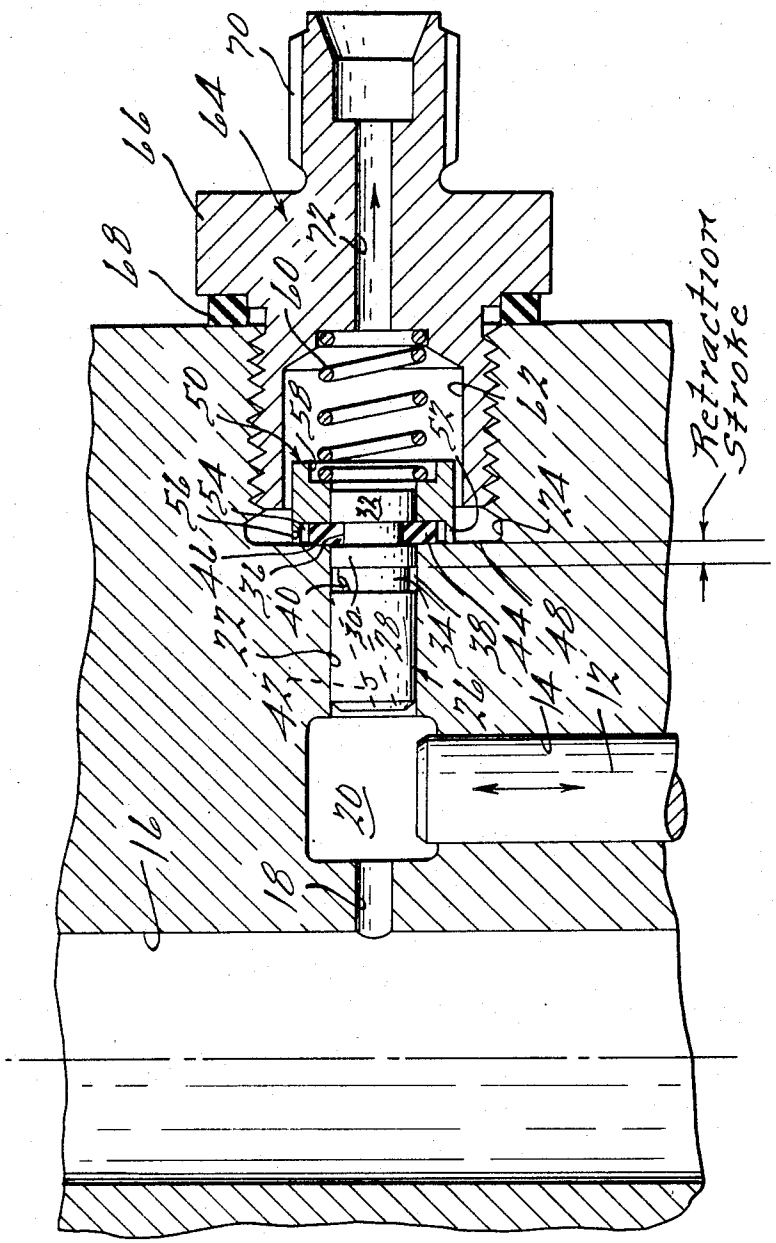
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FLUID FLOW CONTROL VALVE ASSEMBLY

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FLUID FLOW CONTROL VALVE ASSEMBLY

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ABSTRACT OF THE DISCLOSURE

A retraction type delivery valve for a fuel injection system, the valve having a retraction collar slidable in and out of the bore to control flow and also the residual pressure in the injection line, the valve having a positioning ring and a sealing disc that abut the valve body in one direction of movement of the valve to limit the volume retraction movement of the valve.

This invention relates, in general, to a fluid flow control apparatus. More particularly, it relates to a retraction type delivery valve for use in a fuel injection system.

Direct fuel injection systems of the type to which the invention is directed generally have a number of reciprocating pump plungers each intermittently supplying a charge of fuel past a delivery valve to an injection nozzle. The delivery valve is provided for a number of reasons. One is to limit the amount of fuel back-flow into the pump pressure chamber so that if an air pocket is trapped in the high pressure line, it can be driven out on successive pressure strokes of the pump plungers. Otherwise, the air pocket would expand during the decrease in pump pressure, and would not be driven out of the delivery line. In any practical case, one delivery cycle does not displace enough fuel past the injection nozzle to compress the air pocket to the opening pressure of the nozzle.

A second reason for the provision of a delivery valve is to reduce the residual pressure in the high pressure delivery line after each stroke of the pump plunger. This prevents secondary injection due to reverberation of pressure waves in the closed high pressure line when superimposed on high residual pressure.

The above functions generally are accomplished by constructing a delivery valve to have a two part motion during the non-pressure stroke of the pump plungers; first, block the fuel flow between the pump cavity and fuel injection line, and, sceondly, to retract a finite or predetermined small volume of the valve mass out of the high pressure delivery line during the non-pressure stroke of the pump plunger; that is, expand the high pressure line by a finite amount.

Typical of delivery valves of this latter type are those having conical heads, shown and described in U.S. 2,440,194 and 2,382,000. There is a basic difficulty, however, with such constructions. Separate delivery valves are required for each injection nozzle and pump plunger, and since a typical system may have six or more delivery valves, each of the conical head valves must be manufactured to extremely close tolerances so that each of the valves will always retract the same precise volume. Without such control, the delivery through each of the nozzles might be quite different even though the pump plungers deliver the same quantity of fuel. An unbalanced situation would result when each of the nozzles delivered a different quantity of fuel, thereby requiring considerable adjustment and maintenance for the engine to run efficiently. This poses both manufacturing and wear problems therefor.

The invention eliminates the above disadvantages by providing a delivery valve construction that provides a precise, finite retraction volume of the valve in a manner such that each valve will always retract the same volume, and provides leak proof sealing without affecting the travel of the valve. The delivery valve of the invention includes a spool valve having a retraction land slidable in the bore, and a positioning ring secured to the valve in the injection line and having a flat base portion that contacts the flat surface of the housing and compresses an elastic sealing element against the housing.

It is an object of the invention, therefore, to provide a unidirectional flow valve assembly that not only controls the return flow of fluid in a line, but reduces the residual pressure and provides leak proof sealing.

It is another object of the invention to provide a delivery valve that includes a positioning ring that seats against a portion of the valve housing not only to limit the retraction volume movement of the valve, but also to engage a resilient sealing element with the housing to provide leak proof sealing.

Other objects, features and advantages of the invention will become apparent upon reference to the succeeding detailed description thereof, and to the drawing showing, schematically, a cross-sectional view of a delivery valve assembly embodying the invention.

The figure shows a cross-sectional view of a portion of a fuel injection pump. The pump would have a number (only one shown) of plungers **12** reciprocable in a bore **14** in the pump housing by a wobble plate or other suitable mechanism, not shown. A central bore **16** of the pump would contain an axially slidable metering valve fixed on a shaft that is rotatable with the pump drive means, not shown. The bore contacting surface of the valve would contain suitable fuel flow channels so disposed that during each rotation of the metering shaft, fuel would be delivered through the channels from a source (not shown) to spill holes or passages **18**, in a known manner.

The number of spill holes correspond to the number of pump plungers. Each of the spill holes **18** opens into a pump plunger cavity **20** that is intersected on the opposite side by a bore **22**. The bore opens outwardly into an enlarged annular bore or chamber **24** in the pump housing.

The flow of fuel from pump plunger cavity **20** to the fuel injector, not shown, through chamber **24** is controlled by a delivery valve **26** that is slidably and sealingly mounted in bore **22**. The valve is of the spool type, having three axially spaced lands **28**, **30** and **32** of the same diameter interconnected by neck portions **34** and **36** of reduced diameter. The neck portion **34**, together with the wall of bore **22** and the adjacent land faces, constitutes an annular fuel collection chamber **38**. A portion of neck portion **34** is cut away, as shown at **40**, to blend with a passage **42** through the valve that supplies chamber **38** with fuel from pump cavity **20**.

The land **30** constitutes a fuel flow shut off member and a volume retraction collar, when it is in the position shown within bore **22**. When the valve moves to the right sufficiently to move land **30** out of bore **22**, fuel flows freely from chamber **20** through passage **42** into the larger chamber **24**.

A flat faced sealing disc element **44**, of suitable elastic sealing material, has an interference fit within the groove defined by valve lands **30** and **32** and neck portion **36**. The one seal face **46** seats against the pump housing wall portion **48** when valve **26** is withdrawn within bore **22** as shown to provide against leakage of fuel past land **30**, in a manner to be described. The seal is surrounded by a positioning ring **50** that is press fitted on end land **32**.

The ring has a flat bottomed, axially extending ring flange **52** that seats against housing wall **48** to thereby

limit the leftward movement of valve 26 and retraction collar 30. In doing so, it slightly compresses elastic sealing element 44 to provide the leak proof sealing described above.

A radial clearance 54 is provided between ring flange 52 and sealing element 44 to allow for expansion of the sealing element when it is compressed. Any fuel trapped within the clearance space is vented outwardly into chamber 24 through one or more vents 56 in ring flange 52.

The opposite side of positioning ring 50 is stepped at 58 to provide a seat for a compression or return spring 60. The spring is seated at its opposite end against the end of a cup shaped bore 62 provided in an adaptor 64. The adaptor is splined into the pump housing, as shown, with flange portions 66 seating against a suitable annular seal 68. The outer end of the adaptor has splines 70 for a connection with a hose or line connected to a fuel injector nozzle (not shown). A central bore 72 connects bore 62 to the injection nozzle hose.

The injector would be of a known type that remains closed below a predetermined pressure in line 72.

During the initial upward movement of plunger 12, the metering shaft valve (not shown) in bore 16 is in a position to cause a spilling of fuel from cavity 20 out through hole 18 into the central metering shaft bore 16. As the pump plunger moves farther upwardly, the valve in the metering shaft bore rotates to a position closing off spill hole 18. This permits a buildup in pressure of the fuel in cavity 20 and against the end of valve land 28. As soon as the level of the increasing fuel pressure surpasses the force of spring 58 and the residual fuel pressure in injection line 72 and chamber 62, delivery valve 26 will move rightwardly. This will move retraction collar 30 out of bore 22, unseat positioning ring 50 and seal 44, and connect the fuel in pump chamber 20 through passage 42 and chamber 38 to the injection nozzle.

When the pump stroke of plunger 12 is over, and it begins its suction or downward stroke, the pressure in cavity 20 will immediately decay. This is due not only to the expansion of the fuel into the plunger bore 14, but also because the metering shaft bore valve now will be in a position connecting spill hole 18 to a drain port, not shown. Thus, the pressure in injection line 72 and the force of spring 58 will move delivery valve 26 leftwardly towards a closing position. As the valve moves leftwardly, the fuel pressure in injection line 72 will decay and permit the closing of the injection nozzle. Essentially at the same time, the left-hand edge of retraction collar 30 will contact the right-hand edge of bore 22 and stop flow of fuel from fuel injection line 72 back to the pump cavity 20, except for any slight leak around the outer periphery of land 30. Thus, the pressure of the fuel in line 72 now is essentially the same as that at the fuel injection nozzle.

With the further decay in fuel pressure in pump plunger cavity 20, delivery valve 26 continues to move leftwardly until the positioning ring 50 seats against the pump housing and compresses the sealing element 44 to provide leak proof sealing at this point. The travel of retraction collar 30 now is stopped. Any fluid or fuel trapped in the radial clearance space 54 between positioning ring 50 and sealing element 44 is vented outwardly through vents 56 into bore 62. This outward venting permits the residual pressure of the fuel in bore 62 to force the ring 50 against the seal to provide a good seal.

Thus, it will be seen that the width of the retraction collar or land 30 defines the effective increase in the volume of bore 62 and line 72; that is, when the left-hand edge of collar 30 contacts the bore 22, fuel flow is cut off; subsequently, continued leftward movement of the collar into bore 22 until stopped by positioning ring 50 seating against the pump housing retracts a finite mass of the valve out of the bore 62, thereby permitting the volume of fuel therein to expand and reduce its pressure. Accordingly, the residual pressure in line 72 now is less than the opening pressure of the injection nozzle, and after-dribbling and other secondary effects are avoided.

From the above, therefore, it will be seen that the invention provides a delivery valve assembly that provides the two functions of a delivery valve; namely, sealing of the return flow of fuel from the injection line to the pump plunger cavity, and secondly, the retraction of a finite volume of fuel from the injection line chamber to reduce the pressure therein to a value sufficiently below the nozzle opening pressure preventing secondary injection and after-dribbling. It will also be seen that the construction described and shown provides leak proof sealing and a finite stroke of the retraction collar in a manner to provide equal volume retraction for all valves.

While the invention has been shown and described in its preferred embodiment, it will be clear to those skilled in the arts to which the invention pertains that many changes and modifications may be made thereto without departing from the scope of the invention.

I claim:

1. A retraction type delivery valve assembly for use with a fuel pump having a pump plunger cavity and an injection line chamber interconnected to each other comprising, a spool valve slidable sealingly in a conduit connecting said cavity and chamber and having a portion of a larger diameter than said conduit projecting into said chamber to limit movement of said valve in one direction, said valve having spaced lands defining a fluid chamber therebetween, passage means connecting said cavity and fluid chamber, and seal means between said valve portion and one of said lands moving with said valve portion into a sealing engagement with a portion of said injection chamber, said one land constituting an injection line volume control element movable alternately into and out of said injection chamber upon movement of said valve to control flow of fluid under pressure from said passage and fluid chamber to said injection chamber and to seal flow therebetween and control the retraction of a volume of said valve from said injection chamber, said valve portion including a ring member having an axially extending ring flange defining a hollow within said ring member, said flange having a flat edge contactable with a portion of said injection line chamber to limit movement of said valve in said one direction, said seal means being contained within said hollow and comprising a disc-like compressible seal member.

2. A delivery valve assembly as in claim 1, said disc-like seal member being of a diameter less than said ring flange, and aperture means in said ring flange to vent the radial space between said disc-like seal member and ring flange to said injection line chamber.

3. A fluid flow control valve assembly comprising, a source of alternating high and low pressure fluid, a fluid injection line, a valve body having a bore connecting the fluid from said source to said injection line, a spool valve in said valve body bore controlling flow therethrough and movable in one direction by the application of high pressure fluid thereagainst and having a pair of spaced lands defining a fluid chamber therebetween, passage means connecting the fluid from said source to said chamber, one of said lands constituting injection line volume retraction means, valve movement limiting means secured to said valve and engageable at times with said valve body upon movement of said valve in the opposite direction to limit the volume retraction movement of said one valve land, and seal means between said one land and movement limiting means engageable with said valve body upon a predetermined movement of said valve in said opposite direction to seal against fluid flow past said one land, the movement of said valve in said one direction moving said one land and chamber into said line to connect fluid to said line, the movement of said valve in the opposite direction by fluid pressure in said line acting thereon in response to low pressure of said source retracting said one land from said line and engaging said seal means and movement lim-

iting means with said valve body to seal flow past said valve and lower the pressure of the fluid in said line.

4. A valve assembly as in claim 3, said valve having a constant cross-sectional area, said movement preventing means comprising a ring of larger diameter than said valve and having an essentially flat surface engageable over said seal means with said valve body.

5. A valve assembly as in claim 4, said ring having ring flange means enclosing said seal means with a radial clearance therebetween and having a fluid vent passage therethrough permitting vent of fluid to said injection line from said clearance.

6. A valve assembly as in claim 3, said movement limiting means comprising a ring shaped member secured on the end of said valve, said member having a ring flange projecting towards said valve and enclosing said seal means with a radial clearance therebetween, and aperture means in said flange for venting the fluid in said clearance to said injection line.

7. A valve assembly as in claim 6, said ring flange having a flat edge engageable at times with said valve body to limit movement of the valve in the said opposite direction.

8. A valve assembly as in claim 7, said seal means comprising a flat compressible sealing disc compressible in a sealing manner against said valve body by said ring upon engagement of said ring flange with said valve body.

9. A retraction type delivery valve construction comprising, a valve body having a bore having smaller and larger diameter interconnected bore portions, a spool valve having spaced lands thereon reciprocably mounted in said smaller bore for movement of one of said lands into and out of said larger bore by the differential force of a fluid under a varying pressure acting in one direction against one end of said valve opposed by spring means and fluid under pressure acting in the opposite direction against the opposite end of said valve, said valve lands sealingly cooperating with said smaller bore and defining a fluid chamber therebetween, passage means communicating the fluid under pressure from said one end to said chamber, a valve positioning ring in said larger bore operably connected to the end of said valve and having a ring flange portion engageable at times with said valve body upon movement of said valve in said opposite direction to limit said latter movement, and resilient seal means receivable within said ring flange portion between said ring and valve lands seatable at times against the interconnection between said bores, movement of said valve by said first mentioned fluid a predetermined distance in said one direction moving said one land into said chamber and larger bore to permit flow of said fluid under pressure through said passage means into said larger bore, a decrease in pressure of said latter valve moving fluid effecting movement of said chamber and valve land in the opposite direction into said smaller bore by fluid under pressure in said larger bore and said spring means acting against the opposite end of said valve to first block flow between said bores by said valve land and subsequently to continuously retract a predetermined mass of said valve from said larger bore upon continued movement of said valve land until stopped by engagement of said ring flange portion with said body, said latter position of said ring compressing said seal means against the interconnection between said bores to seal against fuel flow past said one land.

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