(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 611 368 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.02.2020 Bulletin 2020/08

(51) Int Cl.:
F02M 51/06 *(2006.01)*

(21) Application number: **18189227.4**

(22) Date of filing: **16.08.2018**

(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
Designated Validation States:
KH MA MD TN

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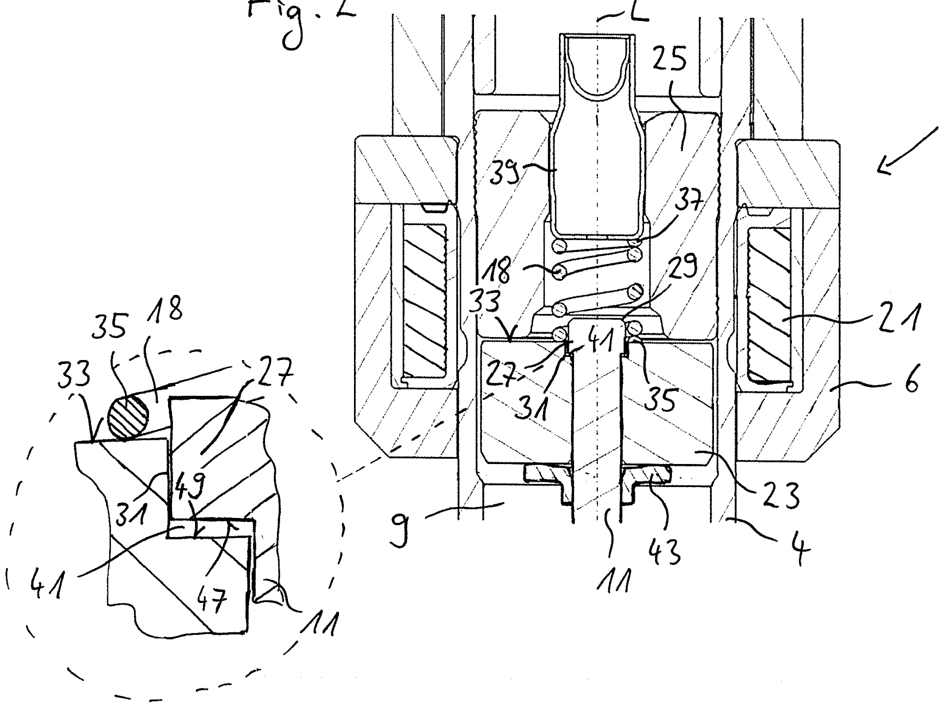
(54) VALVE ASSEMBLY AND FUEL INJECTION VALVE

(57) A valve assembly (3) for an injection valve (1) is disclosed. It comprises a valve body (4), a valve needle (11) axially moveable in a cavity (9) of the valve body (4) and an armature (21) to actuate the valve needle (11). The valve needle (11) comprises a first engagement area (47) and the armature (23) comprises a second engagement area (49) for coupling the armature (23) and the needle (11) when the armature (23) travels upwards and being spaced apart from each other in the closing position of the valve needle (11) . An armature retainer (43) is fixedly coupled to the valve needle (11) below the armature (23). A spring element (18) is in direct contact with an upper side (33) of the armature (23) and acts on the valve needle (11) by way of the armature retainer (43) to bias the valve needle (11) towards the fluid outlet portion (7).

Fig. 2



EP 3 611 368 A1

Description

[0001] The present invention relates to a valve assembly for an injection valve and to an injection valve, e.g. a fuel injection valve of a vehicle. It particularly relates to solenoid injection valves.

[0002] Such injection valves must be able to dose fluids even in the case of high fuel pressure. One design to ensure this is the "free-lift" design. According to this design, the armature of the electro-magnetic actuator unit travels about a "pre-stroke gap" before it engages the needle to open the injector. Thus, kinetic energy is accumulated before the actual opening.

[0003] Sometimes, injection valves according to the "free-lift" design comprise a disc-shaped element, sometimes called "hydro-disc", which is arranged in an axial region of the valve needle facing towards the fluid outlet portion and fixedly connected to the valve needle.

[0004] Injection valves according to the "free-lift" design usually comprise at least two springs: The calibration spring acting on the valve needle, which biases the valve needle towards the fluid outlet portion, and a second spring, sometimes called "armature spring" or "free-lift spring", which acts on the armature and couples the armature to the needle by biasing the armature towards a retaining element of the needle.

[0005] This design is rather complicated and involves a high number of parts, resulting in high costs, high weight of the injector and an elaborate assembly process.

[0006] Therefore, it is an object of the present invention to provide an improved valve assembly according to the "free-lift" design, in particular by reducing the number of parts needed.

[0007] This object is achieved by means of a valve assembly according to claim 1.

[0008] Advantageous embodiments and developments are specified in the dependent claims, the following description and the drawings.

[0009] According to one aspect of the invention, a valve assembly for an injection valve is provided comprising a valve body with a central longitudinal axis comprising a cavity with a fluid inlet portion and a fluid outlet portion. The valve assembly further comprises a valve needle axially moveable 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.

[0010] Furthermore, the valve assembly comprises an armature of an electro-magnetic actuator unit being operable to actuate the valve needle. The armature is axially displaceable relative to the valve body and has an axial play with respect to the valve needle. The valve needle comprises a first engagement area and the armature comprises a second engagement area, the first engagement area and the second engagement area being able to provide a coupling - in particular a form-fit coupling by direct mechanical contact between the first and second engagement areas - between the armature and the needle, when the armature travels upwards. The first engagement area and the second engagement area are spaced apart from each other in the closing position of the valve needle. "Upwards" is understood to mean the direction towards the fluid inlet portion in the context of the present disclosure, "downwards" the direction towards the fluid outlet portion.

[0011] The valve assembly further comprises an armature retainer being fixedly coupled to the valve needle below the armature and a spring element biasing the valve needle towards the fluid outlet portion, the spring element being in direct contact with an upper side of the armature and acting on the valve needle by way of the armature retainer.

[0012] By the armature retainer being fixedly coupled to the valve needle below the armature it is understood that the armature retainer is fixed to the needle on the side of the armature facing towards the fluid outlet portion.

[0013] The upper side of the armature is defined as the side facing towards the fluid inlet portion.

[0014] The valve assembly according to the present invention has the advantage that only one spring is needed to bias the valve needle towards the fluid outlet portion and to couple the armature to the needle. In particular, the spring element is precompressed to bias the valve needle towards the closing position and, at the same time, open an axial gap between the first and second engagement areas by pressing the armature against the armature retainer when the electro-magnetic actuator is de-energized.

[0015] According to an embodiment, the valve needle comprises an annular protrusion on its upper end, the protrusion having an annular lower side facing towards the fluid outlet portion, the annular lower side providing the first engagement area. In this case, the armature retainer may also be denoted as a lower retainer and the annular protrusion as an upper retainer. The upper retainer and the lower retainer are located on opposite sides in axial direction of the armature. The upper retainer and the lower retainer are distanced such that the armature has an axial play between the upper retainer and the lower retainer. In some embodiments, the annular protrusion is in one piece with a shaft of the valve needle. In other embodiments, it is a separate piece which is fixed to the shaft.

[0016] In one development, the armature has an at least generally flat upper side comprising an annular portion providing the second engagement area. In another development, the armature comprises an annular recess in its upper side, the recess having an annular base area facing towards the fluid inlet portion, the annular base area providing the second engagement area.

[0017] According to the latter development, the protrusion of the needle fits into the recess of the armature. The annular portion or the annular base area, respectively, provide a form-fit coupling of the armature and the needle, when the free-lift gap is closed. When the free-lift gap is closed, the first engagement area comes into contact with the second engagement area and the force of the armature traveling upwards acts on the valve needle across the engagement area, taking the needle upwards and thereby opening the valve.

[0018] This has the advantage, that the design of the components providing the engagement is very simple and robust.

[0019] According to an embodiment, the armature retainer is disc-shaped. A disc-shaped armature retainer is sometimes known as a "hydro-disc" and can prevent or at least largely reduce bouncing of the needle: The disc-shaped element limits the movement of the armature relative to the valve needle, and, when the valve needle is in the closing position, also relative to the valve body in direction towards the fluid outlet portion and therefore functions as an armature stop. Furthermore, it operates to dissipate kinetic energy of the armature during the closing-phase of the valve, because fluid is squeezed through the gap between the armature and the disc-shaped element. Thus, the disc-shaped element helps to reduce bouncing of the needle and post-injections.

[0020] According to an embodiment, a lower end of the spring element is supported by the upper side of the armature, while an upper end of the spring element is supported by a calibration tube. The calcibration tube may comprise a filter. Thus, a preload of the spring can be adjusted during assembly by inserting the calibration tube, which also serves to filter incoming fuel.

[0021] According to an aspect of the present invention, a fuel injection valve comprising the valve assembly is provided. The injection valve has the advantages described in connection with the valve assembly.

[0022] Further advantages, advantageous embodiments and developments of the valve assembly will become apparent from the exemplary embodiments which are described below in association with the schematic figures.

Figure 1 shows a sectional view of an injection valve with a valve assembly according to one embodiment of the invention and

Figure 2 shows a detail of figure 1.

[0023] Figure 1 shows an injection valve 1 that is in particular suitable for dosing fuel to an internal combustion engine. The injection valve 1 comprises in particular a valve assembly 3. The valve assembly 3 comprises a valve body 4 with a central longitudinal axis L. A housing 6 is partially arranged around the valve body 4 .

[0024] The valve body 4 comprises a cavity 9. The cavity 9 has a fluid outlet portion 7. The fluid outlet portion 7 communicates with a fluid inlet portion 5 which is provided in the valve body 4. The fluid inlet portion 5 and the fluid outlet portion 7 are in particular positioned at opposite axial ends of the valve body 4. The cavity 9 takes in a valve needle 11. The valve needle 11 comprises a needle shaft 15 and a sealing ball 13 welded to the tip of the needle shaft 15.

[0025] In a closing position of the valve needle 11, it sealingly rests on a seat plate 17 having at least one injection nozzle. A preloaded calibration spring 18 exerts a force on the needle 11 towards the closing position. The fluid outlet portion 7 is arranged near the seat plate 17.

[0026] In the closing position of the valve needle 11, a fluid flow through the at least one injection nozzle is prevented. The injection nozzle may be, for example, an injection hole. However, it may also be of some other type suitable for dosing fluid.

[0027] The valve assembly 3 is provided with an electro-magnetic actuator unit 19. The electro-magnetic actuator unit 19 comprises a coil 21, which is preferably arranged inside the housing 6. Furthermore, the electromagnetic actuator unit 19 comprises an armature 23. The housing 6, parts of the valve body 4 and the armature 23 form an electromagnetic circuit. The actuator unit 19 further comprises a pole piece 25.

[0028] The armature 23 is axially movable in the cavity 9. The needle 11 is guided by a central axial opening in the armature 23. The armature 23 is axially movable relative to the valve needle 11, i.e. it may slide on the needle 11.

[0029] An armature retainer 43 is fixedly coupled to the valve needle 11 below the armature 23, i.e. on the side of the armature 23 facing towards the fluid outlet portion 7. The armature retainer 43 is disc-shaped and may for example be welded to the needle 11.

[0030] The valve needle 11 comprises a protrusion 27 on its upper end 29. The armature 23 comprises a recess 31 in its upper side 33. The protrusion 27 and the recess 31 are shown in more detail in figure 2.

[0031] The calibration spring 18 has a lower end 35 facing towards the fluid outlet portion 7, the lower end 35 being supported by the upper side 33 of the armature 23. Hence, the calibration spring 18 is in direct contact with the upper side 33 of the armature 23 and exerts a force directly on the armature.

[0032] An upper end 37 of the calibration spring 18 is supported by the calibration tube 39, which is fixedly arranged inside the cavity 9. For example, the calibration tube 39 may be press-fitted into a central opening of the pole piece 25.

[0033] The annular protrusion 27 of the valve needle 11 has an annular lower side facing towards the fluid outlet portion 7, the annular lower side providing a first engagement area 47. The recess 31 has an annular base area facing towards the fluid inlet portion 5, the annular base area providing a second engagement area 49.

[0034] In the closing position of the valve 1, there is a gap 41 between the first engagement area 47 and the second engagement area 49. This gap 41 is also called "free-lift" gap. When the coil 21 is energized, the armature 23 experiences a magnetic force and slides upwards towards the pole piece 25, moving in axial direction away from the fluid outlet portion 7, thereby compressing the calibration spring 18 and closing the gap 41. When the armature 23 starts to travel upwards, a gap is formed between the armature 23 and the disc-shaped armature retainer 43 fixedly connected to the needle 11.

[0035] Only after having travelled the gap 41 and after having taken up kinetic energy, the armature 23 takes the valve needle 11 with it by way of direct contact between the first engagement area 47 and the second engagement area 49. Consequently, the valve needle 11 moves in axial direction out of the closing position of the valve 1.

[0036] When the armature 23 reaches the pole piece 25, its movement in upwards direction is stopped. The valve needle 11 is then able to move upwards a little longer, until the armature retainer 43 makes contact with a lower side of the armature 23 again.

[0037] When the coil 21 is de-energized, the calibration spring 18 is able to force the armature 23 to move in axial direction away from the fluid inlet portion and take the needle 11 with it into its closing position. The net hydraulic load on the needle 11 works in the same direction as the force exerted by the calibration spring 18. At the end of the traveling, the needle 11 stops at the valve seat, while the armature 23 moves additionally in the direction of the armature retainer 43 to dissipate energy, opening up the gap 41.

Claims

1. Valve assembly (3) for an injection valve (1), comprising

   - a valve body (4) with a central longitudinal axis (L) comprising a cavity (9) with a fluid inlet portion (5) and a fluid outlet portion (7),
   - a valve needle (11) axially moveable in the cavity (9), the valve needle (11) preventing a fluid flow through the fluid outlet portion (7) in a closing position and releasing the fluid flow through the fluid outlet portion (7) in further positions,
   - an armature (21) of an electro-magnetic actuator unit (20) being designed to actuate the valve needle (11), wherein the valve needle (11) comprises a first engagement area (47) and the armature (23) comprises a second engagement area (49), the first engagement area (47) and the second engagement area (49) being able to provide a coupling between the armature (23) and the needle (11), when the armature (23) travels upwards, the first engagement area (47) and the second engagement area (49) being spaced apart from each other in the closing position of the valve needle (11),
   - an armature retainer (43) being fixedly coupled to the valve needle (11) below the armature (23),
   - a spring element (18) biasing the valve needle (11) towards the fluid outlet portion (7), the spring element (18) being in direct contact with an upper side (33) of the armature (23) and acting on the valve needle (11) by way of the armature retainer (43).

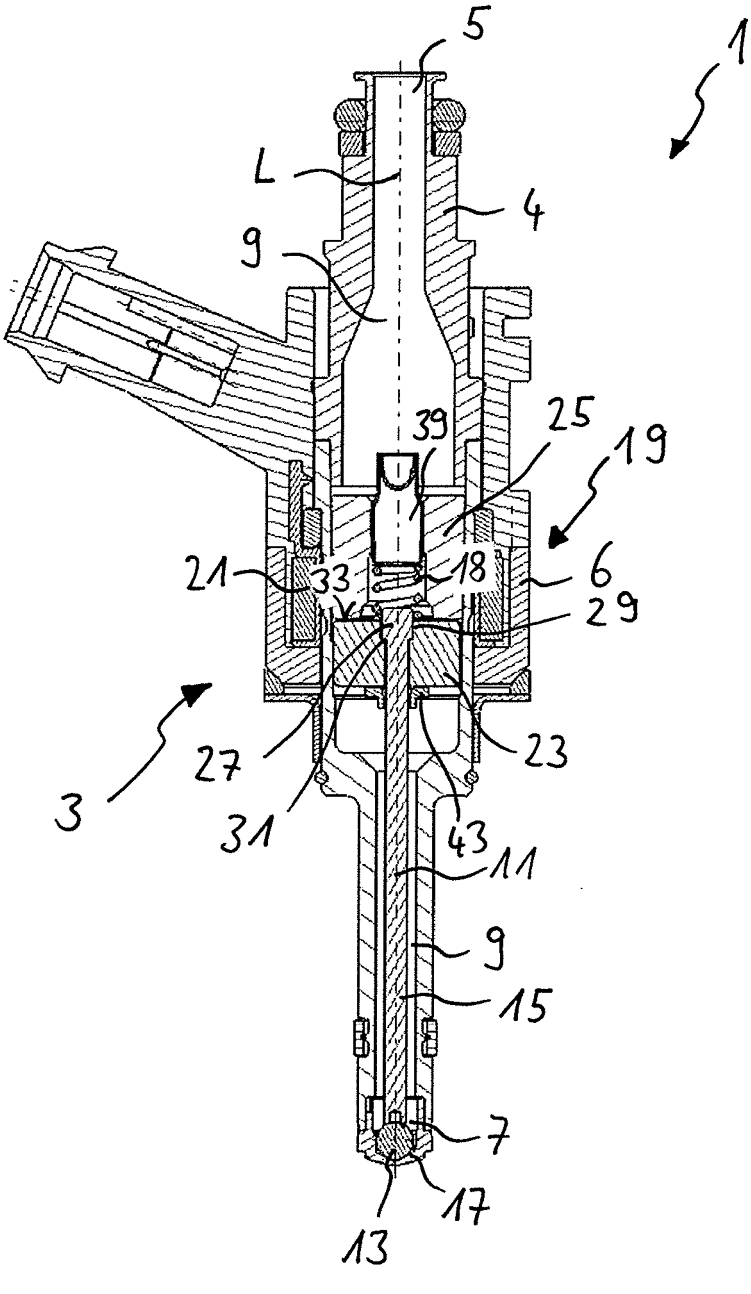
2. Valve assembly (3) according to claim 1, wherein the valve needle (11) comprises an annular protrusion (27) on its upper end (29), the protrusion (27) having an annular lower side facing towards the fluid outlet portion (7), the annular lower side providing the first engagement area (47), and wherein the armature (23) comprises an annular recess (31) in its upper side (33), the recess (31) having an annular base area facing towards the fluid inlet portion (5), the annular base area providing the second engagement area (49).

3. Valve assembly (3) according to claim 1 or 2, wherein the armature retainer (43) is disc-shaped.

4. Valve assembly (3) according any of claims 1 to 3, wherein a lower end (35) of the spring element (18) is supported by the upper side (33) of the armature (23), while an upper end (37) of the spring element (18) is supported by a calibration tube (39).

5. Fuel injection valve (1), comprising a valve assembly (3) according to any of claims 1 to 4.

Fig. 1



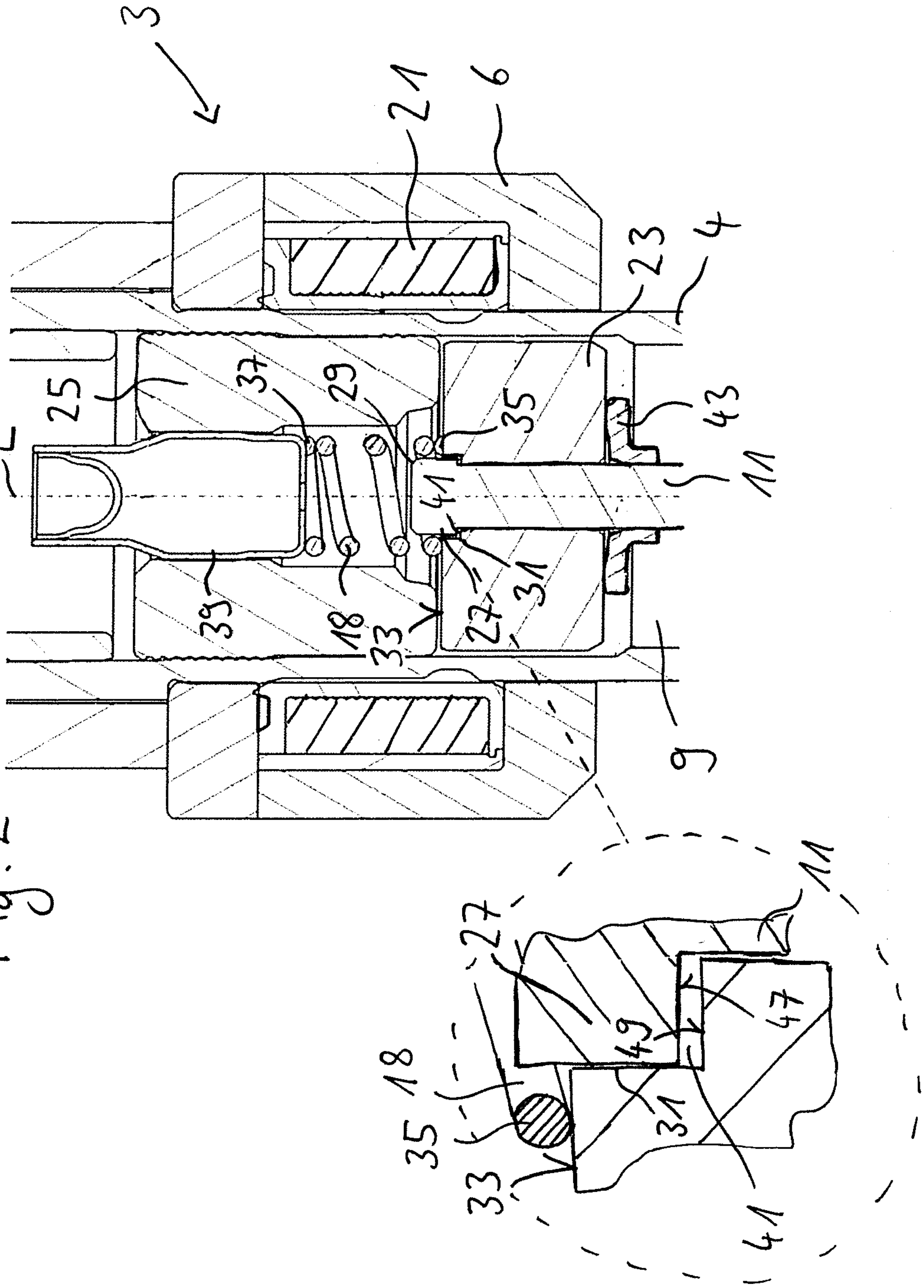

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Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 18 18 9227

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	1 February 2019	Barunovic, Robert

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 18 9227

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