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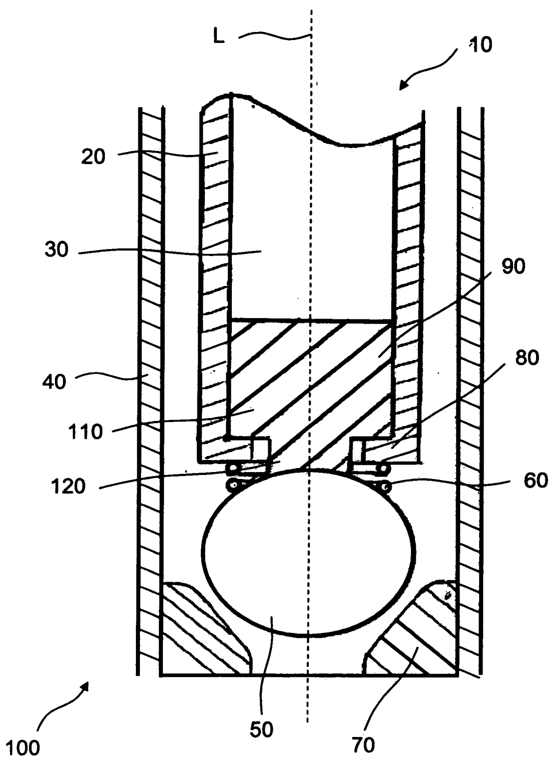
(71) Applicant: **Continental Automotive GmbH**
30165 Hannover (DE)

(72) Inventor: **Guarneri, Giovanni**
56042 Crespina (Pisa) (IT)

(54) **Injection valve having kinetic energy absorbing valve needle**

(57) Injection valve (100), comprising a central longitudinal axis (L) and a valve needle (10). The valve needle (10) comprises a valve needle body (20) being actuated to move axially. The valve needle (10) further comprises a sealing element (50) preventing a fluid injection in a closing position and permitting the fluid injection in further positions. The valve needle (10) also comprises a guiding element (90), being axially moveable and being fixedly coupled to the sealing element (50) and being operable to couple the sealing element (50) to the valve needle body (20). Furthermore the valve needle (10) comprises at least one spring element (60), being preloaded and being adopted to supply the sealing element (50) and/or the guiding element (90) with a spring load to absorb at least partially a kinetic energy of the valve needle body (20), if the sealing element (50) reaches its closing position.

FIG



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Description

[0001] The invention relates to an injection valve comprising a valve needle.

[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 also 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 valve needle of the injection valve, which may, for example, be an electromagnetic 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 diesel engines in the range of up to 2000 bar.

[0005] US 6,523,759 B1 discloses that during operation of the injection valve, a close action of the valve needle to prevent dosing of fluid into the intake manifold or into the combustion chamber is followed by an unwanted reopen and close phase of the valve needle, called needle bounce. During the unwanted reopen and close phase, unwanted fluid is dispensed from the injection valve, resulting in a degraded performance of the injection valve. Therefore, a flow restrictor is disposed in an armature of the valve needle to restrict fluid flow towards an upstream end of the armature, resulting in a reduced bouncing of the valve needle.

[0006] The object of the invention is to create an injection valve which facilitates a reliable and precise function.

[0007] These objects are achieved by the features of the independent claim. Advantageous embodiments of the invention are given in the sub-claims.

[0008] The invention is distinguished by an injection valve comprising a central longitudinal axis and a valve needle. The valve needle comprises a valve needle body being actuated to move axially. The valve needle further comprises a sealing element preventing a fluid injection in a closing position and permitting the fluid injection in further positions. Furthermore, the valve needle comprises a guiding element being axially moveable and being fixedly coupled to the sealing element and being operable to couple the sealing element to the valve needle body. The valve needle also comprises at least one spring element being preloaded and being adopted to supply the sealing element and/or the guiding element with a spring load to absorb at least partially a kinetic energy of the valve needle body, if the sealing element reaches its closing position. This contributes to reducing a bouncing of the valve needle and by this contributes to ensuring a reliable and precise fuel injection. Preferably the valve needle body is coupled to an armature which is actuated by a solenoid in case of an electromagnetic actuated injection valve. In case of a piezoelectric injection valve, the valve needle body is preferably coupled to a piezoelectric actuator. The valve needle body and the sealing element are axially moveable relative to each other and are axially spaced to each other via the at least one spring element. In non-closing positions of the valve needle, the space between the sealing element and the valve needle body is maximal by way of the spring effect of the preloaded spring element. In the moment of reaching the closing position, the sealing element is basically decoupled from the movement of the valve needle body via the spring element and the guiding element. The spring element at least partially absorbs the kinetic energy of the movement of the valve needle body. By this the sealing element is basically not affected by the movement of the valve needle body, thus reducing the bouncing of the sealing element and an uncontrolled fuel injection.

[0009] In an advantageous embodiment of the invention the valve needle body comprises a cavity. The guiding element is disposed at least partially within the cavity and is axially moveable within the cavity. The guiding element is operable to arrange the sealing element coaxial to the valve needle body. This contributes to keep the sealing element coaxial to the valve needle body and by this facilitates a reliable and precise fuel injection. Preferably the guiding element is axially guided by the inner wall of the cavity to keep the sealing element coaxial to the valve needle body.

[0010] In a further advantageous embodiment of the invention the sealing element has a spherical or conical shape. This contributes to ensuring a reliable and precise function of the injection valve.

[0011] In a further advantageous embodiment of the invention a first seat of the at least one spring element is formed by the valve needle body. This facilitates a simple manufacturing of the valve needle.

[0012] In a further advantageous embodiment of the invention a second seat of the at least one spring element is formed by the sealing element. This facilitates a simple manufacturing of the valve needle.

[0013] In a further advantageous embodiment of the invention the valve needle body comprises at least one projection which forms the first seat of the at least one spring element and/or where the guiding element rests on, if the sealing element is in further positions. The further positions of the valve needle represent a non-closing position of the valve needle. In this position the guiding element rests on the projection of the valve needle body and by this pretends the maximal space between the sealing element and the valve needle body. The maximal space between the sealing element and the valve needle body is predetermined in such a way, that the spring element is still preloaded.

[0014] An exemplary embodiment of the invention is explained in the following with the aid of a schematic drawing. The figure depicts an injection valve with a valve needle.

[0015] Elements of the same design and function are identified by the same reference character.

[0016] An injection valve 100 (figure), that is in particular suitable for dosing fuel into an internal combustion engine, comprises an injection valve housing 40 with a central longitudinal axis L, a valve needle 10 and a valve needle seat 70. The valve needle 10 comprises a valve needle body 20, a sealing element 50, a guiding element 90 and a spring element 60.

[0017] The valve needle body 20 preferably has a cylindrical shape and is actuated by an actuator of the injection valve 100, e.g. an electromagnetic actuator or a piezoelectric actuator. While being actuated, the valve needle body 20 moves axially within the injection valve housing 40. The valve needle body 20 comprises a cavity 30 wherein the guiding element 90 is partially disposed. The guiding element 90 comprises a first and a second portion 110, 120 and is at least partially made of stainless steel. The first portion 110 is disposed within the cavity 30 of the valve needle body 20 and has preferably a cylindrical shape with a diameter basically identical to an inner diameter of the cavity of the valve needle body 20. Preferably the guiding element 90 is mainly guided in axial direction by its first portion 110, whereas the guiding element 90 is guided through the inner wall of the cavity 30. The diameter of the second portion 120 is less than the diameter of the first portion 110. The second portion 120 of the guiding element 90 preferably has a cylindrical shape and is fixedly coupled to the sealing element 50, e.g. welded. By this the guiding element 90 is operable to keep the sealing element 50 basically coaxial to the valve needle body 20 and the guiding element 90 and the sealing element 50 are both axially moveable within the injection valve housing 40. This facilitates a precise and reliable fuel injection.

[0018] The valve needle body 20 comprises a projection 80, which forms a seat where the first portion of the guiding element 90 rests on, if the sealing element 50 is in a non-closing position. E.g. the projection 80 may be formed by means of plastical deformation. The axial expansion of the second portion predetermines the maximal space between the sealing element 50 and the valve needle body 20.

[0019] The sealing element 50 has a spherical shape. Alternatively, the sealing element 50 can have a conical shape. In a closing position of the valve needle 10, the sealing element 50 sealingly rests on the valve needle seat 70, by this preventing a fluid flow through at least one injection nozzle of the injection valve 100. The injection nozzle may be, for example, an injection hole. However, it may also be of some other type suitable for dosing fluid. The sealing element 50 permits the fluid injection into the combustion chamber in further positions, i.e. when it does not rest on the valve needle seat 70. The further positions represent non-closing positions.

[0020] By using the guiding element 90, the sealing element 50 is mechanically coupled to the valve needle body 20.

[0021] The spring element 60 is a helical spring and preferably made of stainless steel. The spring element 60 is arranged around the second portion 120 of the guiding element 90. The projection 80 of the valve needle body 20 forms a first seat of the spring element 60 and the sealing element 50 itself forms a second seat of the spring element 60. The spring element 60 is preloaded and keeps the guiding element 90 to rest on the projection 80, if the valve needle 10 is in a non-closing position.

[0022] If the sealing element 50 is in the closing position, the axial space between the sealing element 50 and the projection 80 of the valve needle body 20 facilitates an axial movement, i.e. up and down movement, of the valve needle body 20 within a predetermined axial area.

[0023] If the sealing element 50 impacts the valve needle seat 70 in a closing phase of the injection valve 100 the spring element 60 and the guiding element 90 basically decouple the sealing element 50 from the movements of the valve needle body 20. By this the movements of the valve needle body 20 do not affect the position of the sealing element 50 which still rests on the valve needle seat 70, while the kinetic energy of the valve needle body 20 is at least partially absorbed by the spring element 60. After the sealing element 50 impacts the valve needle seat 70, the valve needle body 20 typically oscillates in axial direction with decreasing oscillation amplitude. A damping constant of the decreasing oscillation of the valve needle body 20 is, among other effects, dependent on the spring rate of the spring element 60. Due to the decoupling of the axial oscillation of the valve needle body 20 and the sealing element 50, the sealing element 50 still rests on the valve needle seat 70 and by this contributes to eliminating a bouncing of the sealing element 50 after impacting the valve needle seat 70. This contributes to preventing an uncontrolled fuel injection during the closing phase of the injection valve 100.

[0024] In another embodiment, the spring element 60 is arranged in such a way that it directly affects the guiding element 90, e.g. within the cavity 30 of the valve needle body 20.

[0025] In a further embodiment, the valve needle 10 comprises more than one spring element. For example, one spring element that directly affects the sealing element 50 as shown in the figure and another spring element that directly affects the guiding element 90, e.g. within the cavity 30 of the valve needle body 20.

Claims

1. Injection valve (100), comprising a central longitudinal axis (L) and a valve needle (10), the valve needle (10) comprising

- a valve needle body (20) being actuated to move axially,
- a sealing element (50) preventing a fluid injection in a closing position and permitting the fluid injection in further positions,
- a guiding element (90), being axially moveable and being fixedly coupled to the sealing element (50) and being operable to couple the sealing element (50) to the valve needle body (20),
- at least one spring element (60), being preloaded and being adopted to supply the sealing element (50) and/or the guiding element (90) with a spring load to absorb at least partially a kinetic energy of the valve needle body (20), if the sealing element (50) reaches its closing position.

2. Injection valve (100) according to claim 1, the valve needle body (20) comprising a cavity (30), whereas the guiding element (90) is disposed at least partially within the cavity (30) and is axially moveable within the cavity (30) and is operable to arrange the sealing element (50) coaxial to the valve needle body (20).

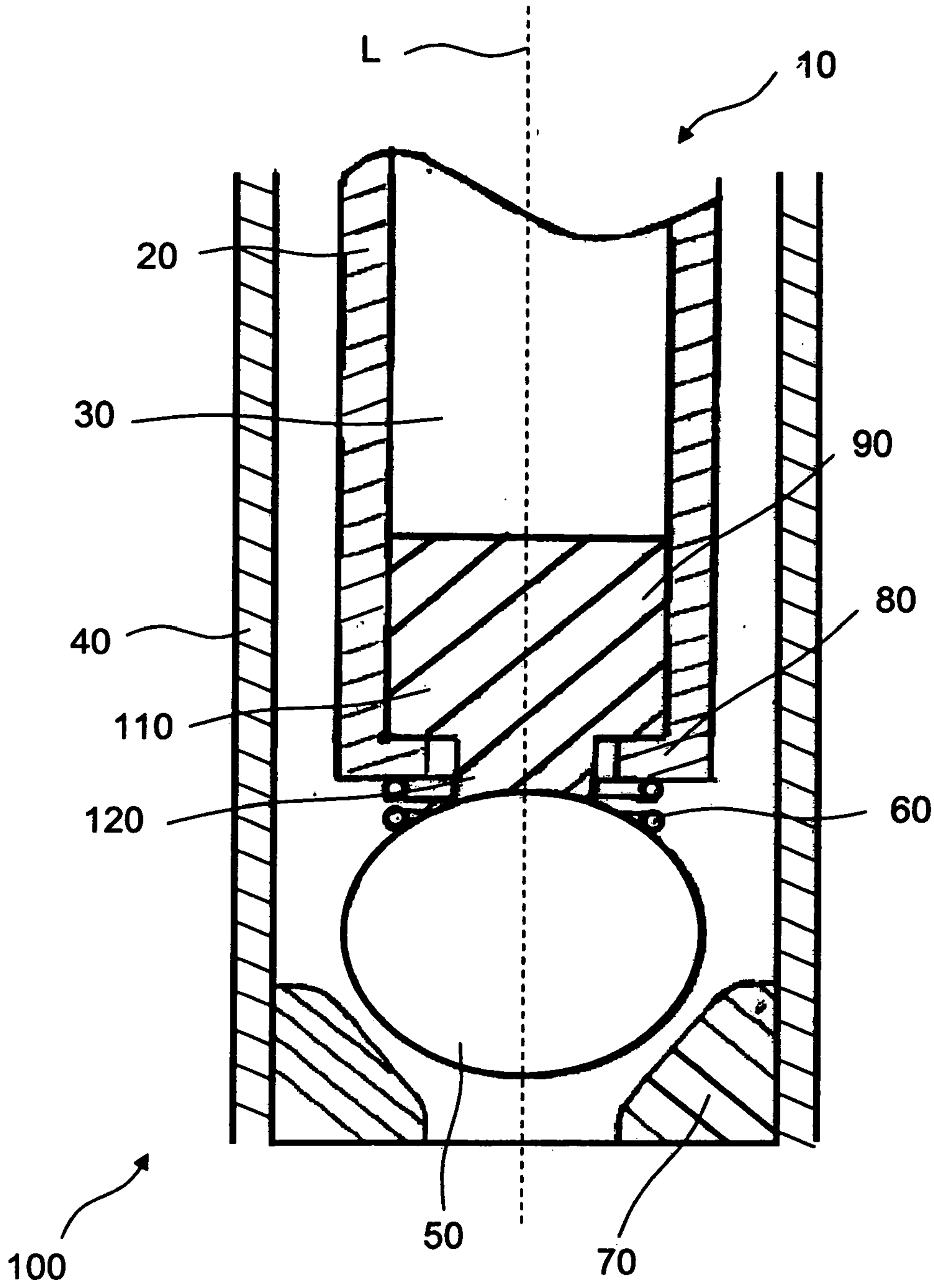
3. Injection valve (100) according to claim 1 or 2, the sealing element (50) having a spherical or conical shape.

4. Injection valve (100) according to one of the preceding claims, wherein a first seat of the at least one spring element (60) is formed by the valve needle body (20).

5. Injection valve (100) according to one of the preceding claims, wherein a second seat of the at least one spring element (60) is formed by the sealing element (60).

6. Injection valve (100) according to one of the preceding claims, wherein the valve needle body (20) comprises at least one projection (80) which forms the first seat of the at least one spring element (60) and/or where the guiding element (40) rests on, if the sealing element (50) is in further positions.

FIG



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EUROPEAN SEARCH REPORT

Application Number
EP 09 00 3116

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 02/06664 A (BOSCH GMBH ROBERT [DE]; YILDIRIM FEVZI [DE]; HOHL GUENTHER [DE]; HUEBE) 24 January 2002 (2002-01-24) * page 4, lines 19-30 * * page 5, lines 1-12; figure 1 * -----	1-6	INV. F02M61/18 F02M61/20 F02M61/10 ADD. F02M63/00
X A	DE 103 25 734 A1 (BOSCH GMBH ROBERT [DE]) 23 December 2004 (2004-12-23) * claims 5,8,9; figures 2,3 * -----	1-3,5 4,6	
A	WO 02/46604 A (BOSCH GMBH ROBERT [DE]; DANTES GUENTER [DE]; NOWAK DETLEF [DE]) 13 June 2002 (2002-06-13) * page 11, lines 25-39; figure 2c * -----	1-5	
			TECHNICAL FIELDS SEARCHED (IPC)
			F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 September 2009	Kolland, Ulrich

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 09 00 3116

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

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