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FUEL INJECTOR PUMP WITH HYDRAULICALLY CONTROLLED INJECTION VALVE

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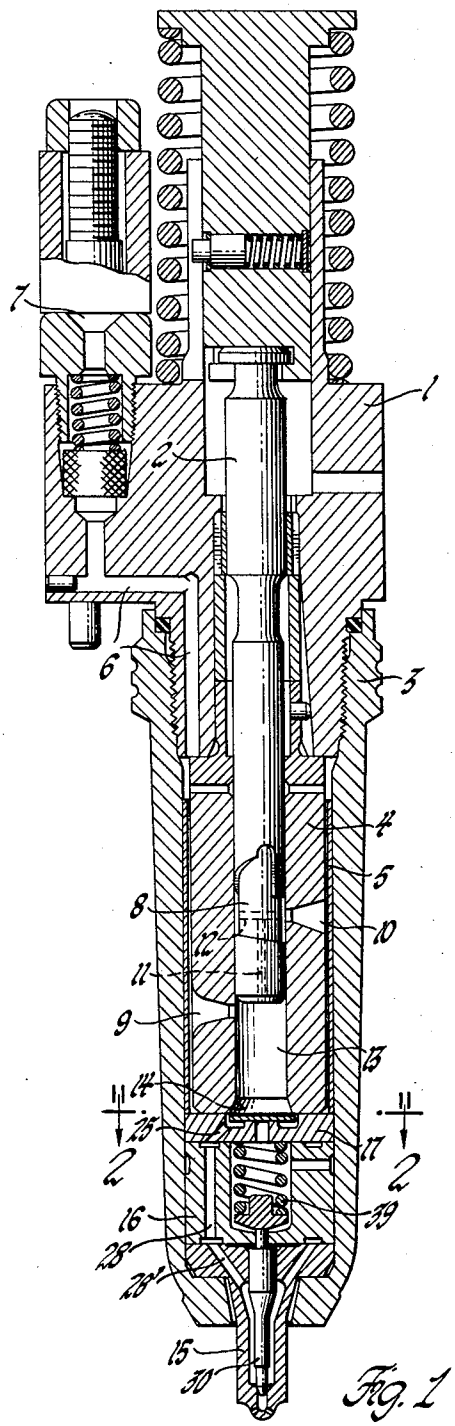

Fig. 1

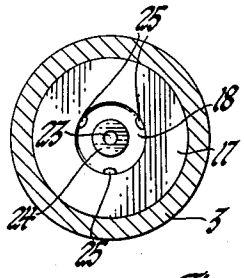

Fig. 2

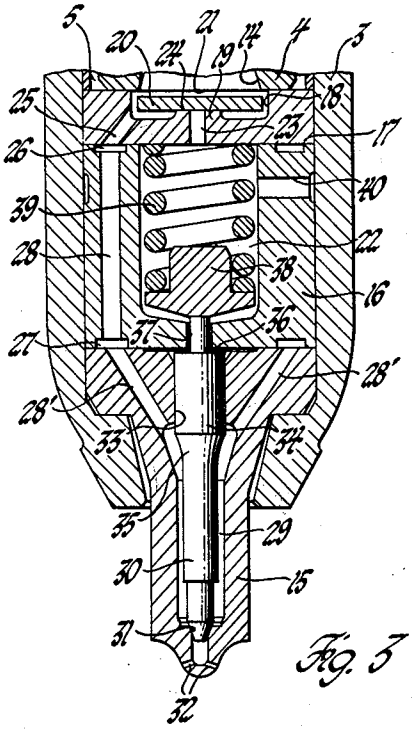

Fig. 3

INVENTOR.
Thomas E. Rademaker

BY

S. C. Thorpe

ATTORNEY

United States Patent Office

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FUEL INJECTOR PUMP WITH HYDRAULICALLY CONTROLLED INJECTION VALVE

Thomas E. Rademaker, Grand Rapids, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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This invention relates to fuel injection apparatus, and particularly to unit type fuel injector-pumps for diesel engines.

In the prior Shade et al. application for United States Letters Patent, Serial No. 80,063, filed January 3, 1961, now Patent No. 3,006,556, a novel check valve arrangement for preventing blow-back of combustion gases from the engine cylinder into the pump cylinder of the injector was provided. In accordance therewith, a circular flat disc performs this check valve function, and it is located so as to seat in closed position against the open end of the injector pump cylinder. The injector therein disclosed is of the needle valve type, in which a needle valve normally closes the fuel outlet end of a fuel delivery passage, the check valve accommodating fuel flow into this passage from the pump cylinder. Opening movement of the needle valve is opposed by a spring within a chamber which is isolated from the fuel delivery passage at all times during operation of the injector-pump.

It is the principal object of my invention to improve upon such prior Shade et al. construction by arranging the spring chamber to be connected to the fuel delivery passage immediately upon ending of fuel injection, and thereby equalize the pressure on both sides of the needle valve so as to assist the spring in effecting rapid closing of the needle valve. By providing a passage through the spring seat at the upper end of this chamber to connect with the fuel delivery passage when the check valve is in its closed position against the end of the pump cylinder, I accomplish this desired equalization of pressures on the needle valve at the end of fuel injection. There is no interference with the normal operation of the unit since this added passage is maintained closed by the check valve during fuel injection.

A clearer understanding of the invention will be had from the following description of one specific embodiment thereof, having reference to the attached drawing, wherein:

FIGURE 1 is a longitudinal sectional view through a unit injector-pump incorporating my novel arrangement for equalizing fuel pressure on the injection valve at the end of injection.

FIGURE 2 is a transverse sectional view taken substantially along line 2—2 of FIGURE 1.

FIGURE 3 is an enlarged fragmentary view similar to FIGURE 1, showing the parts in greater detail.

Referring now in detail to the drawing, the upper portion of the unit is conventional and comprises a housing 1 in which a plunger 2 is reciprocable. Forming an extension of and threaded to the lower end of the housing 1 is a nut 3 within which is supported a bushing 4, forming the pump cylinder for the plunger 2. An annular space 5 surrounding the bushing 4 within the nut is supplied with fuel via passages 6 in the housing from an external fuel connection 7. The plunger has the usual bypass means including an external groove 8, by which opening and closing of ports 9 and 10 in the bushing are controlled, and connecting axial and transverse passages 11 and 12 for bypassing fuel from the pump cylinder 13 to the annular fuel space 5 when the groove 8 is in registry with one or the other of the ports 9 and 10. Thus during each downward or injection stroke of the plunger from its position shown, fuel is initially bypassed to the reservoir 5 from the cylinder 13 below the

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plunger, but after the groove 8 has moved out of registry with the upper port 10 and the lower port 9 is closed by the plunger, fuel is displaced under high pressure through the opening 14 in the lower end of the bushing 4 until the groove moves into registry with the lower port 9 to again bypass the fuel and end injection. Other details of the upper or pump part of the unit are not important to the present invention, and are common to the constructions shown and described in such prior patents as Engel, Jr. 2,951,643 and Teichert 2,898,051, hence will not require further description here.

Clamped to the lower end of the bushing 8 by the nut 3 is a fuel injector, including a valve body comprising a spray tip 15, spacer block 16 and spring retainer 17. As best shown in FIGURES 2 and 3, the spring retainer has a cavity 18 facing the cylinder opening 14, and projecting centrally upwardly from the bottom of the cavity is a protuberance 19 which forms a stop for a circular flat disc check valve 20. The cavity 18 extends laterally beyond the extremities of the cylinder opening 14, and the lower end of the cylinder or bushing 8 forms a seat 21 for the check valve 20 when in position to close the opening 14. Extending centrally through the protuberance 19 and into a spring chamber 22 formed within the spacer block 16 is a passage 23. The upper end of the protuberance or stop 19 forms a seat 24 for the check valve when in its position shown, blocking the entrance to the passage 23 from the cavity 18.

A plurality of circumferentially spaced inclined passages 25 are also provided in the spring retainer to connect the cavity 18 with an annular groove 26 in the upper end of the spacer block 16. This groove 26 is connected with a similar annular groove 27 on the bottom face of the spacer block 16 by a longitudinal passage 28 through the spacer block, and this lower groove 27 is, in turn, connected by a plurality of inclined passages 28' to a central passage 29 surrounding a needle valve 30 within the spray tip 15. At the lower end of this passage 29 is an outlet for fuel delivery in the form of a tapered seat 31 for the needle valve, below which seat are connecting spray orifices 32 in the lower end of the spray tip 15.

The upper end of the spray tip 15 is provided with a bore 33 for guiding opening and closing movements of the needle valve 30. The piston portion 34 of the needle valve slidably fits this bore 33, and has its lower end 35 exposed to fuel pressure in the passage 29 and its upper end 36 is exposed to fuel pressure in the spring chamber 22 via an opening 37. A reduced portion of the needle valve upper end extends through this opening 37 and abuts a spring seat 38. Compressed between this spring seat and the spring retainer 17 is a coil spring 39 which biases the needle valve 30 to its closed position shown.

In operation, during displacement of fuel at injection pressure from the pump cylinder, the fuel pressure therein maintains the check valve 20 seated against the protuberance 19 on the spring retainer, blocking application of such fuel pressure to the spring chamber 22. This fuel at injection pressure is, however, free to pass into the cavity 18 and thence through the fuel delivery passage means (passages 25, 28, 28', and 29) where it acts against the end 35 of the valve piston portion 34 to raise the needle valve and open the outlet 31 for injection of the fuel into the engine (not shown) via the spray orifices 32. Upon the plunger reaching its position wherein the plunger groove 8 registers with the lower port 9, the injection fuel pressure within the cylinder 13 and the fuel delivery passages in the injector immediately dissipates by reason of the fuel being bypassed through the plunger passages 11 and 12 and groove 8 to the reservoir 5 which is at relatively low (e.g. 40 p.s.i.) supply fuel pressure. The check valve 20 thereupon closes, i.e. moves upward into seating engagement with the end 21 of the cylinder bushing

8, and the remaining fuel pressure still existing in the passages 25, 28, 28' and 29 is subjected to the upper end 36 of the needle valve piston portion via the passage 23, spring chamber 22 and passage 37. As the result, fuel pressure is thereby substantially equalized on both sides of the needle valve, and its return spring 39 acts immediately to move it into closed position, against the outlet 31. Any tendency of fuel pressure to build up within the spring chamber 22, as would prevent or resist reopening of the needle valve during the next injection cycle, is prevented by venting the spring chamber through a passage 40 to the exterior of the spacer block 16. While a relatively close fit exists between this spacer block and the nut 3, as well as between the nut and the spring retainer 17, there is sufficient diametral clearance between these parts for such necessary venting of the spring chamber to the annular supply reservoir 5.

While only a single preferred embodiment of the invention has been disclosed, it is appreciated that numerous minor changes in the construction and arrangement of the parts may be made without departing from the spirit and scope of the invention as defined in the following claims.

I claim:

1. In a unit fuel injector-pump, a pump cylinder open at one end for fuel delivery, an injector opposite the open end of said cylinder, said injector including a valve body, a fuel delivery outlet, a valve movable to open and close said outlet, passage means connecting said cylinder end and said outlet, said passage means including a bore slidably guiding opening and closing movements of said valve, a chamber in said body communicating with the end of said bore toward which the valve moves during opening, said valve having a piston portion exposed to fuel pressure in said passage means adjacent said outlet for moving the valve in its opening direction, said passage means including a cavity in said body facing said cylinder open end, a check valve in said cavity for preventing reverse flow through said passage means to said cylinder, said cylinder having a seating surface for said check valve when in closed position, said body having a stop limiting opening movement of the check valve, said stop being located in said cavity, and a passage through said stop connecting said cavity and said chamber, said passage being closed by said check valve when said check valve is against said stop.

2. In a unit fuel injector-pump, a pump cylinder open at one end, a plunger reciprocable in said cylinder for displacing fuel therefrom via said open end, a fuel injector having a valve body secured to said end of the cylinder, said valve body having a cavity facing the cylinder, a spring chamber, a passage connecting said cavity and chamber, a fuel delivery passage connected at one end to said cavity and terminating at its other end with a fuel outlet, a needle valve normally closing said outlet, a bore slidably guiding said needle valve for movement toward and away from said outlet, a spring in said chamber biasing the needle valve closed, said needle valve having a piston portion exposed to fuel pressure in said delivery passage tending to open the needle valve and exposed to fuel pressure in the spring chamber tending to close the needle valve, and a check valve movable in said cavity between a position interconnecting said passages and a position interconnecting said cylinder and said fuel delivery passage.

3. In a unit fuel injector-pump, a pump cylinder open at one end for fuel delivery, an injector opposite said cylinder end having a fuel outlet, passage means connecting said cylinder end and said outlet, a valve movable to close and open said outlet, a spring biasing the valve closed, a chamber enclosing said spring, said valve having a piston portion with one end exposed to fuel pressure in said passage means for moving the valve in the opening direction against the biasing force of said spring and its other end exposed to fuel pressure in said spring chamber for assisting said spring in moving the valve in the closing direction, said passage means including a cavity in said injector facing and extending laterally of said cylinder open end, a check valve in said cavity for preventing reverse flow into said cylinder from said cavity, a stop in said cavity limiting opening movement of said check valve, a passage through said stop connecting said cavity and said chamber, said cylinder end having a seating surface engageable by the check valve to block reverse flow into the cylinder from the cavity, and said stop having a seating surface engageable by the check valve to block fuel flow into the chamber from the pump cylinder via said cavity and said passage.

4. In a unit fuel injector-pump, a fuel supply connection, a pump cylinder, a plunger reciprocable in the cylinder, said cylinder being open at one end for injection of fuel displaceable by the plunger during its injection stroke and having a side port connected to said supply connection and traversed by the plunger during its fuel injection stroke, said plunger having bypass means connected to said cylinder open end and connectible to said port upon traverse thereby of the plunger on its injection stroke to terminate injection, a fuel injector including a valve body connected to said cylinder end, said body having a chamber, a passage connecting said chamber to the open end of said cylinder, an injection fuel delivery passage connected at one end to cylinder open end and terminating with a fuel outlet, an injection valve in said delivery passage normally closing said outlet, said injection valve being exposed to fuel pressure in said chamber urging the injection valve closed and having a piston portion exposed to fuel pressure in said delivery passage urging the injection valve open, and a check valve movable against said cylinder end to interconnect said passages and block reverse flow into the cylinder from said delivery passage, said check valve being alternately movable against said valve body to block flow into said first named passage from said cylinder end and accommodate flow into said delivery passage from said cylinder end.

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