

(19)



(11)

EP 2 698 527 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

19.02.2014 Bulletin 2014/08

(51) Int Cl.:

F02M 61/08 (2006.01)**F02M 61/18** (2006.01)**F02M 63/00** (2006.01)**F02M 51/06** (2006.01)(21) Application number: **12180630.1**(22) Date of filing: **16.08.2012**

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

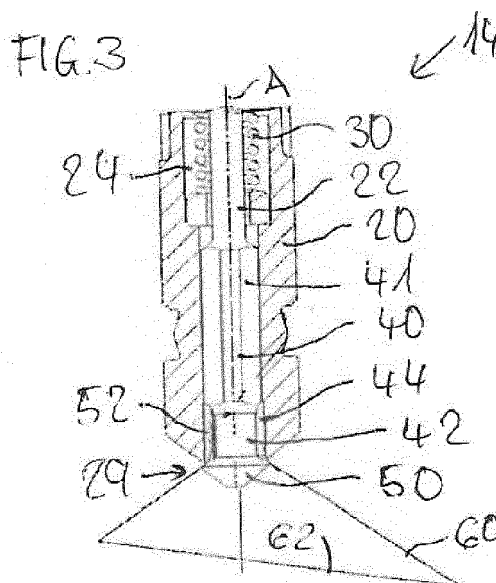
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30165 Hannover (DE)(54) **Valve assembly for an injection valve and injection valve**

(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), the valve needle (22) preventing a fluid flow through the fluid outlet portion (28) in a closing position and releasing the fluid flow through the fluid outlet portion (28) in further positions. The valve needle (22) has a guide portion (40) being designed to guide the valve needle (22) in the valve body (20), a tip portion (50) being de-

signed to act together with the valve body (20) to prevent the fluid flow through the fluid outlet portion (28), and a lower needle portion (42) being arranged axially between the guide portion (40) and the tip portion (50). The lower needle portion (42) comprises a recess (44). The recess (44) enables a fluid flow to the fluid outlet portion (28). A flow resistance element (52) is arranged in the recess (44) radially between the lower needle portion (42) and the valve body (20). The flow resistance element (52) is shaped in a manner that at least in an axial portion of the recess (44) the recess (44) has a cross-section area with a given axially asymmetric shape.

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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 more than 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 claims. 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 movable in the cavity, the valve needle preventing a fluid flow through the fluid outlet portion in a closing position and releasing the fluid flow through the fluid outlet portion in further positions. The valve needle has a guide portion being designed to guide the valve needle in the valve body, a tip portion being designed to act together with the valve body to prevent the fluid flow through the fluid outlet portion, and a lower needle portion being arranged axially between the guide portion and the tip portion and comprising a recess. The recess enables a fluid flow to the fluid outlet portion. A flow resistance element is arranged in the recess radially between the lower needle portion and the valve body. The flow resistance element is shaped in a manner that at least in an axial portion of the recess the recess has a cross-section area with a given axially asymmetric shape.

[0008] This configuration of the valve assembly has the advantage that a fluid flow in the recess and in the fluid outlet portion is available which is axially asymmet-

ric. By this, the flow resistance element may influence the angle and the structure of the fluid spray outside the valve assembly. Consequently, a fluid spray with an axially asymmetric spray structure may be generated.

[0009] In an advantageous embodiment the flow resistance element is fixedly coupled to the valve needle. This has the advantage that the flow resistance element has a fixed position relative to the valve needle. Consequently, a robust spray with an axially asymmetric spray structure may be generated.

[0010] In a further advantageous embodiment the valve needle and the flow resistance element are forming a one-piece element. This has the advantage that the valve needle may be manufactured together with the flow resistance element in one manufacturing process. Consequently, the valve needle with the flow resistance element may be manufactured with low costs.

[0011] In a further advantageous embodiment the flow resistance element is shaped as a bar extending in axial direction between the guide portion and the tip portion of the valve needle. This has the advantage that the flow resistance element may be manufactured in an easy manner.

[0012] According to a second aspect the invention is distinguished by an injection valve comprising an actuator unit and the valve assembly. The valve needle is actuable by the actuator unit.

[0013] 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 with a valve assembly in a longitudinal section view,

Figure 2 a part of the valve assembly in a longitudinal section view in a closing position of the valve needle,

Figure 3 a part of the valve assembly in a longitudinal section view in an opening position of the valve needle, Figure 3A a cross-sectional view of a spray of the injection valve, and

Figure 4 a perspective view of the valve needle.

[0014] Elements of the same design and function that appear in different illustrations are identified by the same reference characters.

[0015] 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.

[0016] The housing 12 has a tubular shape. The actuator unit 16 is arranged in the housing 12. In the shown embodiment the actuator unit 16 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.

[0017] The valve assembly 14 comprises a valve body

20 with a central longitudinal axis A and a cavity 24 which is axially led through the valve body 20. A valve needle 22 which is movable in axial direction is arranged in the cavity 24.

[0018] The injection valve 10 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.

[0019] 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 the valve needle 22. 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.

[0020] A spring 30 is arranged between the valve body 20 and the valve needle 22. The valve needle 22 comprises a spring rest 34. The valve body 20 and the spring rest 34 of the valve needle 22 support the spring 30.

[0021] The injection valve 10 is of an outward opening type. A bellow 36 is arranged between the valve needle 22 and the valve body 20. The bellow 36 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 in which the actuator unit 16 is arranged 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.

[0022] Figures 2 and 3 show an enlarged view of the valve assembly 14 with the valve needle 22. The valve needle 22 has a guide portion 40. The guide portion 40 can guide the valve needle 22 in the valve body 20. The guide portion 40 comprises fluid channels 41 which allow a fluid flow from the fluid inlet portion 26 to the fluid outlet portion 28.

[0023] The fluid channels 41 may be uniformly distributed around the longitudinal axis A. For example, a cross-sectional shape of the guide portion may have an n-fold rotational symmetry, wherein $n \geq 2$, preferably $n \geq 3$, and in particular $n \geq 4$ or $n = 4$. Expediently, n may have a value of 20 or less, in particular of 10 or less. In the present context, a cross-sectional shape is understood to have an n-fold rotational symmetry when a rotation of $360^\circ/n$ around the longitudinal axis A images the cross-sectional shape onto itself, n being a natural number. However, the cross-sectional shape may expediently have a non-circular contour.

[0024] Furthermore, the valve needle 22 has a lower needle portion 42. The lower needle portion 42 has a recess 44. The recess 44 has a basically annular shape. The recess 44 allows a fluid flow to the fluid outlet portion 28. In particular, the lower needle portion 42 may be formed as a constricted section of the valve needle 22 by means of the recess 44.

[0025] At an axial end of the lower needle portion 42

facing away from the fluid inlet portion 26 the valve needle 22 has a tip portion 50. Preferably, the tip portion 50 is conical. The tip portion 50 cooperates with the valve body 20 to prevent or enable the fluid flow through the fluid outlet portion 28.

[0026] Radially between the valve body 20 and the lower needle portion 42 a flow resistance element 52 is arranged in the recess 44. The flow resistance element 52 is fixedly coupled to the valve needle 22. In the shown embodiment the valve needle 22 and the flow resistance element 52 are formed in one piece (Figure 4). The flow resistance element 52 is shaped as a bar. The bar extends in axial direction between the guide portion 40 and the tip portion 50. Due to the flow resistance element 52 the cross-section area of the recess 44 obtains a given axially asymmetric shape. In particular, a geometric center of the cross-section of the lower needle portion 42 including the flow resistance element 52 is radially spaced apart from the central longitudinal axis A.

[0027] In the following, the function of the injection valve 10 will be described in detail:

[0028] The fluid is led from the fluid inlet portion 26 in the housing 12 to the guide portion 40. The fluid passes through the channels 41 of the guide portion 40 and reaches the lower needle portion 42 to be led through the recess 44 to the fluid outlet portion 28 near the tip portion 50 of the valve needle 22. 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 (Figure 2). Outside of the closing position of the valve needle 22, the valve needle 22 enables the fluid flow through the fluid outlet portion 28 and the valve nozzle 29. The fluid flow through the valve nozzle 29 results in a spray 60 which has basically a hollow conical shape. The spray 60 propagates away from the valve nozzle 29 with a spray front 62 (Figure 3).

[0029] In the case that the actuator unit 16 has a piezoelectric actuator, the piezoelectric actuator may change its axial length if it gets energized. By changing its length the actuator unit 16 may effect a force on the valve needle 22. The valve needle 22 can move in axial direction out of the closing position to form the gap between the valve body 20 and the valve needle 22 at the axial end of the injection valve 10 facing away from of the actuator unit 16.

[0030] The spring 30 may force the valve needle 22 towards the actuator unit 16. In the case when the actuator unit 16 is de-energized the actuator unit 16 shortens its length. 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.

[0031] The design of the valve needle 22 with the flow resistance element 52 allows to obtain an injection valve 10 with a restriction of the fluid flow in the recess 44

upstream the tip portion 50 of the valve needle 22. Due to the flow resistance element 52 the front 62 of the spray 60 may have a shape which is not perpendicular to the axis A of the valve needle 22 (Figure 3). The front 62 of the spray 60 may be tilted relative to the longitudinal axis A of the valve needle 22. Furthermore, due to the flow resistance element 52 the cross section of the spray 60 is axially asymmetric as shown in Figure 3A.

[0032] Consequently, injection valves 10 of the outward opening type with the flow resistance element 52 as shown here allow an application of these injection valves 10 in arrangements where an axially asymmetric shaped spray 60 is favorable. This is, for example, if the injection valve 10 is in a side position of a combustion chamber of the internal combustion engine. Consequently, a low emission and a low number of particles of the exhaust gas may be obtained for those applications.

[0033] The invention is not limited to specific embodiments by the description on the basis of said exemplary embodiments but comprises any combination of elements of different embodiments. Moreover, the invention comprises any combination of claims and any combination of features disclosed by the claims.

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), the valve needle (22) preventing a fluid flow through the fluid outlet portion (28) in a closing position and releasing the fluid flow through the fluid outlet portion (28) in further positions, the valve needle (22) having

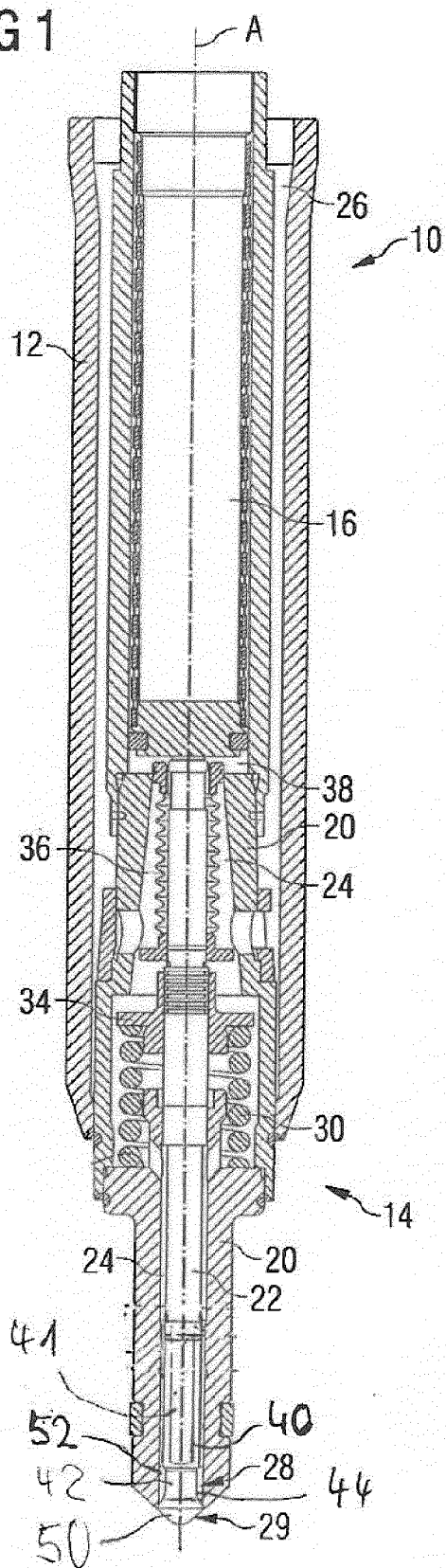
- a guide portion (40) being designed to guide the valve needle (22) in the valve body (20),
- a tip portion (50) being designed to act together with the valve body (20) to prevent the fluid flow through the fluid outlet portion (28), and
- a lower needle portion (42) being arranged axially between the guide portion (40) and the tip portion (50) and comprising a recess (44), the recess (44) enabling a fluid flow to the fluid outlet portion (28), wherein

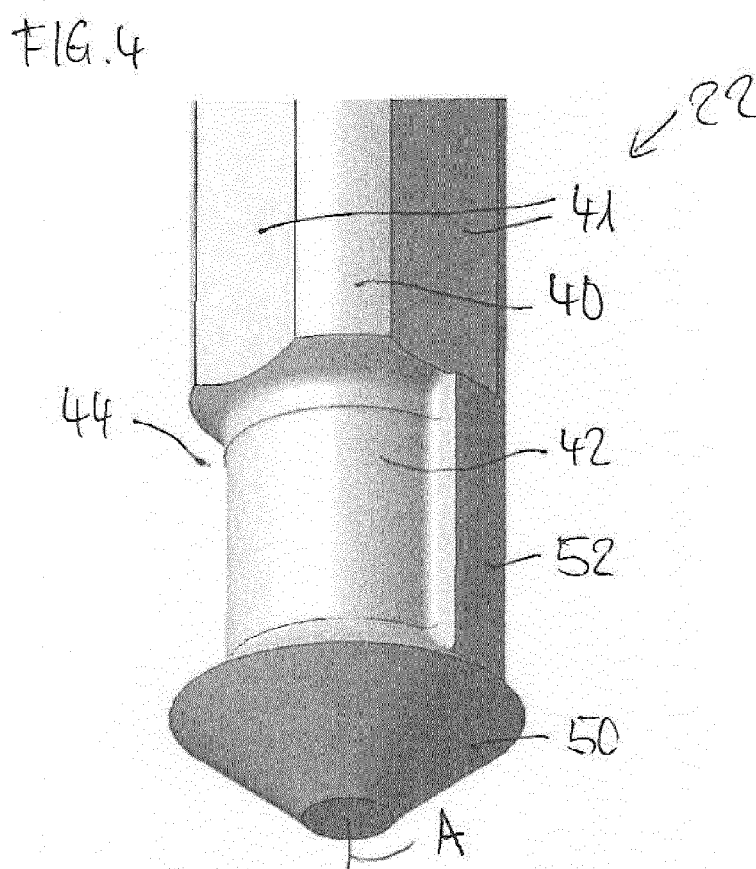
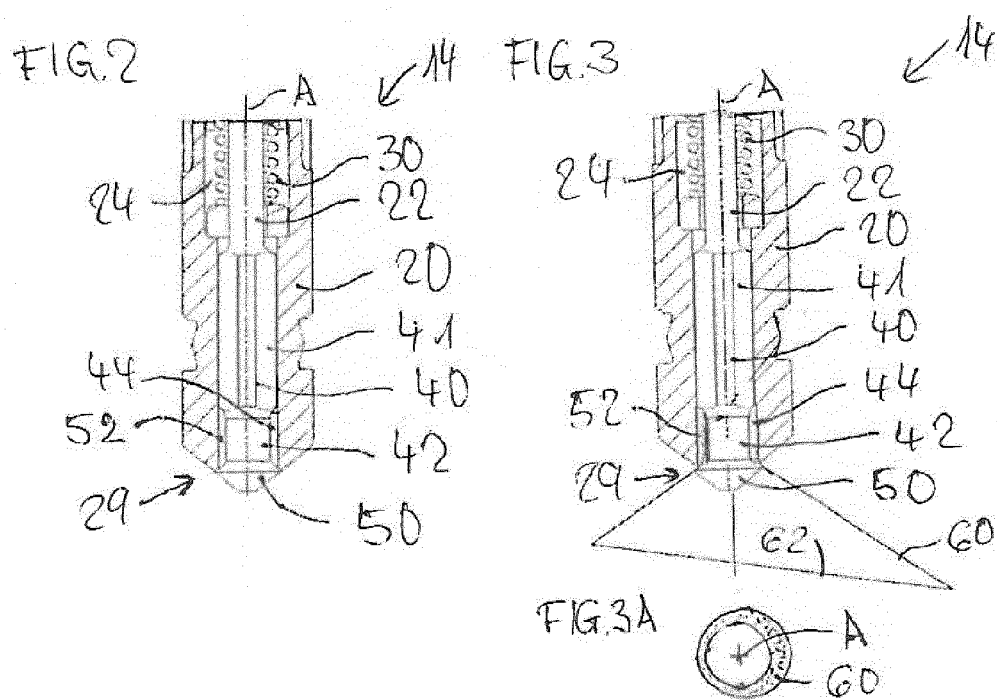
a flow resistance element (52) is arranged in the recess (44) radially between the lower needle portion (42) and the valve body (20), the flow resistance element (52) being shaped in a man-

ner that at least in an axial portion of the recess (44) the recess (44) has a cross-section area with a given axially asymmetric shape.

2. Valve assembly (14) in accordance with claim 1, wherein the flow resistance element (52) is fixedly coupled to the valve needle (22).
3. Valve assembly (14) in accordance with claim 2, wherein the valve needle (22) and the flow resistance element (52) are forming a one-piece element.
4. Valve assembly (14) in accordance with claim 2 or 3, wherein the flow resistance element (52) is shaped as a bar extending in axial direction between the guide portion (40) and the tip portion (50) of the valve needle (22).
5. Injection valve (10) comprising an actuator unit (16) and the valve assembly (14) in accordance with one of the preceding claims, wherein the valve needle (22) is actuable by the actuator unit (16).

FIG 1







EUROPEAN SEARCH REPORT

Application Number
EP 12 18 0630

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	US 4 082 224 A (MANGUS ERVIN E) 4 April 1978 (1978-04-04) * column 4, line 36 - line 54; figures 2,8,9 * * abstract *	1-5	INV. F02M61/08 F02M61/18 F02M63/00 F02M51/06
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A	EP 0 891 851 A1 (FISA CORP [JP]) 20 January 1999 (1999-01-20) * the whole document *	1-4	
			TECHNICAL FIELDS SEARCHED (IPC)
			F02M
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 18 December 2012	Examiner Hermens, Sjoerd
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			

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EPO FORM 1503 03.82 (F04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 18 0630

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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18-12-2012

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