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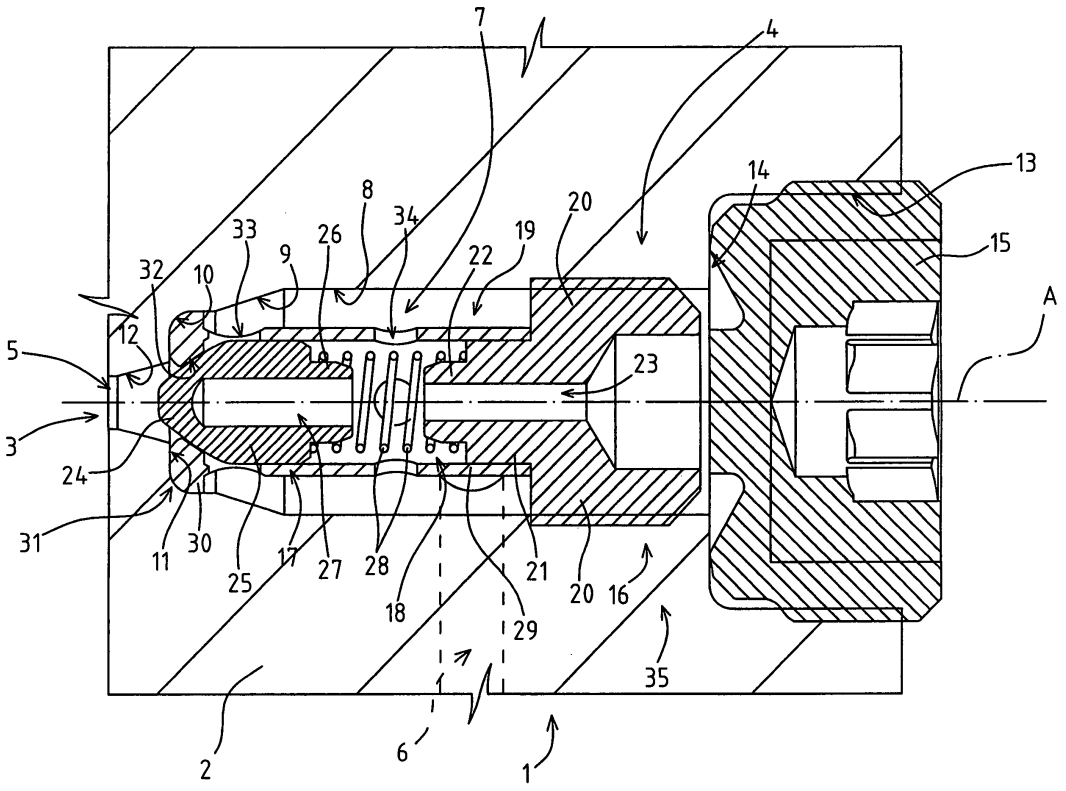
(54) **High-pressure fuel pump**

(57) A high-pressure fuel pump (1) is provided with a pump housing (2); a fuel delivery duct (3); and a delivery valve (4), which extends along a longitudinal axis (A), is arranged along the delivery duct (3), and has a valve seat (7) directly machined in the pump housing (2); a shutter (17) movable between a closed and an open position in the valve seat (7); a fastening member (16) suitable for being fastened to the pump housing (2); a helical spring (18) suitable for biasing the shutter (17) in the closed position; and a sleeve (20), which is fitted to the fastening member (16) and has a sealing ring (30), which is coupled to the valve seat (7) in fluid-tight manner and defines a fuel passage and an abutment for said shutter (17) so as to allow the shutter(17) closing the fuel passage.



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Description

[0001] The present invention relates to a high-pressure fuel pump for an internal combustion diesel engine.

[0002] In particular, the present invention relates to a high-pressure fuel piston pump for feeding fuel to a common rail of an internal combustion diesel engine.

[0003] A high-pressure fuel pump of this type generally comprises a pump housing; a fuel delivery duct; and a delivery valve, which extends along a longitudinal axis along the delivery duct, and comprises a valve seat directly machined in the pump housing; a shutter movable between a closed and an open position in the valve seat; a fastening member suitable for being fastened to the pump housing, and a helical spring suitable for biasing the shutter in the closed position.

[0004] The helical spring is cyclically compressed between the fastening member and the shutter along the above-identified longitudinal axis and cyclically abuts the shutter against a given portion of the valve seat for closing the delivery valve.

[0005] The delivery valve allows the fuel flowing along the delivery duct when the fuel pressure in the delivery duct upstream of the delivery valve reaches a level capable of exerting a force on the shutter higher than the sum of the force exerted by the fuel pressure within the delivery duct downstream of the delivery valve and of the force of the helical spring acting on the shutter. In other words, the delivery valve opens and closes at each stroke of the piston. The shutter is generally made of hard material and the high number of shocks wears out the portion of valve seat in abutment with the shutter.

[0006] As a consequence of the wear the travel of the shutter may change and also the tightness of the coupling between the shutter and valve seat can be severely put in jeopardy.

[0007] Since the valve seat is directly machined in the pump housing, when the portion of valve seat is irreparably worn out the entire high-pressure fuel pump has to be replaced.

[0008] The above-mentioned drawbacks that call for expensive replacements are particularly evident in high-powered diesel engines that require a high fuel flow rate.

[0009] Furthermore, diesel fuels with a poor lubrication power amplify the wear and shorten the life of the high-pressure fuel pump.

[0010] It is an object of the present invention to make a high-pressure fuel pump which is free from the drawbacks of the known art with particular reference to the operation of the delivery valve at high flow rates and pressure up to 2200 bars.

[0011] According to the present invention, there is provided a high-pressure fuel pump comprising a pump housing; a fuel delivery duct; and a fuel delivery valve, which extends along a longitudinal axis, is arranged along the delivery duct, and comprises a valve seat directly machined in the pump housing; a shutter movable between a closed and an open position in the valve seat; a fastening member suitable for being fastened to the pump housing; and a helical spring suitable for biasing the shutter in the closed position; the high-pressure fuel pump being characterised by further comprising a sleeve, which is fitted to the fastening member and comprises a sealing ring, which is coupled to the valve seat in fluid-tight manner and defines a fuel passage and an abutment for said shutter so as to allow the shutter closing the fuel passage.

[0012] According to the present invention, the shutter does not come into contact with the valve seat so that the pump housing is prevented form being worn out and/or damaged by the shutter.

[0013] According to a preferred embodiment of the present invention the fastening member, the shutter, the helical spring, and the sleeve are assembled together to form a valve assembly, before inserting the valve assembly in to the valve seat.

[0014] In accordance with the above-identified preferred embodiment the assembling steps of the high-pressure fuel pump are simplified.

[0015] For a better understanding of the present invention, a preferred embodiment thereof will now be described only by way of a non-limitative example, and with reference to the accompanying drawing, wherein the enclosed figure is a sectional view, with parts removed for clarity, of a high-pressure fuel pump in accordance with the present invention.

[0016] With reference to figure 1, reference numeral 1 indicates as a whole a high-pressure fuel pump suitable for receiving fuel from a low pressure pump (not shown) and for compressing the fuel to pressures higher than 2200 bars for feeding the fuel itself to a common rail of an internal combustion diesel-engine (not shown) in the enclosed figure.

[0017] Pump 1 comprises a pump housing 2 essentially made of a block of metallic material, in which there are machined a cylinder (not shown), a fuel feeding duct (not shown) to the cylinder, a fuel delivery duct 3; and a delivery valve 4 arranged along the delivery duct 3.

[0018] The delivery duct 3 is directly machined in the pump housing 2 and comprises a hole 5 upstream of the valve 4; and a hole 6 downstream of the valve 4. The valve 4 comprises a seat 7 directly machined in the pump housing 2 between hole 5 and hole 6. Hole 5 and seat 7 extend in sequence about a longitudinal axis A, while hole 6 extends radially with respect to the longitudinal axis A and departs from seat 7.

[0019] Seat 7 is delimited by a hole 8 larger than hole 5 and coaxial with hole 5; a truncated cone-shaped face 9 converging towards hole 5; a curved surface 10 flowing into a shoulder 11 perpendicular to the longitudinal axis A, and a further truncated cone-shaped face 12 bridging the shoulder 11 to hole 5 and converging towards hole 5. The seat 7 can be accessed from the outside of the pump housing 2 through a further hole 13, which is larger than hole 8 and is adjacent to an outer face of the pump housing 2.

[0020] The reduction of diameter between hole 13 and hole 8 forms a shoulder 14 perpendicular to longitudinal axis A. Hole 13 is provided with an inner thread and is closed by a threaded bolt 15 in fluid-tight manner. Bolt 15 comprises a portion suitable to abut against shoulder 14 and securing tightness.

[0021] The valve 4 comprises in addition to seat 7, a fastening member 16; a shutter 17; a helical spring 18 compressed between the fastening member 16 and shutter 17; and sleeve 19, which is fitted to the fastening member 16 and houses the shutter 17 and the helical spring 18.

[0022] Fastening member 16, shutter 17, helical spring 18, and sleeve 19 are housed in the seat 7 and are arranged along longitudinal axis A.

[0023] The fastening member 16 comprises a bolt 20, which is provided with an outer thread for engaging a threaded portion of hole 8; a protrusion 21 extending along longitudinal axis A from bolt 20; and a further protrusion 22, which extends along longitudinal axis A from protrusion 21. Helical spring 18 is force fitted about protrusion 22, whereas sleeve 19 is force fitted about protrusion 21. Fastening member 16 is provided with a through hole 23 extending along longitudinal axis A and aligned with longitudinal axis A.

[0024] In the enclosed figure shutter 17 is spear-shaped and is provided with a cone-shaped sealing member 24 flowing into a cylindrical portion 25 and a shank 26, which is force fitted in the helical spring 18. The shank 26 is further provided with a blind hole 27 protruding inside the sealing member 25 to reduce the inertial mass of the shutter 17.

[0025] In an alternative embodiment not shown the shutter is ball-shaped.

[0026] Helical spring 18 comprises a number of turns 28 having a constant diameter and distributed with a constant pitch along longitudinal axis A.

[0027] Sleeve 19 comprises a cylindrical wall 29 arranged about longitudinal axis A and a sealing ring 30 defining a free edge of the cylindrical wall 29 (of the sleeve 19). In other words, the cylindrical wall 29 is force fitted about the protrusion 21 of the fastening member 16 and the sealing ring 30 is located on the side opposite to the fastening member 16. The sealing ring 30 is coupled to the valve seat 7 in fluid-tight manner. The sealing ring 30 is forced against shoulder 11 by threadeadly engaging bolt 20 into hole 8. Sealing ring 30 is provided with an outer sealing surface 31 matching with the curved surface 10 of the valve seat 7 and an inner sealing surface 32 matching with the shape of sealing member 24 of the shutter 17 when the shutter 17 is in the closed position.

[0028] Cylindrical wall 29 is spaced apart from hole 8 (the outer diameter of the wall 29 is smaller than the diameter of hole 8) so that an annular chamber is formed between the cylindrical wall 29 and the seat 7. The cylindrical wall 29 is provided with a number of openings 33 in close proximity to sealing ring 30 so that displacement of the shutter 17 let the fuel flowing from a central passage of the sealing ring 30 to the openings 33 into the annular chamber and, then, into hole 6. The cylindrical wall 29 is further provided with a number of further openings 34 arranged circumferentially in the middle of the cylindrical wall 29 so as to avoid that fuel dwelling inside the sleeve 19 disturbs the displacement of the shutter 17.

[0029] The inner diameter of the sleeve 19 and the outer diameter of the cylindrical portion 25 of the shutter 17 are selected so that the sleeve 19 guides the displacement of the shutter 17 along longitudinal axis A and avoids lateral displacement of the shutter 17 and any misalignment of the shutter 17 with respect to longitudinal axis A.

[0030] In other words, the shutter 17 and the sleeve 19 are slindingly coupled along longitudinal axis A.

[0031] Operations of the delivery valve 4 in the high-pressure fuel pump 1 are well known from the above description. It is worthy to remark that the fastening member 16, the shutter 17, the helical spring 18 and the sleeve 19 can be assembled together so as to form a valve assembly 35 that is further inserted into the valve seat 7 that is closed by bolt 15 in a fluid-tight manner.

[0032] The advantages of the high-pressure fuel pump 1 are the following: shutter 17 does not come into contact with the valve seat 7 so that the pump housing 2 is prevented form being worn out and/or damaged by the shutter 17; the fastening member 16, the shutter 17, the helical spring 18 and the sleeve 19 can be assembled so as to form the valve assembly 35 before inserting it into the valve seat 7 so simplifying the assembling steps; and, should some part of the valve assembly 35 be worn out or damaged during use, the valve assembly 35 can be easily and conveniently be replaced by a new assembly 35 without calling for the replacement of the high-pressure fuel pump 1.

[0033] Further advantages of the high-pressure fuel pump 1 consist in that the eventual misalignments between holes 8 and 13 so as eventual misalignments between bolt 15 and fastening member 16 do not prejudice the correct assembly of the delivery valve 4; and the seat 7 does not require re-working of the surface that, in known valves, contacts directly the shutter.

Claims

1. A high-pressure fuel pump (1) comprising a pump housing (2); a fuel delivery duct (3); and a fuel delivery valve (4), which extends along a longitudinal axis (A), is arranged along the delivery duct (3), and comprises a valve seat (7) directly machined in the pump housing (2); a shutter (17) movable between a closed and an open position in the valve seat (7); a fastening member (16) suitable for being fastened to the pump housing (2), and a helical spring (18) suitable for biasing the shutter (17) in the closed position; the high-pressure fuel pump (1) being **characterised by** fur-

ther comprising a sleeve (20), which is fitted to the fastening member (16) and comprises a sealing ring (30), which is coupled to the valve seat (7) in fluid-tight manner and defines a fuel passage and an abutment for said shutter (17) so as to allow the shutter (17) closing the fuel passage.

2. Pump according to claim 1, **characterized in that** the said sleeve (19) houses said shutter (17) and said spring (18).

3. Pump according to claim 2, **characterized in that** said sleeve (19) is force fitted to the fastening member (16).

4. Pump according to claim 3, **characterised in that** the helical spring (18) is force fitted to the fastening member (16).

5. Pump according to any one of the foregoing claims, **characterised in that** the fastening member (16), the shutter (17), the helical spring (18) and the sleeve (19) are assembled together to form a valve assembly (35), before inserting the valve assembly (35) in the valve seat (7).

6. Pump according to any one of the foregoing claims, **characterised in that** the sleeve (19) is provided with a first number of openings (33) arranged in close proximity of said sealing ring (30) to let the fuel flowing through the fuel passage of said sealing ring (30) to flow to the outside of the sleeve (19) when the valve (4) is open.

7. Pump according to any one of the foregoing claims, **characterised in that** the sleeve (19) is provided with a second number of openings (34) located in the middle of the sleeve (19) along the longitudinal axis (A)

8. Pump according to any one of the foregoing claims, **characterized in that** the sleeve (19) and the shutter (17) are slidingly coupled so that the sleeve (19) guides the displacement of the shutter (17) along longitudinal axis (A) and avoids lateral displacement of the shutter (17) and any misalignment of the shutter (17) with respect to the longitudinal axis (A).

9. Pump according to any one of the foregoing claims, **characterized in that** the fastening member (16) comprises a bolt (18) threaded into the valve seat (7); a first protrusion (21) force fitted into the sleeve (19) and a second protrusion (22) force fitted into the helical spring (18).

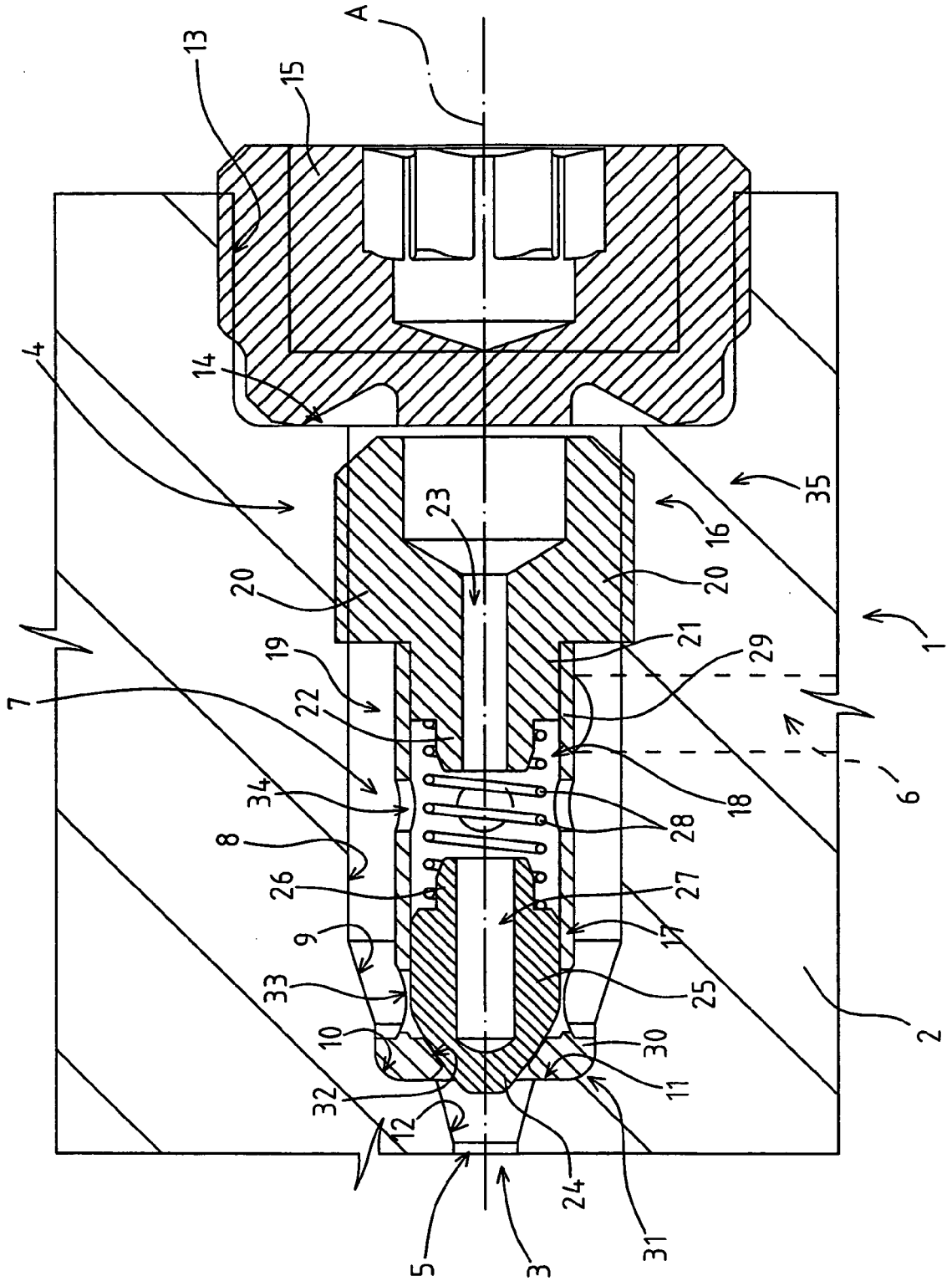
10. Pump according to any one of the foregoing claims, **characterized in that** the fastening member (16) is provided with a through hole (23) extending along longitudinal axis (A); the valve seat (7) being closed in fluid-tight manner by a further bolt (15).

11. Pump according to any one of the foregoing claims, **characterized in that** the shutter (17) is spear shaped and comprised a shank (26) force fitted into the helical spring (18).

12. Pump according to claim 11, **characterized in that** the shutter (17) has a blind hole (27) to reduce the inertial mass of the shutter (17).

13. Pump according to any one of the foregoing claims, **characterized in that** said sealing ring (30) defines a free edge of said sleeve (19).

14. Pump according to any one of the foregoing claims, **characterized in that** the sealing ring (30) is provided with an outer sealing surface (31) matching the shape of a curved surface (10) of the valve seat (7) and an inner sealing surface (32) matching the shape of the shutter (17).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EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5338

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 September 2006	LANDRISCINA, V

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