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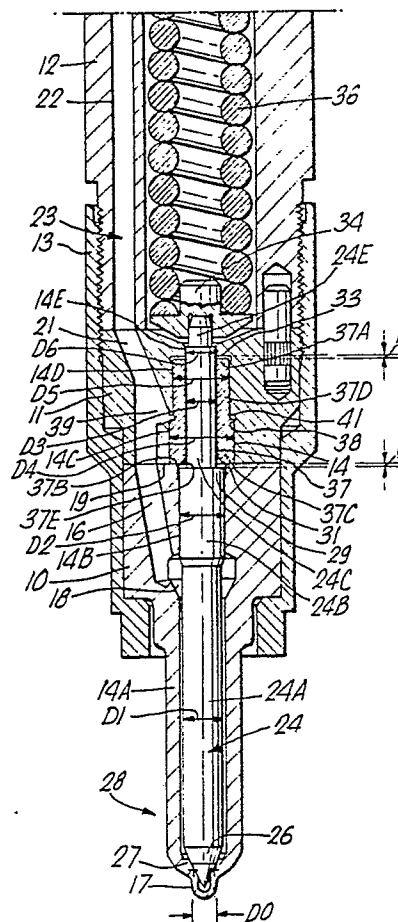
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54 Fuel injection nozzle.

57 A two stage lift fuel injection nozzle for supplying fuel to an internal combustion engine including a valve member (24), the valve member (24) being retractable rearwardly from a first position in which the fuel injection nozzle is closed to a second position against a biasing force provided by a spring, and from a second position to a third more retracted position against the spring and a forwardly directed force due to the pressure of fuel supplied to a sleeve which, between the second and third position, acts on the valve member (27).



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FUEL INJECTION NOZZLE

The present invention relates to a fuel injection nozzle. Fuel injection nozzles are used to supply fuel to an internal combustion engine. They are used in both diesel and petrol injection engines, although the preferred embodiment to be described is primarily intended for a diesel injection engine which operates at high pressures.

The preferred fuel injection nozzle of the invention is of a so called "two-stage lift" type of injection nozzle, in which a valve member which closes fuel injection jets in the nozzle, is retractable against a spring force over a first range of movement by the effect of a lower fuel pressure range, and over a further, second range of movement by the effect of a discontinuously greater range of pressure. In some instances, it is desired that the discontinuity between the two ranges of pressures be great, but in some applications it is desired that the discontinuity be small and there have been difficulties with providing fuel injection nozzles in which this discontinuity is present, but is small.

The present invention provides, according to one aspect, a fuel injection nozzle for supplying fuel to an internal combustion engine comprising

a body including a bore and a fuel inlet passage through which, in use, fuel under pressure is supplied to the bore, one end of said bore including an outlet and a valve means;

a valve member moveably mounted in the bore, said valve member being arranged so that when it is in a first position it closes said valve means to close communication between said bore and said outlet, the valve member including a rearwardly facing shoulder means;

a sleeve means surrounding the valve member behind the rearwardly facing shoulder means, said valve member being retractable from said first position to a second position in which its rearwardly facing shoulder means engages said sleeve means;

a stop means, said valve member being further retractable from said second position to a third position in which it is stopped from further retraction by engagement of said stop means with a first part of said sleeve means and a second part of said sleeve means with said rearwardly facing shoulder means of said valve member;

biasing means for urging the valve member in a forwards direction towards said first position,

the arrangement being such that the valve member is retractable rearwardly from the first position to the second position against the biasing means by a first force provided by the pressure of fuel applied to the valve member in the rearwards direction alone, and the valve member is retractable from

the second position towards the third position against said biasing means by a combination of said first force and a second forwardly directed force due to the pressure of the fuel applied directly to a third part of said sleeve means.

Said first part of said sleeve means is preferably a rear end surface of said sleeve means, said second part is preferably a front end surface of said sleeve means and the third part is preferably a rearwardly facing shoulder intermediate the opposite ends of the sleeve means.

The rearwardly facing shoulder of the sleeve means preferably extends into a chamber formed by the sleeve means, and the bore, the chamber being fluidly connected to said fluid inlet passage whereby the pressure of the fuel is applied to said chamber.

Means may be provided to restrain movement of the sleeve means whilst said valve member is between said first and second positions, so that the second force is not transmitted by the front end of the sleeve means to said rearwardly facing shoulder. Said means to restrain the sleeve means may comprise a shoulder in the bore, which engages with the front end surface of the sleeve means.

An example of fuel injection nozzle in accordance with the invention will now be described with reference to the accompanying drawing in which shows an axial section through the nozzle.

The nozzle comprises a body 10 above which is mounted an adapter plate 11. Above the adapter plate 11 is a spring housing 12, parts 10, 11, 12 being mounted in a casing 13. The parts 10 to 13 are of high grade steel suitable to withstand high pressure. Body 10 and adapter plate 11 which are mounted face to face include a stepped axial bore 14.

The lower (front) end of the bore 14 is substantially closed, but includes fuel jets 17.

As is apparent from the drawings, the bore 14 extends both into the body 10 and through the adapter plate 11. The part of the bore 14 in the body 10 comprises a front end 14A between an enlarged part of the bore 14 forming a gallery 18 and the fuel jet 17, and a second more rearward part 14B between the gallery 18 and a rear face 19 of the body 10.

The parts 14C, 14D, 14E of the bore 14 in the adapter plate 11 are shown in the figure. The diameter of the part 14C is greater than that of 14B. The diameter of the part 14D is smaller than that of 14C. The diameter of part 14E is considerably smaller than the diameter of the part 14D whereby a forward facing shoulder 33 is formed between the parts 14D and 14E.

An oblique bore 16 extends from the gallery 18 formed by an enlargement of the bore 14 to the rear face 19 of the body 10.

The rear end of oblique bore 16 aligns with a bore 21 formed through the adapter plate 11 and the rear end of this bore 21 align with a bore 22 through the housing 12. The bores 16,21,22 form a fuel inlet passage 23.

Slidably mounted within the bore 14 is a valve member 24. A first part 24A of the valve member 24 of diameter D1 extends between the gallery 18 and the front end of the bore 14. This part 24A is narrower than the corresponding part 14A of the bore 14 so as to allow fuel to pass from the gallery 18 to around the front end 26 of the valve member 24. The front end 26 of the valve member 24 cooperates with a valve seat 27 formed at the front end of the bore 14, to provide a valve 28. Axial movement of the valve member 24 controls the flow of fuel from the bore 14 to the jets 17.

Above the gallery 18, a second part 24B of the valve member 24 has an outer diameter D2 larger than the first part 24A but the same as the diameter of the corresponding part 14B of the bore 14 (with a suitable working clearance). The rear end of part 24B of the valve member 24 is defined by a rearward facing shoulder 29 and the bore 14 includes a rearward facing shoulder 31 (between bore parts 14B and 14C) disposed at a distance a rearwardly of the shoulder 29 when the valve member 24 is in a position closing the valve 28 (ie as in the Figure and defined as a "first position"). In fact this rearwardly facing shoulder 31 comprises the rear end 19 of body 10 and is provided by the greater diameter of the bore part 14C in the adapter plate 11 than the bore part 14B in the body 10.

Rearward of the shoulder 29, the valve member 24 forms a third narrower cylindrical part 24C of diameter D3. The rear end of the part 24C is terminated by a coaxial spigot 24E extends rearwardly into engagement with a spring seat 34 which is urged forwardly by a coil spring 36.

Between the shoulder 29 and the shoulder 33 there is mounted a sleeve 37, the sleeve 37 having an inner diameter that it is a sliding fit with the part 24C of the valve member 24 and a stepped outer diameter, with a rearwardly directed shoulder 38 between a forward greater diameter part 37C of diameter D4 and a rearward part 37D of diameter D5. The sleeve 37 also has rear, 37A, and front, 37B, ends. The rear end 37A of the sleeve 37 is spaced from the shoulder 33 by a distance b. The parts 37C and 37D are sliding fits with close clearance with the respective bore parts 14C,14D.

A side bore 39 interconnects the fuel inlet passage 23 and an annular slot 41 formed between the shoulder 38 and adjacent part of the bore 14, the relevant parts of the bore 14 and sleeve 37

being relieved to provide the slot 41.

In use of the injection nozzle, the complete assembly is mounted to an engine and fuel is supplied to the fuel inlet passage 23 and thence to the jets 17 where it is injected into the engine.

Initially the valve 28 is closed by the spring 36 (ie the valve member 24 is in the first position as shown the Figure). Fuel under pressure is supplied to the fuel inlet passage 23, and the pressure passes down that passage through the adapter plate 11 to the gallery 18. The pressure of the fuel within the gallery 18, causes a first, rearward force to tend to retract the valve member 24 against the bias of the coiled compression spring. This is because the fluid pressure of the fuel is applied to an effective cross sectional area of the valve member 24 comprising an annular area of outer diameter D2, and inner diameter approximating to the diameter of the valve seat 27. When the force provided by the fuel pressure applied over that annular area is sufficient to overcome the biasing force of the compression spring, the valve member 24 will retract thereby opening the valve 28. It will normally continue to retract because although substantially to all of the forward faces of the valve member 24, thereby effectively increasing the rearwardly applied first force.

The pressure of fuel is also applied through the side bore 39 to the annular slot 41 and this produces a force which urges the sleeve 37 forwards so that the front end 37B of sleeve 37 engages the rearwardly facing shoulder 31 of the bore 14.

If the fuel system is operating such that the pressure of the fuel within the gallery 14 continues to increase then the valve member 24 will continue to retract.

When the valve member 24 has retracted by the distance a the rearwardly facing shoulder 29 of the valve member 24 will strike the front end 37B of sleeve 37. At this point, (referred to as the "second position" of the valve member 24) for the valve member 24 to retract further, it is necessary for the sleeve 37 to move rearwardly against a second force caused by the fuel fluid pressure in the annular slot 41 applied to the shoulder 38 of sleeve 37 (ie over an annular area having an inner diameter D5 and an outer diameter D4). Thus it is necessary for the fuel pressure to increase so that the rearwardly directed first force is sufficient to overcome not only the spring force of the compression spring, but also the forwardly directed second force.

There is no fuel pressure in the area of the front end 37B of the sleeve 37 owing to the relief of the pressure by the clearance between the inside diameter of the sleeve 37 and the outside diameter of the part 24C of the valve member 24. This is aided by relieving 24C of the valve member 24.

This is aided by relieving the lower inside diameter of the sleeve 37 at 37E.

When the fuel pressure rises to a point sufficient to move the valve member 24 rearwardly from the second position, the valve member 24 will move towards a third position in which the rear surface 37A of the sleeve 37 engages with the shoulder 33 of the adapter plate 11. The sleeve 37 is then effectively trapped between the valve member 24 and the adapter plate 11 thereby preventing further rearward movement of the valve member 24.

The present arrangement of the invention has a number of advantages. The value of the second force is proportional to the area of the annulus having an inner diameter D5 and an outer diameter D4 and this can readily be adjusted during manufacture so as to be quite small. On the other hand, the surfaces which finally stop the valve member in its rearward movement and which are therefore subject to wear, comprise the relatively large areas of the opposite ends of the sleeve 37 acting between the shoulder 33 and the shoulder 29 of the valve member 24. The relatively large size of the surfaces reduces the wear on them.

The invention is not restricted to the details of the foregoing example. For example, it might be applied to 'other types of' injection nozzle. Also the adapter plate 11 could be part of the body 12.

Claims

1. A fuel injection nozzle for supplying fuel to an internal combustion engine comprising a body (10) including a bore (14) and a fuel inlet passage (23) through which, in use, fuel under pressure is supplied to the bore (14), one end (14A) of said bore (14) including an outlet (17) and a valve means (27);

a valve member (24) movably mounted in the bore (14), said valve member (24) being arranged so that when it is in a first position it closes said valve means (27) to close communication between said bore (14) and said outlet (17), the valve member (27) including a rearwardly facing shoulder means (29);

a sleeve means (37) surrounding the valve member (27) behind the rearwardly facing shoulder means (29), said valve member (27) being retractable from said first position to a second position in which its rearwardly facing shoulder means (29) engages said sleeve means (37);

a stop means (33), said valve member (27) being further retractable from said second position to a third position in which it is stopped from further retraction by engagement of said stop means (33) with a first part (37A) of said sleeve means (37)

and a second part (37B) of said sleeve means (37) with said rearwardly facing shoulder means (29) of said valve member (27);

biasing means (36) for urging the valve member (24) in a forwards direction towards said first position,

the arrangement being such that the valve member (24) is retractable rearwardly from the first position to the second position against the biasing means (36) by a first force provided by the pressure of fuel applied to the valve member (27) in the rearwards direction alone, and the valve member is retractable from the second position towards the third position against said biasing means (36) by a combination of said first force and a second forwardly directed force due to the pressure of the fuel applied directly to a third part (38) of said sleeve means (37).

2. A fuel injection nozzle as claimed in claim 1 characterised in that said first part (37A) of said sleeve means (37) is a rear end surface of said sleeve means.

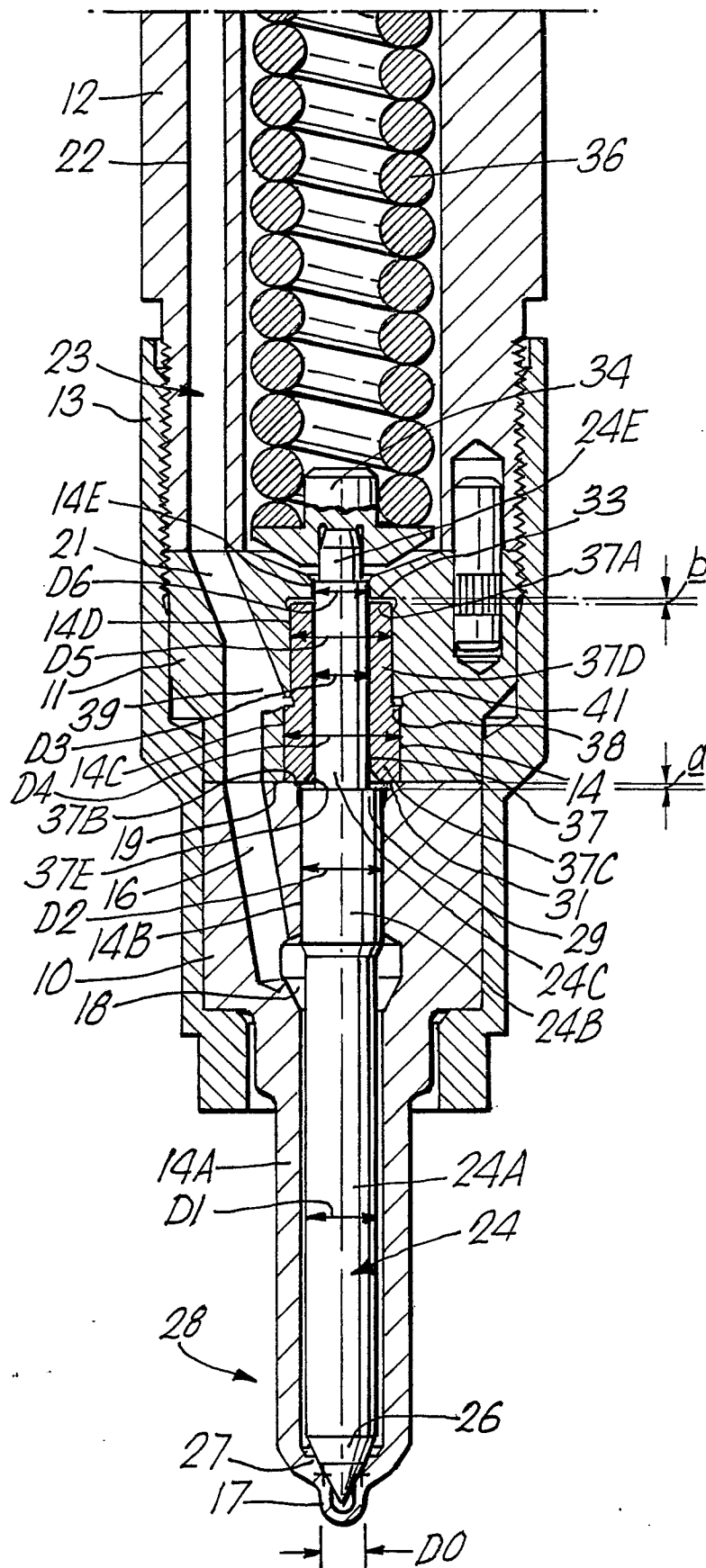
3. A fuel injection nozzle as claimed in claim 1 or 2 characterised in that said second part (37B) of said sleeve means (37) is a front end surface of said sleeve means.

4. A fuel injection nozzle as claimed in any of claims 1 to 3 characterised in that the third part (38) of said sleeve means (37) is a rearwardly facing shoulder (38) intermediate the opposite ends of the sleeve means.

5. A fuel injection nozzle as claimed in any of claims 1 to 4 characterised in that the rearwardly facing shoulder (38) of the sleeve means (37) extends into a chamber (41) formed by the sleeve means (37) and the bore (14), the chamber (41) being fluidly connected to said fuel inlet passage (23) whereby the pressure of the fuel is applied to said chamber (41).

6. A fuel injection nozzle as claimed in any of claims 1 to 5 characterised in that means (31) is provided to restrain movement of the sleeve means (37) whilst said valve member (27) is between said first and second positions, so that the second force is not transmitted by the front end (37B) of the sleeve means (37) to said rearwardly facing shoulder (29).

7. A fuel injection nozzle as claimed in claim 6 characterised in that said means (31) to restrain the sleeve means (37) comprises a shoulder (31) in the bore (14), which engages with the front end surface (37B) of the sleeve means (37).





EP 89 30 9497

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-240693 (ROBERT BOSCH GMBH) * column 2, line 39 - column 4, line 42; figures 1-4 * -----	1-7	F02M45/08
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F02M
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 25 JANUARY 1990	Examiner HAKHVERDI M.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			