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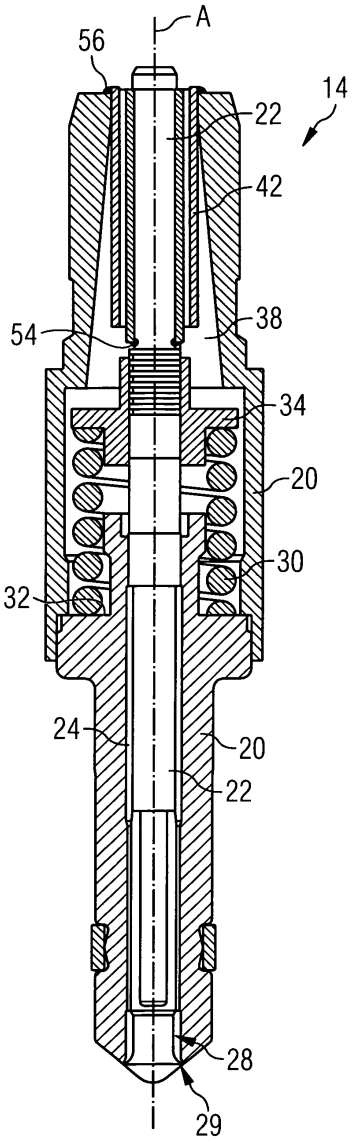
(54) Valve assembly for an injection valve and injection valve

(57) Valve assembly (14) of an injection valve (10), the valve assembly (14) comprising a valve body (20) including a central longitudinal axis (A), the valve body (20) comprising a cavity (24) with a fluid outlet portion (28), a valve needle (22) axially movable in the cavity (24) and a sealing element (42). The sealing element (42) has an inner fixing element (44) and an outer fixing element (48), wherein the inner fixing element (44) is at least partially arranged inside the outer fixing element (48), the outer fixing element (48) having an outer surface (50) coupled with the valve body (20) and the inner fixing element (44) having a cavity (45) forming an inner surface (46) coupled with the valve needle (22), and the inner fixing element (44) and the outer fixing element (48) are sealingly coupled by a layer (52) of an elastic material.

FIG 2



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Description

[0001] The invention relates to a valve assembly for an injection valve and an injection valve.

[0002] Injection valves are in widespread use, in particular for internal combustion engines where they may be arranged in order to dose the fluid into an intake manifold of the internal combustion engine or directly into the combustion chamber of a cylinder of the internal combustion engine.

[0003] Injection valves are manufactured in various forms in order to satisfy the various needs for the various combustion engines. Therefore, for example, their length, their diameter and all the various elements of the injection valve being responsible for the way the fluid is dosed may vary in a wide range. In addition to that, injection valves may accommodate an actuator for actuating a needle of the injection valve, which may, for example, be an electromagnetic actuator or piezoelectric actuator.

[0004] In order to enhance the combustion process in view of the creation of unwanted emissions, the respective injection valve may be suited to dose fluids under very high pressures. The pressures may be in case of a gasoline engine, for example, in the range of up to 200 bar and in the case of a diesel engine in the range of up to 2000 bar.

[0005] The object of the invention is to create a valve assembly for an injection valve and an injection valve which is simply to be manufactured and which facilitates a reliable and precise function.

[0006] This object is achieved by the features of the independent claim. Advantageous embodiments of the invention are given in the sub-claims.

[0007] According to a first aspect the invention is distinguished by a valve assembly of an injection valve, the valve assembly comprising a valve body including a central longitudinal axis, the valve body comprising a cavity with a fluid outlet portion, a valve needle axially moveable in the cavity, and a sealing element. The sealing element has an inner fixing element and an outer fixing element, wherein the inner fixing element is at least partially arranged inside the outer fixing element. The outer fixing element has an outer surface coupled with the valve body and the inner fixing element has a cavity forming an inner surface coupled with the valve needle, and the inner fixing element and the outer fixing element are sealingly coupled by a layer of an elastic material. The sealing element is sealingly coupling the valve body with the valve needle and enables an axial movement of the valve needle relative to the valve body.

[0008] This has the advantage that a sealing element with a good sealing performance can be obtained. A further advantage is that mechanical forces from outside the valve assembly on the valve needle can result in a movement of the valve needle due to the elastic properties of the sealing element. Furthermore, the construction of the sealing element can be very simple and consequently, it is possible to obtain low costs for the sealing element.

[0009] In an advantageous embodiment of the invention, the inner fixing element comprises a section formed as a hollow circular cylinder. In a further advantageous embodiment of the invention, the outer fixing element comprises a section formed as a hollow cylinder. These cylindrical forms allow a simple manufacturing of the inner and the outer fixing element. Furthermore, hollow circular cylinders are highly appropriate for the use in components with circular cross sections as in injection valves.

[0010] In a further advantageous embodiment of the invention the layer is consisting of rubber. This allows the use of a material which has a long term stability in view of tightness against fluids like fuels. Furthermore, the layer may be produced very simply and for very low costs. Preferably the layer consists of viton (Registered Trade Mark). Viton is a synthetic rubber and fluoropolymer elastomer which has a high stability against aggressive chemicals like fuels.

[0011] In a further embodiment of this invention, the rubber is a vulcanized rubber adhesively coupling the inner fixing element to the outer fixing element. By this a secure coupling between the layer and the fixing elements can be achieved.

[0012] In a further advantageous embodiment of the invention, the inner fixing element is coupled to the valve needle by a first welding connection and the outer fixing element is coupled to the valve body by a second welding connection. This enables a coupling of the sealing element in the valve assembly which can have a very high stability.

[0013] According to a second aspect the invention is distinguished by an injection valve with a chamber arranged in the valve body and an actuator unit arranged in the chamber in a way that the valve needle is actuable by the actuator unit and the sealing element prevents a fluid flow between the cavity and the chamber. By these means a good sealing between the chamber with the actuator unit and the cavity is achieved to avoid a fluid flow from the fluid bearing cavity to the chamber with the actuator unit which is sensitive against fluid contact, in particular, if the fluid is a fuel.

[0014] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings. These are as follows:

Figure 1, an injection valve in a longitudinal section view,

Figure 2, a valve assembly of the injection valve in a longitudinal section view, and

Figure 3, a sealing element of the valve assembly of the injection valve in a longitudinal section view.

[0015] Elements of the same design and function that

appear in different illustrations are identified by the same reference characters.

[0016] An injection valve 10 (figure 1) that is used as a fuel injection valve for an internal combustion engine, comprises a housing 12, a valve assembly 14 and an actuator unit 16.

[0017] The housing 12 has a tubular shape. The actuator unit 16 is inserted into the housing 12 and comprises a piezo actuator, which changes its axial length depending on a control signal applied to it. The actuator unit 16 may, however, also comprise another type of actuator, which is known to a person skilled in the art for that purpose. Such an actuator may be, for example, a solenoid.

[0018] The valve assembly 14 comprises a valve body 20 with a central longitudinal access A and a cavity 24 which is axially led through the valve body 20. On one of the free ends of the cavity 24, a fluid outlet portion 28 is formed, which is closed or open depending on the axial position of a valve needle 22. The injection valve 10 further has a fluid inlet portion 26 which is arranged in the housing 12 and which is hydraulically coupled to the cavity 24 and a not shown fuel connector. The fuel connector is designed to be connected to a high pressure fuel chamber of an internal combustion engine, the fuel is stored under high pressure, for example, under the pressure of about 200 bar.

[0019] The valve body 20 has a valve body spring rest 32 and the valve needle 22 comprises a valve needle spring rest 34, both spring rests 32, 34 supporting a spring 30 arranged between the valve body 20 and the valve needle 22.

[0020] The injection valve 10 is of an outward opening type. In an alternative embodiment the injection valve 10 may be of an inward opening type. Between the valve needle 22 and the valve body 20 a bellow 36 is arranged which is sealingly coupling the valve body 20 with the valve needle 22. By this a fluid flow between the cavity 24 and a chamber 38 is prevented. Furthermore, the bellow 36 is formed and arranged in a way that the valve needle 22 is actuable by the actuator unit 16.

[0021] Figure 2 shows a sectional view of the valve assembly 14 with a sealing element 42. Figure 3 shows the sealing element 42 in a longitudinal section in an enlarged detailed view.

[0022] The sealing element 42 has a cylindrical inner fixing element 44 and cylindrical outer fixing element 48 coaxially arranged to the inner fixing element 44. The inner fixing element 44 has a cavity 45 which forms an inner surface 46, the outer fixing element 48 has an outer surface 50. The inner fixing element 44 is partially arranged inside the outer fixing element 48. Between the inner fixing element 44 and the outer fixing element 48 a layer 52 is arranged. The layer 52 is of an elastic material and is sealingly coupling the inner fixing element 44 and the outer fixing element 48. The inner fixing element is coupled to the valve needle 22 by the inner surface 46 and a first welding connection 54. The outer fixing element 48 is coupled with the valve body 20 by the outer surface 50 and a second welding connection 56. By these means a stable coupling of the sealing element 42 with the valve body 20 and the valve needle 22 may be enabled.

[0023] The layer 52 consists of rubber, in particular of a vulcanized rubber which is adhesively coupling the inner fixing element 44 to the outer fixing element 48. By this a secure connection between the layer 52 and the fixing elements 44, 48 is enabled. Furthermore, the layer 52 made of a rubber enables a movement of the valve needle 22 in axial direction relative to the valve body 20. In a preferred embodiment, the rubber is viton (Registered Trade Mark), which is a rubber with a high resistiveness against fluids such as fuels thereby enabling a long cycle time of the injection valve.

[0024] The inner fixing element 44 and the outer fixing element 48 are preferably made of stainless steel, as this material enables a long life time of the fixing elements 44, 48 as of their little corrosiveness.

[0025] The sealing element 42 has a length D and an outer diameter D. The ratio of the length L to the outer diameter D of the sealing element 42 is preferably equal or less than one. This is equivalent with that the sealing element 42 is disk-shaped. This embodiment has the advantage that the layer 52 made of rubber can be very easily vulcanized. Furthermore, if the length L of the sealing element 42 is small the length of the valve assembly 14 can be small as well which is an advantage if only little space is available. Furthermore, the side loads of the valve needle relative to the valve body 20 and the friction of the valve needle 22 are small.

[0026] In the following, the function of the injection valve 10 will be described in detail:

> The fuel is led from the fluid inlet portion 26 in the housing 12 towards the valve body 20 and then towards the fluid outlet portion 28. The fluid flow from the fluid outlet portion 28 to the chamber 38 with the actuator unit 16 is prevented by the sealing element 42.

[0027] The valve needle 22 prevents a fluid flow through the fluid outlet portion 28 in the valve body 20 in a closing position of the valve needle 22. Outside of the closing position of the valve needle 22, the valve needle 22 enables the fluid flow through the fluid outlet portion 28.

[0028] In the case that the actuator unit 16 has a piezoelectric actuator, the piezoelectric actuator may change its axial length if it gets energized in an expansion duration of some micro-seconds. By changing its length the actuator unit 16 may effect a force on the valve needle 22. Due to the elastic properties of the layer 52 of the sealing element 42 the valve needle 22 is able to move in axial direction out of the closing position. Outside of the closing position of the valve needle 22 there is a gap between the valve body 20 and the valve needle 22 at an axial end of the injection valve 10 facing away from

of the actuator unit 16. The gap forms a valve nozzle 29.

[0029] The spring 30 can force the valve needle 22 via the valve needle spring rest 34 towards the actuator unit 16. In the case when the actuator unit 16 is de-energized the actuator unit 16 shortens its length. Due to the elasticity of the layer 52 of the sealing element 42 the spring 30 can force the valve needle 22 to move in axial direction in its closing position. It is depending on the force balance between the force on the valve needle 22 caused by the actuator unit 16 and the force on the valve needle 22 caused by the spring 30 whether the valve needle 22 is in its closing position or not.

Claims

1. Valve assembly (14) of an injection valve (10), the valve assembly (14) comprising

   - a valve body (20) including a central longitudinal axis (A), the valve body (20) comprising a cavity (24) with a fluid outlet portion (28),
   - a valve needle (22) axially movable in the cavity (24),
   - a sealing element (42) with
   an inner fixing element (44) and an outer fixing element (48), wherein the inner fixing element (44) is at least partially arranged inside the outer fixing element (48), the outer fixing element (48) having an outer surface (50) coupled with the valve body (20) and the inner fixing element (44) having a cavity (45) forming an inner surface (46) coupled with the valve needle (22), and the inner fixing element (44) and the outer fixing element (48) being sealingly coupled by a layer (52) of an elastic material,
   with the sealing element (42) sealingly coupling the valve body (20) with the valve needle (22) and enabling an axial movement of the valve needle (22) relative to the valve body (20).

2. Valve assembly (14) in accordance with claim 1 with the inner fixing element (44) comprising a section formed as a hollow circular cylinder.

3. Valve assembly (14) in accordance with claim 1 or claim 2 with the outer fixing element (48) comprising a section formed as a hollow circular cylinder.

4. Valve assembly (14) in accordance with one of the preceding claims with the layer (52) consisting of rubber.

5. Valve assembly (14) in accordance with claim 4 with the rubber being a vulcanized rubber adhesively coupling the inner fixing element (44) to the outer fixing element (48).

6. Valve assembly (14) in accordance with one of the preceding claims with the inner fixing element (44) being coupled to the valve needle (22) by a first welding connection (54) and the outer fixing element (48) being coupled to the valve body (20) by a second welding connection (56).

7. Injection valve (10) comprising the valve assembly (14) in accordance with one of the preceding claims.

8. Injection valve (10) in accordance with claim 7 with a chamber (38) arranged in the injection valve (10) and an actuator unit (16) arranged in the chamber (38) in a way that the valve needle (22) is actuable by the actuator unit (16) and the sealing element (42) preventing a fluid flow between the cavity (24) and the chamber (38).

FIG 1

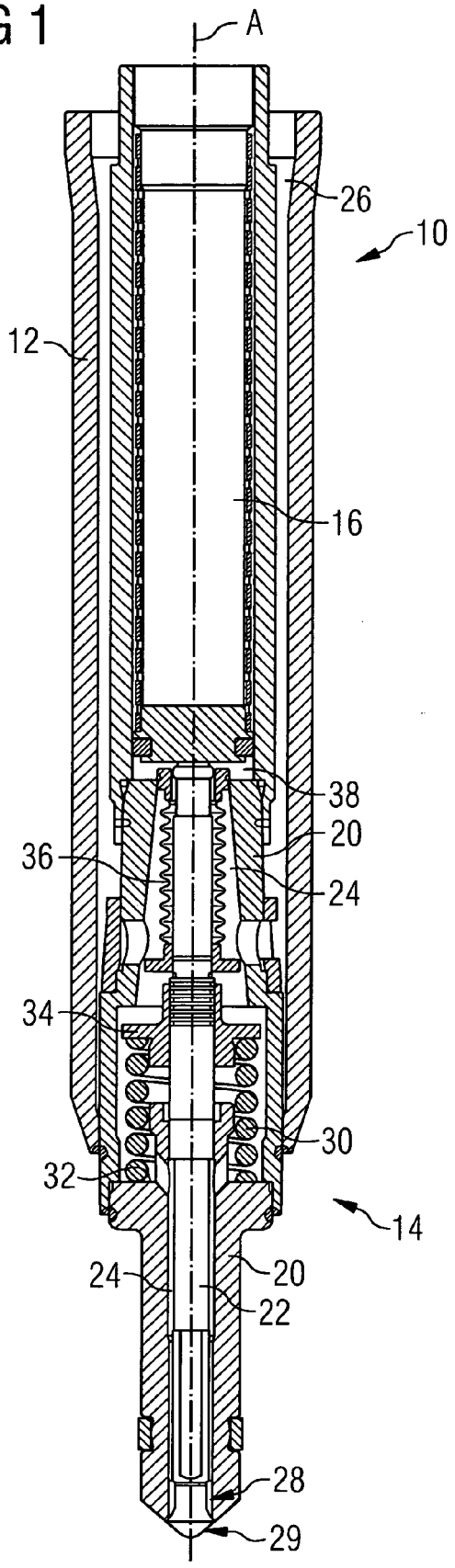


FIG 2

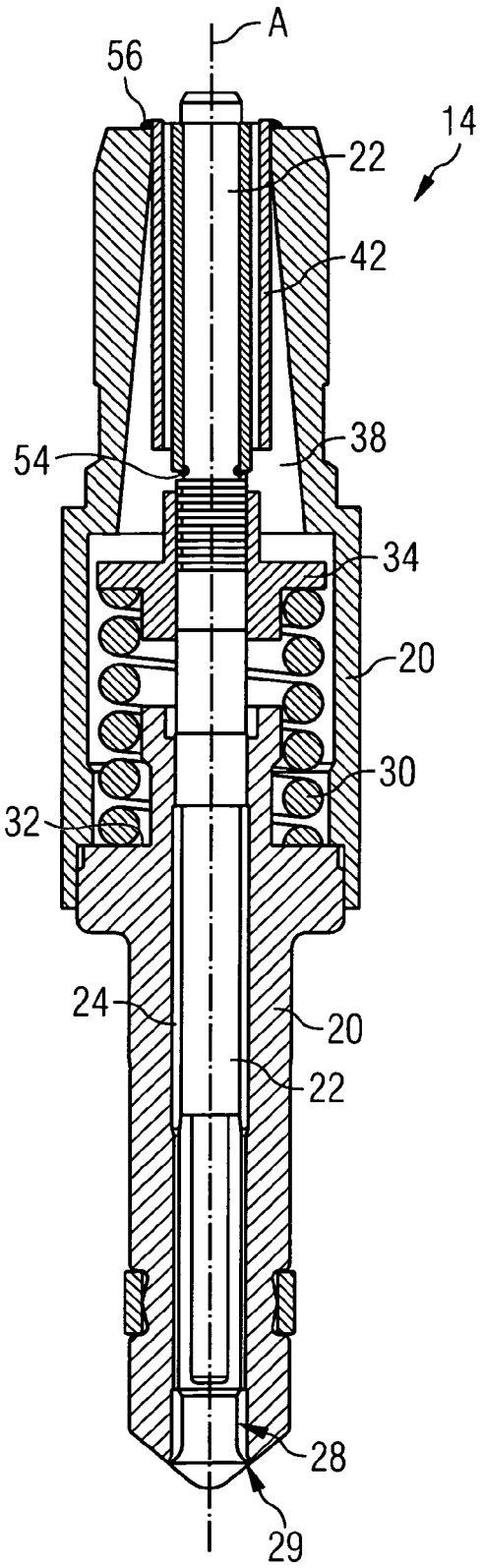
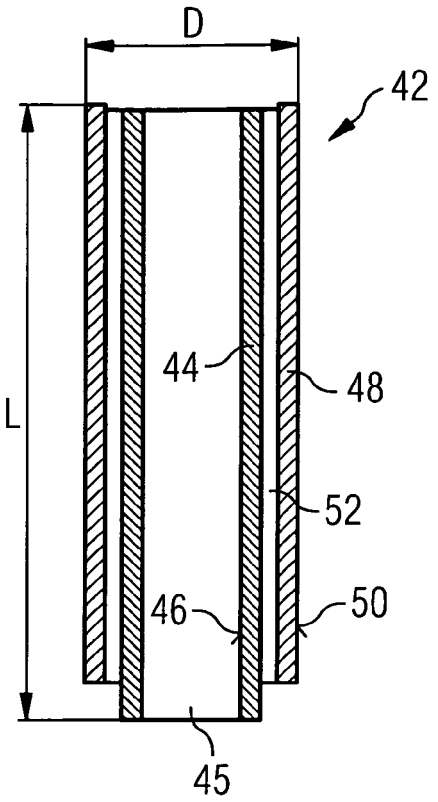


FIG 3



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EUROPEAN SEARCH REPORT

Application Number
EP 06 00 0640

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 102 60 289 A1 (SIEMENS AG) 8 July 2004 (2004-07-08) * paragraph [0026] - paragraph [0029]; figure 1 *	1-8	INV. F02M55/00 F02M61/08 F02M61/16 F02M61/12
A	EP 1 445 478 A (SIEMENS VDO AUTOMOTIVE S.P.A) 11 August 2004 (2004-08-11) * paragraph [0013] - paragraph [0028]; figure 1 *	1-8	F16K41/10
A	EP 1 445 480 A (SIEMENS VDO AUTOMOTIVE S.P.A) 11 August 2004 (2004-08-11) * the whole document *	1-8	
A	EP 1 391 609 A (SIEMENS VDO AUTOMOTIVE S.P.A) 25 February 2004 (2004-02-25) * the whole document *	1-8	
A	GB 2 071 762 A (DAIMLER BENZ AG) 23 September 1981 (1981-09-23) * page 2, line 35 - line 44; figure 6 *	1-8	TECHNICAL FIELDS SEARCHED (IPC)
A	DE 23 46 767 A1 (CASALS CARDONA INDUSTRIAL S.A) 18 July 1974 (1974-07-18) * paragraph [0002] - paragraph [0003]; figure 3 *	1	F02M F16K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12 June 2006	Nobre, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 00 0640

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12-06-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 10260289 A1	08-07-2004	WO 2004057179 A1	08-07-2004
		EP 1573196 A1	14-09-2005
EP 1445478 A	11-08-2004	JP 2004225686 A	12-08-2004
EP 1445480 A	11-08-2004	NONE	
EP 1391609 A	25-02-2004	DE 60204454 D1	07-07-2005
		DE 60204454 T2	04-05-2006
GB 2071762 A	23-09-1981	DE 3009461 A1	01-10-1981
		FR 2478209 A1	18-09-1981
		IT 1170771 B	03-06-1987
		US 4389018 A	21-06-1983
DE 2346767 A1	18-07-1974	ES 410485 A1	16-12-1975

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82