlling the fuel pressure, orifice size, and the duration of the injector on-time. Because of recent advances, electromagnetic injectors are becoming very precise in their metering qualities and very fast in their operation. With these advantages, the electronic fuel injector valve will continue to assist the advances in electronic fuel metering, thereby improving economy, reducing emissions, and aiding the driveability of the vehicle.

Present electromagnetic injectors are usually divided into two sections wherein the first section or stator means generates a magnetic force to control the second section or valve assembly which meters the fuel. The two sections are operably coupled by a magnetically attractable armature physically connected to a valve member. The valve member is normally biased against a valve seat by a closure spring and opens in response to the magnetic force.

Many of these injector valves have a fuel input under pressure to an entry port at the stator end of the injector. The fuel then flows by a generally central path through the body of the injector to the valve assembly. These structures are usually termed "top feed" injectors.

Other injector structures have been made whereby lower pressures of fuel input may be made to the end of the valve assembly. These structures are usually termed "bottom feed" injectors. The lower fuel pressure of the "bottom feed" injector reduces the demand for a more expensive fuel pump and pressurizing system which is necessitated in the "top feed" injector. Further, with a "bottom feed" injector, more flexible mounting procedures may be used to advantage. It is known that such "bottom feed" injectors can be utilized either in single point or multi-point systems.

Examples of "bottom feed" injectors and their mounting structures in two advantageous single point systems are found in US Application Serial No. 956 693, filed November 1, 1978 in the name of W.B. Claxton, and US Serial No. 875 832, filed February 7, 1978 in the name of G.L. Casey; both of which applications are commonly assigned to the assignee of the present application and the disclosure of which is hereby expressly incorporated herein by reference.

These injectors meter fuel by the length of time that the valve mechanism is open and have a static fuel flow rate dependent upon the size of the exit orifice. Relatively small changes in the metering orifice size can substantially change the flow rate of the injector and thus the exit orifice size must be precisely controlled. Claxton discloses a means by which the static flow rate of the fuel injector may be tailored after assembly without reboring the exit orifice. This obviates the expense of remanufacturing the injector if the static flow rate is out of tolerance.

Further, Claxton discloses a fact-acting valve which can be dynamically cycled into the millisecond range because of its low-mass armature and needle valve combination. Another low-mass armature and needle combination is illustrated in US Application Serial No. 940 522, filed on September 8, 1978 by J.C. Cromas, et al. and assigned commonly to the assignee of the present application, the disclosure of which is hereby expressly incorporated herein by reference.

Another fuel injector having a low-mass armature and valve member combination is disclosed in a US Patent 4 030 688 issued in the name of A.M. Kiwior on July 21, 1977 and which is commonly assigned with the present application. Kiwior discloses the use of a ball valve on the end of a flexible stem mating with a conical valve seat that has been coined. The armature and valve member combination of this injector also utilizes bearing surfaces on the medial section for guiding purposes, although it has a self-centering valve.

While all of the injectors discussed to this point can be used in either single point or multi-point applications, it appears that single point applications will become more and more prevalent. One such single point system requires an electromagnetic injector that is mounted above the throttle blade of the air ingestion path for the internal combustion engine. When mounted in such a manner, the most desirous spray pattern for the injector is either full atomization or a wide angled "hollow cone" type of pattern. The hollow cone spray pattern is termed such because much of the injected fuel is contained between an inner and outer cone angle which have their apexes substantially at the point of injection. The hollow cone pattern is advantageous in above throttle blade injection because it does not wet the sides of the throttle bore or the throttle plates substantially and directs the fuel into the turbulent air between the throttle blade and bore wall for excellent mixing and atomizing prior to engine ingestion.

One of the methods of generating a wide angle spray is to generate a swirling or a vortex from the fuel injector which spreads the fuel substantially uniformly between the angles desired. In the application by Claxton, a number of vortex generation techniques that are useful to provide wide angle sprays are disclosed. Further, US Patent 3 241 168 issued to Croft illustrates a swirl generation means with a swirl chamber in an electromagnetic fuel injector.

Croft and Claxton, however, generate wide angled spray patterns that are difficult to control at lower pulse widths for the injectors. Both references have swirl chambers that have relatively large residual volumes when the injector is off. When the injector is opened there is a delay before the spray pattern is regenerated and the vortex can be built up. Croft attempts to solve this problem by using a complicated recirculation path to continually move fuel through the swirl chamber when the valve is closed. These injectors also meter fuel with their exit orifices which, as has been explained before, makes them subject to contamination problems. The valve members of these injectors furhter extend into the valve seats a substantial length and this extension tends to disturb the vortex generated therein. The swirling fuel tends to drag along the surfaces of the valve tip and lose momentum.

The present invention proposes an electromagnetic fuel injector having an energizable stator means for controlling the movement of a valve member of a valve assembly to open and close the injector and thereby meter fuel, said valve assembly comprising a valve housing including a valve housing bore terminating with a valve seat which is connected to an exit orifice, a valve assembly including a valve reciprocally located in said valve housing bore, operable to close said exit orifice by sealing said valve seat with a ball valve, a swirl chamber for imparting to the fuel flow exhausted from the exit orifice a swirl component that is tangential with respect to the spray axis of the injector, and means for supplying fuel from a pressurized source to said swirl chamber, characterized in that said fuel supply means includes means forming a hollow cylinder of fuel between said source and said swirl chamber, and at least one orifice communicating fuel between said fuel cylinder forming means and said swirl chamber.

A high flow rate electromagnetic injector valve with a rapid response time is provided by the invention. The injector valve comprises an electromagnetic stator means and a valve assembly. The valve assembly includes a valve housing in which a valve member is reciprocally mounted for opening and closing an exit orifice. The valve member seats against a valve seat connecting a central valve housing bore to the exit orifice. Fuel under pressure enters the valve housing bore via a plurality of entry orifice proximate to the valve member and valve seat interface to provide a low pressure "bottom feed" injector.

One feature of a preferred embodiment of the present invention relates to the centering of the armature within the central bore of the injector. In the preferred embodiment, the bore is machined to closely mate the exterior surface of the armature. Additionally, the central bore is provided with notch, into which is placed an O-ring. The interior diameter of the O-ring is closely controlled to mate with the outside diameter of the armature. The O-ring is preferably formed of Dupont Vespel SP-22 or Amoco Torlong 4301.

Another feature of the preferred embodiment involves the utilization of axial fuel passages in the cup-shaped armature to reduce the hydrostatic drag created by the movement of the armature through the fuel in the injector cavity.

Another feature of the preferred embodiment involves the use of a cone shaped spring guide to reduce the amount of or substantially eliminate the spring windup which occurs due to the rotational movement of the mechanism for adjusting the static and dynamic response of the injector.

A further feature of the preferred embodiment of the present invention involves the use of hollow cylindrical sleeve, wherein one end of the sleeve is provided with a lip to form a spacer. When installed, the sleeve is concentrically located within the bore and forms a hollow cylindrical cavity between the sleeve and the inside surface of the housing by means of the interaction of the lip and the inside surface of the housing. The sleeve is formed with passages which are tangential to the interior of the sleeve to create a swirling of the fuel being fed to the exit orifice. Also, radial apertures may also be provided to give a downward (toward the exit orifice) motion to the fuel and also to provide additional fuel volume.

As a modification of the above noted passages formed in the sleeve concentrically mounted within the housing, it is contemplated that the lower (close to the injector valve seat) edge of the sleeve may be formed with channels in lieu of the passages. Again, the channels are formed tangentially to the bore of the sleeve to swirl the fuel. It should be noted that the valve seat must be modified to accomodate the channel modification and permit fuel flow to the exit orifice.

Additionally, the preferred embodiment includes a cap-stem-ball combination armature of the type described in the above referenced US Application Serial No. 7 444. Since the stem of the armature is in the magnetic circuit for the armature, it has been discovered that the operation of the injector is improved by fabricating the stem of non-magnetic material.

To further enhance the magnetic characteristics of the injector, the main air gap adjusting sleeve is fabricated to be non-saturating in operation through the proper selection of materials and configuration. Thus, a maximum of lux is forced through the air gap, and the coil current and coil turns are minimized.

A further feature of the present invention involves the provision of an exit orifice and flow path for the fuel, the flow path including the mechanism for creating the swirl at the outlet of the injector. The flow path is created through the interior cavity of the housing and not the interior of the valve stem. Thus, fuel is permitted to continuously flow event during the time the injector valve is closed to reduce the inertia of the fuel when the valve is opened.

The invention will now be described with reference to the accompanying drawings in which :

- Figure 1 is a side view, in cross-section, of a preferred injector embodiment incorporating certain features of the present invention ;

- Figure 2 is a sectional view of the injector of Figure 1 taken along line 2-2 thereof ;

- Figure 3 is a partial view of the nozzle end of Figure 1 illustrating a modification to the fuel flow passageways thereof ;

- Figure 4 is a cross-sectional view of the nozzle of Figure 3 taken along line 3-3 thereof ;

- Figure 5 is a modification of the nozzle end of the injector of Figure 4 ; and

- Figure 6 is a schematic depiction of the fuel flow path through the injector of Figure 1 when the fuel recirculation system is employed.

In the typical electronic single point fuel injection system for the metering of fuel to an internal combustion engine, the system comprises an electromagnetic injector valve 10 which is electrically controlled by an electronic control unit. A plurality of engine operating parameters provide an input to the control unit, including the speed or RPM at which the engine is turning, the absolute pressure of the intake manifold, the temperature of the air ingested, and the engine coolant temperature, by means of conventional sensors.

Referring now to the drawings, in particular to Figures 1 and 2 thereof, there is illustrated an injector 10 having a body 12 which is utilized to close the main operative portions of the injector. The operative portions of the injector include an electromagnetic coil 16 which, when energized, generates a flux flowing through an armature assembly 18 and a stator assembly 10, through an air gap 22. The movement of the armature 18 causes the opening and closing of a ball and valve seat assembly 26 to control the flow of fuel from the interior of the injector into the engine.

As the tubular body 12 is part of the magnetic circuit of the injector, the material used is preferably standard carbon steel. This material provides excellent mechanical strength and exhibits adequate magnetic permeability at low cost. The body 12, as well as all other outside surface of the injector valve 10 can be trated by conventional methods for corrosion resistance and environmental hazards.

Referring particularly to the body of the housing assembly 12, it is seen that the housing is generally formed of a large diameter portion 30 and a small diameter portion 32, the large diameter portion being formed with a shoulder portion 34 and a rim portion 36.

The combination of the shoulder 34 and rim portion 36 is utilized to firmly retain the interior operative portions, including armature assembly 18 and stator assembly 20 within the housing 12, as will be more fully explained hereafter.

Referring now to the small diameter portion 32, it is seen that the portion 32 is formed with an aperture 40 which communicates the exterior of the housing 12 with an interior fuel chamber 42. It is to be noted that the injector being described is what is known as a "bottom feed" injector, wherein the injector is inserted into a fuel rail and fuel is introduced from the fuel rail through aperture 40 to the cavity 42. A suitable filter assembly 46 is provided which basically comprises a cylindrical base member 48 which base member is fabricated by injection molding glass-filled nylon, in situ, on the end of the injector. Prior to the injection molding process, a nylon screen 50 is placed on the end of the injector, and the screen 50 is held in place by the molded material. Thus, the fuel is filtered prior to entering the interior cavity of the injector.

The fuel flows into the injector through passages 40 (some of which are not shown), fills the hollow cylindrical cavity 42, and flows into the swirl chamber 43 adjacent the ball portion of the armature assembly 18 through passage 52. As is best seen in Figure 2, the passages 52 are formed on a tangent to the interior cavity of the injector to create the swirling effect described above. Also, as seen from Figure 1, the passages 52 are tilted toward the exit orifice of the injector to direct fuel toward the orifice.

Referring now to the nozzle end of the injector 10, the small diameter portion 32 is closed by means of a valve seat element 54 which is press fitted into the end 32 of the injector 10. Specifically, the valve seat is formed with a conical surface 56 having a coined portion which mates with a ball 60 of the armature assembly 18. The seat element is pressed toward a shoulder portion 62 but is spaced therefrom by a spacer element 66. Particular details of the seat element 54 may be discovered by reviewing the copending US Patent Application Serial No. 7 444.

As described above, the fuel flows through the filter assembly 46 and passageway 40 into the cavity 42. It is seen that the cavity 42 is formed as a generally hollow thin walled cylinder, the outer diameter of which is formed by the inside diameter of the small diameter portion 32, and the inner diameter of which is formed by a sleeve element 70. The sleeve element 70 is also formed as a generally thin walled hollow cylinder having an outwardly extending lip portion 72 which is adapted to engage the inside diameter of the small diameter portion 32. Thus, the main wall of the sleeve 70 is spaced from the small diameter portion 32 by means of lip 72. The sleeve 70 is held in the position shown, abutting spacer 66, by means of a bowed ring 74. The bowed ring is forced over a shoulder 78 and into a groove 80 to retain the ring 74 in position. In order to preclude wear and oxidation, the sleeve 70 is formed of 300 series stainless steel.

The sleeve 70 forms a guide for the ball 60 of the armature assembly 18. The armature assembly 18 also includes a cup-shaped element 84, which element is attached to the ball 60 by means of a stem member 86. The stem member 86 is formed of non-magnetic material in order to open circuit the flux path through the stem 86. In order to rigidly attach one to the other, the stem 86 is welded at one end to the ball 60 and at the other end to the cup-shaped element 84. The cup-shaped element 84 is formed with a plurality of apertures 88 to permit the free flow of fluid from the exterior of the cup-shaped element to the interior of the element 84 for a purpose to be hereinafter explained.

In order to maintain alignment of the two parts, the exterior surface of cup 84 should be machined to closely mate with the inside surface of the central bore 92 of the housing 12. However, to insure centering of the cup-shaped element 84 within the central bore, the housing, at the transition between the large diameter portion 30 and the small diameter portion 32 is notched to receive an O-ring 96. The O-ring is shown as being preferably of square cross section and is formed of Dupont Vespel SP-22 or Amoco Torlong 4301. The inside diameter of the O-ring 96 closely fits and slidably engages the outside diameter of cup-shaped element 84.

The stator assembly 20 includes a pole piece member 100 into which is telescopically received a tube element 102 and an adjusting pin 104. The pole piece 100 is formed with a pair of apertures 108, 110 which are adapted to receive electrical connecting elements 116 for the solenoid coil assembly 16. The coil assembly 16 is formed of a multiturn coil 114 which is connected to the pair of terminals 116, the entire assembly being plotted or encapsulated in a molding material which covers substantially all of the exterior of the coil and terminal assembly.

During assembly of the injector, the O-ring 96 is fitted into the notch formed for that purpose, and the coil assembly 16 is then slid into the interior of the large diameter portion. A pair of O-rings 120, 122 are then positioned as shown and the pole piece 100 is inserted into thr large diameter portion 30. A pair of end portions 132, 134 are then swaged over the pole piece 100 to firmly position the pole piece as shown.

The tube 102 is threaded into the interior of the pole piece 100, the degree of insertion into the pole piece determining the amount of air gap 22. As is seen in Figure 1, the ball 60 is seated on surface 56 which then establishes the position of cup-shaped element 84 due to rigid connection between the ball 60 and cup-shaped element 84 by stem 86. The armature assembly is urged into engagement with the seat surface 56 by means of a spring element 140, one end of which seated on an interior surface of the cup-shaped element 84, and the other end of which engages a spring guide element 142. The position of the spring guide element within tube 102 is determined by pin 104 which is threaded into the interior of tube 102. An O-ring 146 is provided to seal the interior cavity of the adjusting mechanism including tube 102 and pin element 104.

Thus, with the injector assembly as shown, the ball 60 is urged into engagement with surface 56 by spring 140, the compression of which is determined by the position of element 142. Thus, the dynamic operation of the ball valve is adjusted by means of adjusting the compression of spring 140.

The particularly configuration of spring guide 142 has been contrived to reduce or substantially eliminate spring windup which may occur during the adjustment procedure. Obviously, if spring windup occurs, the adjustment of the dynamic response of the injector valve will vary after the valve is cycled should spring windup occur. This is due to the subsequent unwinding of spring 140 as the valve is operated.

In order to adjust the air gap 22, the sleeve or tube 102 is rotated within pole piece 100 to axially advance the tube 102 within pole piece 100. A minimum air gap is established by means of a shim 150. It is to be noted that the static and dynamic adjustment may be accomplished from one end of the injector.

Referring now to Figures 3 and 4, there is illustrated a modification of the fuel feed and swirl mechanism of Figures 1 and 2. In the modified embodiment, there is illustrated a plurality of channels or slots 160 ground into a modified sleeve 162, the sleeve 162 being identical to sleeve 70 except for the substitution of grooves 160 for the passages 52. In the event sleeve 70 is modified to include grooves 160, it is to be understood that the seat mechanism 54 must be modified in order to permit fuel to flow into the area adjacent the mating of ball 60 with seat 54.

Referring now to Figure 5, there is illustrated still a further modification of the sleeve 70. Paticularly, a sleeve 166 is shown in Figure 5, sleeve 166 being provided, by grinding or molding, with a plurality of tangential grooves 168 and radial grooves 170. The tangential grooves 168 are provided to cause a swirling action of the valve tip, as was the case with grooves 160 and passages 52. In order to provide an additional volume of fuel flow and also to provide a generally downward movement to the swirling fuel, grooves 170 are provided, which grooves are generally radially oriented with the upper portion of the grooves tilted toward to the exit orifice 56.

Referring now to Figure 6, there is illustrated a schematic depiction of the injector of Figure 1, the schematic format being utilized to more clearly illustrate an auxiliary fuel flow. As is readily apparent, when the interior cavity of the injector is completely enclosed, there is no movement of fuel within the cavity. Thus, when the ball valve is open the fuel has a certain degree of inertia which must be overcome in order to create the swirl or vortex within the interior cavity of the injector and start the injection of fuel. It has been found to be desirable to have a certain amount of fuel flow within the injector during the time that the injector is closed and fuel is not being injected.

In order to accomplish this, a vent 176 is provided which is interconnected with a fuel reservoir at a lower pressure than the fuel present at passages 52 formed in sleeve 70 as described in conjunction with the description of Figure 1. As high pressure fuel flows into passages 52 and, with the ball valve 60 closed, fuel will flow in the direction shown by the arrows in Figure 6. In view of the fact that the vent 170 is at a low pressure, fuel will flow through a passage 178 and orifice 176 back to the fuel reservoir. In this way, a swirling action is created around ball valve 60, which swirling action will be present when the ball valve 60 is open, thereby increasing the response of the injector.

Referring back to Figure 1, the vent 176 is seen to be positioned adjacent to passage 178. Thus, fuel flows from the tip cavity, through the passages 88 into the interior of cup-shaped element 84. Fuel can then flow through the air gap 22 into passage 178 and out of the injector through vent 176. Thus a flow path for the fuel has been established through the injector from passage 52 to vent 176.

While a preferred embodiment, and certain modifications thereto, have been illustrated and described, it is to be understood that many other modifications could be made to the preferred and modified embodiments without departing from the spirit and scope of the following claims.

CLAIMS

1. An electromagnetic fuel injector having an energizable stator means (20) for controlling the movement of a valve member of a valve assembly (10) to open and close the injector and thereby meter fuel, said valve assembly comprising : a valve housing (30, 32) including a valve housing bore (92) terminating with a valve seat (56) which is connected to an exit orifice, a valve assembly (60) including a valve (60) reciprocally located in said valve housing bore, operable to close said exit orifice by sealing said valve seat (56) with a ball valve (60), a swirl chamber (43) for imparting to the fuel flow exhausted from the exit orifice a swirl component that is tangential with respect to the spray axis of the injector, and means (40) for supplying fuel from a pressurized source to said swirl chamber, characterized in that said fuel supply means includes means (70) forming a hollow cylinder (42) of fuel between said source and said swirl chamber, and at least one orifice (52) communicating fuel between said fuel cylinder forming means (70) and said swirl chamber (43).

2. An injector according to claim 1, characterized in that said orifice (52) is positioned proximate to the interface of said ball valve (60) and said valve seat (56).

3. An injector according to claim 2, characterized in that said cylinder forming means (70) is a sleeve (70) having at least one lip (72) formed thereon.

4. An injector according to claim 3, characterized in that said sleeve is formed as a generally thin walled hollow cylinder having an outwardly extending lip portion (72) which is adapted to engage the inner surface of said housing bore (92).

5. An injector according to claim 3, characterized in that said one orifice (52) is an aperture formed through said sleeve (70) adjacent said exit orifice.

6. An injector according to claim 3, characterized in that said one orifice (52) is a groove formed in said sleeve (70) adjacent said exit orifice.

7. An injector according to claim 5 or 6, characterized in that said orifice (52) is formed tangential to said housing bore (92).

8. An injector according to claim 1, wherein said valve assembly includes a valve armature (84) and a valve member including a ball valve (60) reciprocally located in said valve housing bore (92), a

stem member (86) rigidly interconnecting said valve armature (84) and said ball valve (60), characterized in that said stem member (86) is formed of non-magnetic material to enhance the magnetic characteristics of said injector.

9. An injector according to claim 1, wherein said valve assembly includes a generally cylindrically shaped portion (84) positioned remote from said exit orifice, characterized in that it comprises means (96) for centering said cylindrical shaped portion (84) including shoulder means formed on an interior surface of said bore and concentric therewith, and bushing means positioned adjacent said shoulder means and having an interior surface closely fitting the exterior surface of said cylindrically shaped portion, said bushing being mounted for relative movement to one of said shoulder and said cylindrically shaped portion.

10. An injector according to claim 9, characterized in that said bushing (96) is positioned for relative movement between said bushing and said cylindrically shaped portion.

11. An injector according to claims 9 or 10, characterized in that said bushing is fabricated from Dupont Vespel SP-22 or Amoco Torlon 4301.

12. An injector according to claim 1, wherein said valve assembly includes a large area member (84) reciprocall y located in said valve housing bore, characterized in that said large area member is provided with aperture means (88) to permit the flow of fuel through said flat area member and reduce the drag of said flat area member through the fuel.

13. An injector according to claim 12, characterized in that said flat area member is a cup-shaped element, said flat area being the bottom of said cup-shaped element.

14. An injector according to claim 13, characterized in that said aperture means (88) includes at least one aperture in said bottom.

15. An injector according to claim 1, wherein said valve assembly comprises an armature assembly (84) movably mounted relative to said stator means (20) within said housing and movable into and out of engagement with the valve seat (56), said armature assembly being separable from said stator means by an air gap, means (140) resiliently biasing said armature means into engagement with the valve seat, and said resilient means being disposed between said stator means and said armature assembly and including spring means and a spring-guide element (142)

engageable at one end with said stator means and at the other end with said spring means, said stator means including means (104) for adjusting the force of said resilient means exerts on said armature assembly, said adjusting means engaging said spring-guide element (142) and being rotatable to axially move said spring-guide element and vary the force on said armature assembly, characterized in that said spring-guide element minimizes the transfer of rotary motion to said spring means to preclude windup of said spring means.

16. An injector according to claim 15, characterized in that said adjusting means is a pin having a small diameter relative to the transverse dimension of said spring-guide element.

17. An injector according to claim 16, characterized in that said spring means is a helical spring, said spring-guide element having a circular shoulder formed thereon to receive said other end of said spring means.

18. An injector according to claim 17, characterized in that the diameter of said spring means is substantially larger than the diameter of said pin means.

19. An injector according to claim 6, characterized in that said armature assembly includes a cup-shaped element (84), the open end of said cup-shaped element facing said resilient means and receiving said one end thereof.

20. An injector according to claim 14, wherein said stator means includes second adjusting means axially movable to adjust said air gap, said second adjustable means being rotatable relative to said spring, characterized in that said spring-guide element precludes the rotational motion of said second adjustable means from being transmitted to said spring.

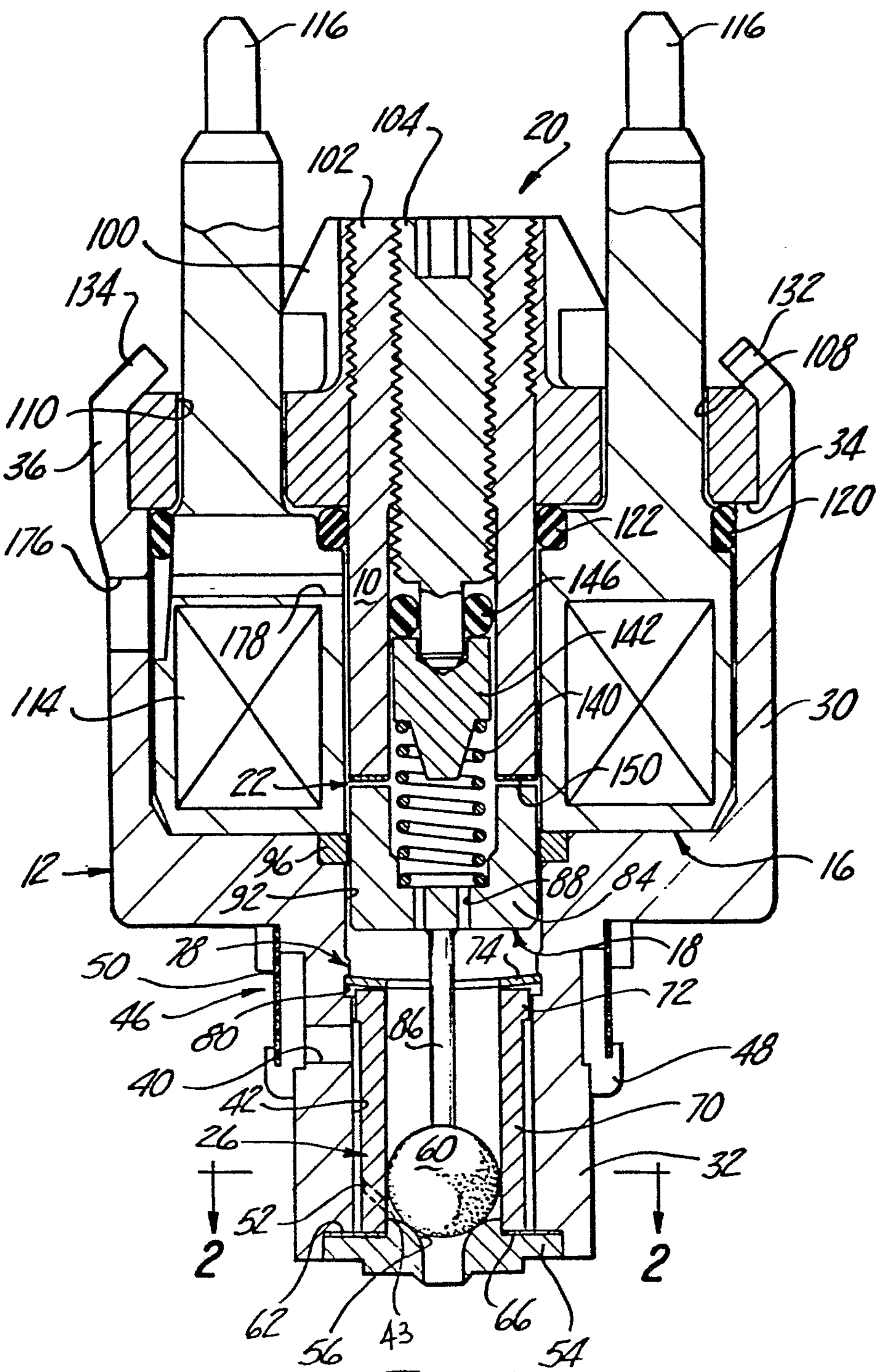
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Fig-1

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Fig-2

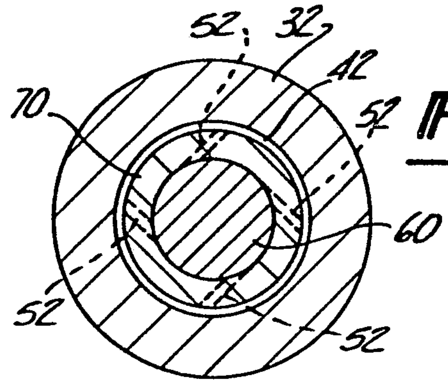

Fig-3

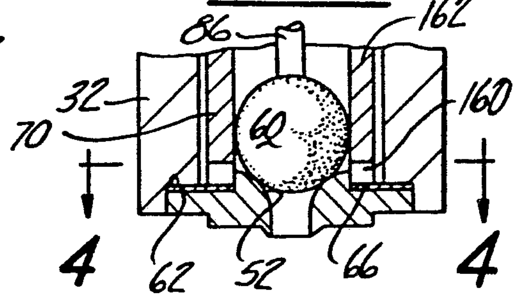

Fig-4

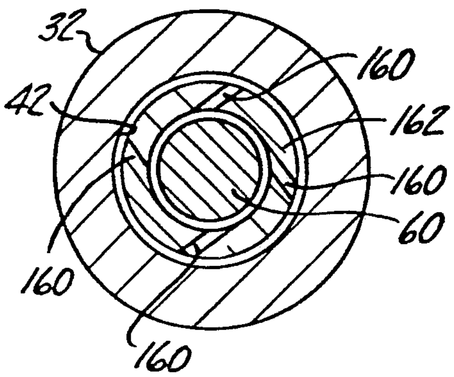

Fig-5

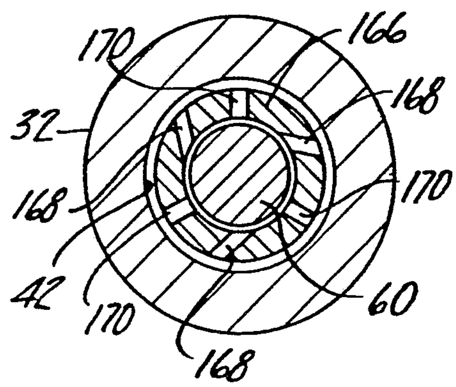

Fig-6