

(19)



(11)

EP 2 703 633 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
05.03.2014 Bulletin 2014/10

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

(21) Application number: **12182002.1**

(22) Date of filing: **28.08.2012**

(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

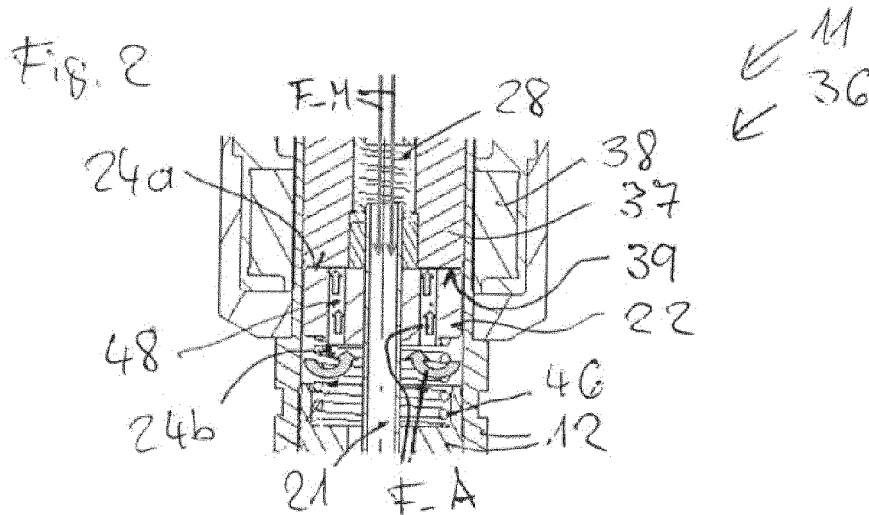
(72) Inventors:
 • **Grandi, Mauro**
57128 Livorno (IT)
 • **Malasoma, Claudio**
57023 Cecina (LI) (IT)
 • **Biasci, Enio**
56010 Campo (Pisa) (IT)

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

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

(57) The invention relates to a valve assembly (11) for an injection valve (10), comprising a valve body (12) including a central longitudinal axis (L), the valve body (12) comprising a cavity (18) with a fluid inlet portion (42) and a fluid outlet portion (40), a valve needle (20) axially movable in the cavity (18), the valve needle (20) preventing a fluid flow through the fluid outlet portion (40) in a

closing position and releasing the fluid flow through the fluid outlet portion (40) in further positions, and an electro-magnetic actuator unit (36). The electro-magnetic actuator unit (36) is designed to actuate the valve needle (20). The electro-magnetic actuator unit (36) comprises a pole piece (37) and an armature (22), comprising at least one aperture (48) extending from the first axial end (24a) to the second axial end (24b) of the armature (22).



EP 2 703 633 A1

Description

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

[0002] Injection valves are in wide spread 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 needle of the injection valve, which may, for example, be an electromagnetic actuator or a piezo electric 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 more than 2000 bar.

[0005] DE 102 57 896 A1 discloses a valve stem for a fuel injector being an elongated circular-section rod. The armature is mounted near the top and is circular, with a through-passage for fuel flowing toward the valve at the nozzle tip.

[0006] DE 199 50 761 A1 discloses a fuel injection valve which has a valve needle that interacts with a valve seat surface and an armature movably guided on the valve needle. The armature contains at least one fuel channel.

[0007] DE 199 27 900 A1 discloses a fuel injection valve which has a magnetic coil for controlling an armature, coupled to the valve closure element via a valve needle.

[0008] DE 198 49 210 A1 discloses a fuel injection valve which has a magnetic coil acting on an armature in a lifting direction against a restoring spring and a valve needle connected to a valve closure body.

[0009] The object of the invention is to create a valve assembly which facilitates a reliable and precise function.

[0010] The object of the invention is to create a valve assembly for an injection valve and an injection valve which are simply to be manufactured and which facilitate a reliable and precise function of the injection valve.

[0011] According to a first aspect the invention is distinguished by a valve assembly for an injection valve, comprising a valve body including a central longitudinal axis, the valve body comprising a cavity with a fluid inlet portion and 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, and an electro-magnetic actuator unit being designed to actuate the valve needle. The electro-magnetic actuator unit comprises a pole piece and an armature, the armature being axially movable in the cavity, the pole piece comprising a stop surface facing the armature and being designed to limit an axial movement of the armature relative to the pole piece. The armature has a first axial end facing the stop surface of the pole piece and a second axial end facing the fluid outlet portion. The armature comprises at least one aperture extending from the first axial end to the second axial end of the armature. At the first axial end of the armature the at least one aperture is in complete overlap with the stop surface of the pole piece.

[0012] This has the advantage that an entrance of fluid between the armature and the pole piece may be obtained easily. Consequently, fluid may be pressed against the pole piece to facilitate the release of the armature from the pole piece during the closing of the valve assembly. Therefore, a sticking effect between the surfaces of the armature and the pole piece may be avoided. Consequently, a force to release the armature from the pole piece may be kept small. Consequently, the closing time of the valve assembly may be small. Consequently, the valve assembly may be operated very fast. Furthermore, due to the small force to release the armature from the pole piece the maximum of the pressure needed for operating the valve assembly - in particular for moving the armature away from the pole piece - may be kept small.

[0013] In an advantageous embodiment the at least one aperture has a cylindrical shape and is extending in axial direction. This has the advantage that the armature and the valve assembly can be manufactured in a simple manner.

[0014] According to a second aspect the invention is distinguished by an injection valve with a valve assembly according to the first aspect of the invention.

[0015] 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, and

Figure 2, an enlarged view of the valve assembly in a section II of Figure 1 in a longitudinal section view.

[0016] Elements of the same design and function that appear in different illustrations are identified by the same reference character.

[0017] Figure 1 shows an injection valve 10 that is in particular suitable for dosing fuel to an internal combustion engine and which comprises in particular a valve assembly 11. The valve assembly 11 comprises a valve body 12 with a central longitudinal axis L. The valve as-

sembly 11 comprises an inlet tube 14. The inlet tube 14 is fixedly coupled to the valve body 12. A housing 16 is partially arranged around the valve body 12. A cavity 18 is arranged in the valve body 12. The cavity 18 takes in a valve needle 20. The valve needle 20 is hollow and has a recess 21 which is arranged in direction of the central longitudinal axis L over a portion of the axial length of the valve needle 20 or over the whole axial length of the valve needle 20.

[0018] The cavity 18 of the valve body 12, the recess 21 of the valve needle 20 and channels between the cavity 18 of the valve body 12 and the recess 21 of the valve needle 20 are parts of a main fluid line F_M.

[0019] The valve assembly 11 comprises an armature 22 and a retainer 23. The armature 22 is separate from the retainer 23. The armature 22 is axially movable in the cavity 18. The retainer 23 is formed as a collar around the valve needle 20 and can guide the valve needle 20 in axial direction inside the inlet tube 14.

[0020] In the present embodiment, the armature 22 is separate from the valve needle 20 and is axially movable relative to the valve needle 20. However, it is also conceivable that the armature 22 is rigidly connected to the valve needle 20 so that the armature 22 and the needle 20 are prevented from relative axial movement with respect to each other. In this case, the retainer 23 and the armature 22 may be also formed as one piece.

[0021] A recess 26 is provided in the inlet tube 14. A main spring 28 is arranged in the recess 26 of the inlet tube 14. The main spring 28 is mechanically coupled to the retainer 23. The retainer 23 forms a first seat for the main spring 28.

[0022] A filter element 30 is arranged in the inlet tube 14 and forms a further seat for the main spring 28. During the manufacturing process of the injection valve 10 the filter element 30 can be moved axially in the inlet tube 14 in order to preload the main spring 28 in a desired manner. By this the main spring 28 exerts a force on the valve needle 20 towards an injection nozzle 34 of the injection valve 10.

[0023] In a closing position of the valve needle 20, it sealingly rests on a seat plate 32 thereby preventing a fluid flow through the at least one injection nozzle 34. The injection nozzle 34 may be, for example, an injection hole. However, it may also be of some other type suitable for dosing fluid.

[0024] The valve assembly 11 is provided with an actuator unit 36 that is preferably an electro-magnetic actuator. The electro-magnetic actuator unit 36 comprises a pole piece 37 and a coil 38. The pole piece 37 is fixedly coupled to the valve body 12. The pole piece 37 has a stop surface 39 which faces the armature 22. The stop surface 39 may limit an axial movement of the armature 22 relative to the pole piece 37. The coil 38 is preferably arranged inside the housing 16. Furthermore, the electro-magnetic actuator unit 36 comprises the armature 22. The housing 16, the pole piece 37, parts of the valve body 12 and the armature 22 are forming an electromag-

netic circuit.

[0025] The cavity 18 comprises a fluid outlet portion 40 which is arranged near the seat plate 32. The fluid outlet portion 40 communicates with a fluid inlet portion 42 which is provided in the valve body 12.

[0026] A step 44 is arranged in the valve body 12. For example, the cavity 18 of the valve body 12 has a shape comprising a step. An armature spring 46 - which is preferably a coil spring - is fixedly coupled to the step 44 in the valve body 12. The step 44 and the armature spring 46 form a stop element for the armature 22.

[0027] The armature 22 has a first axial end 24a which faces the stop surface 39. Furthermore, the armature 22 has a second axial end 24b which faces the fluid outlet portion 40.

[0028] At least one aperture 48 is arranged in the armature 22. Preferably, the armature 22 has a plurality of apertures 48. The apertures 48 extend from the first axial end 24a to the second axial end 24b of the armature 22. The apertures 48 are designed as through holes. Preferably, the apertures 48 have a cylindrical shape and are extending in axial direction. The apertures 48 are hydraulically coupling the stop surface 39 of the pole piece 37 with the fluid outlet portion 40. The apertures 48 are in complete overlap with the stop surface 39 of the pole piece 37 at the first axial end 24a of the armature 22.

[0029] In the following, the function of the injection valve 10 is described in detail:

The fluid is led from the fluid inlet portion 42 towards the fluid outlet portion 40.

[0030] The valve needle 20 prevents a fluid flow through the fluid outlet portion 40 in the valve body 12 in a closing position of the valve needle 20. Outside of the closing position of the valve needle 20, the valve needle 20 enables the fluid flow through the fluid outlet portion 40.

[0031] In the case when the electro-magnetic actuator unit 36 with the coil 38 gets energized the actuator unit 36 may effect an electro-magnetic force on the armature 22. The armature 22 is attracted by the electro-magnetic actuator unit 36 with the coil 38 and moves in axial direction away from the fluid outlet portion 40. The armature 22 takes the valve needle 20 with it so that the valve needle 20 moves in axial direction out of the closing position. Outside of the closing position of the valve needle 20 fluid can flow via the main fluid line F_M from the fluid inlet portion 42 to the recess 21 of the valve needle 20, further through the channels between the recess 21 of the valve needle 20 and the cavity 18 of the valve body 12 to the fluid outlet portion 40. The gap between the valve body 12 and the valve needle 20 at the axial end of the injection valve 10 facing away from of the actuator unit 36 forms a fluid path and fluid can pass through the injection nozzle 34.

[0032] In the case when the actuator unit 36 is de-energized the main spring 28 can force the retainer 23 and

the valve needle 20 to move in axial direction until the closing position of the valve needle 20 is reached. It is depending on the force balance between the force on the valve needle 20 caused by the actuator unit 36 and the force on the valve needle 20 caused by the main spring 28 whether the valve needle 20 is in its closing position or not.

[0033] Due to the apertures 48 in the armature 22 fluid may be pressed against the pole piece 37 via an armature fluid line F_A (Figure 2). Sticking between the armature 22 and the pole piece 37 may be avoided and the force to release the armature 22 from the pole piece 37 may be kept small. Consequently, the armature 22 is released from the pole piece 37 during the closing process of the valve assembly 11 in an easy manner. The armature 22 may move axially in direction to the fluid outlet portion 40 thereby enabling the valve needle 20 to reach its closing position. Consequently, a small closing time of the valve assembly 11 may be achieved.

[0034] Due to the advantageous dynamic of the valve assembly 11 pressure fluctuations in the fluid outlet portion 40 and mass flow fluctuations of the fluid may be kept small. Consequently, the fluid spray leaving the fluid outlet portion 40 via the injection nozzle 34 may have a high stability.

the armature (22) the at least one aperture (48) is in complete overlap with the stop surface (39) of the pole piece (37).

- 5 2. Valve assembly (11) according to claim 1, wherein the at least one aperture (48) has a cylindrical shape and is extending in axial direction.
- 10 3. Injection valve (10) with a valve assembly (11) according to one of the preceding claims.

Claims

1. Valve assembly (11) for an injection valve (10), comprising
 - a valve body (12) including a central longitudinal axis (L), the valve body (12) comprising a cavity (18) with a fluid inlet portion (42) and a fluid outlet portion (40),
 - a valve needle (20) axially movable in the cavity (18), the valve needle (20) preventing a fluid flow through the fluid outlet portion (40) in a closing position and releasing the fluid flow through the fluid outlet portion (40) in further positions, and
 - an electro-magnetic actuator unit (36) being designed to actuate the valve needle (20), the electro-magnetic actuator unit (36) comprising a pole piece (37) and an armature (22), the armature (22) being axially movable in the cavity (18), the pole piece (37) comprising a stop surface (39) facing the armature (22) and being designed to limit an axial movement of the armature (22) relative to the pole piece (37), the armature (22) having a first axial end (24a) facing the stop surface (39) of the pole piece (37) and a second axial end (24b) facing the fluid outlet portion (40),
 - wherein the armature (22) comprises at least one aperture (48) extending from the first axial end (24a) to the second axial end (24b) of the armature (22), and at the first axial end (24a) of

Fig. 1

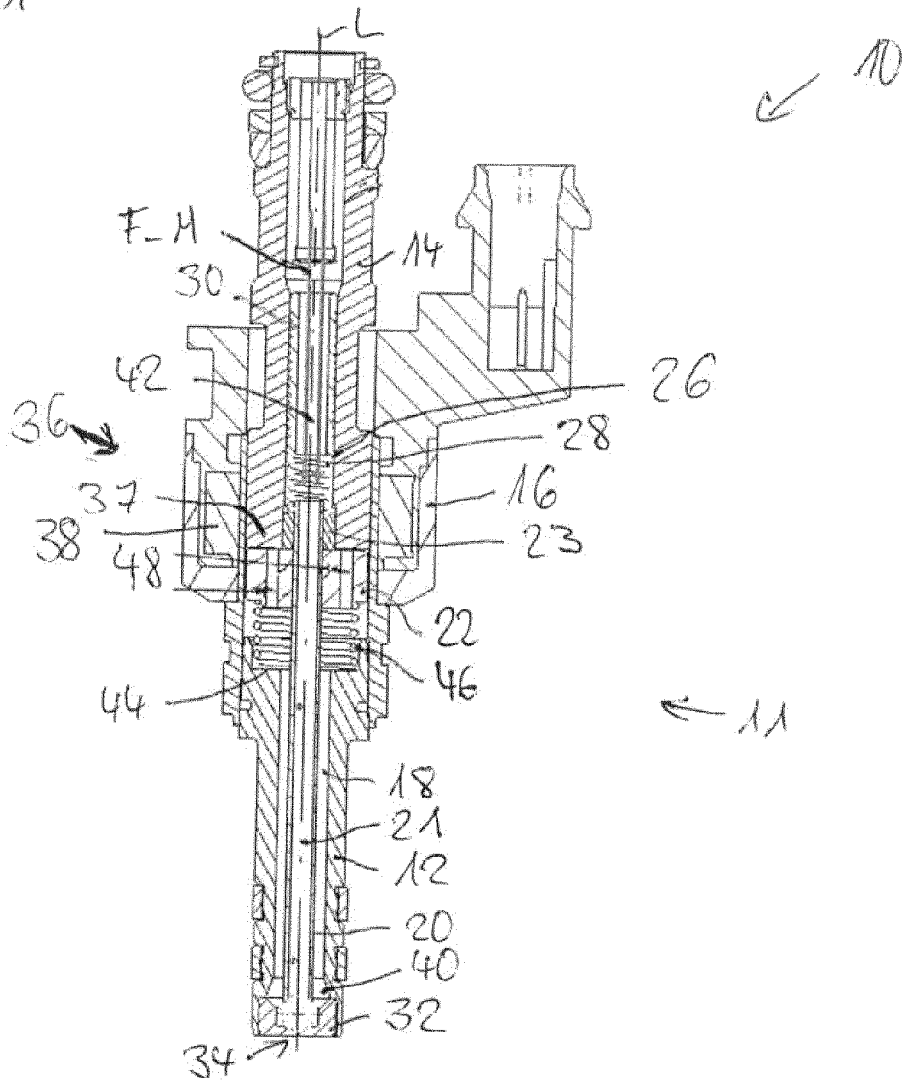
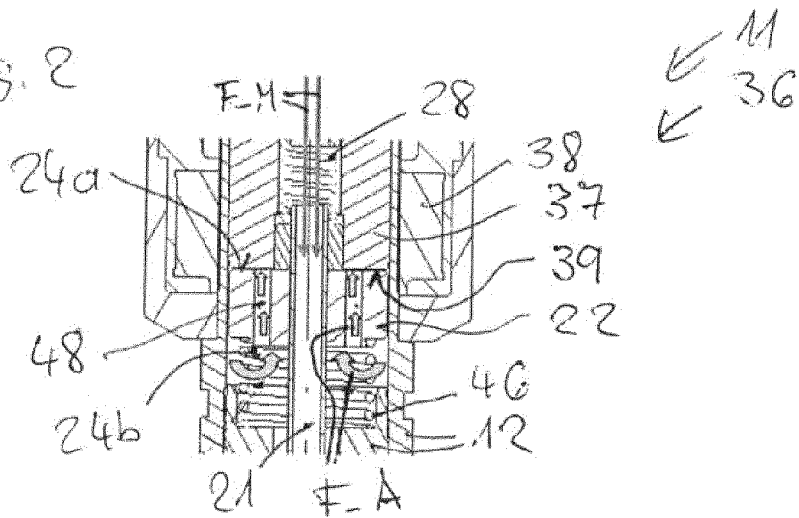


Fig. 2





EUROPEAN SEARCH REPORT

Application Number
EP 12 18 2002

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 2009/127355 A1 (MATSUSAKA NOBORU [JP] ET AL) 21 May 2009 (2009-05-21) * paragraph [0018]; figure 1 * -----	1-3	INV. F02M51/06
X	WO 03/018994 A1 (BOSCH GMBH ROBERT [DE]; GLASER ANDREAS [DE]) 6 March 2003 (2003-03-06) * figures * * page 5, lines 26,27 * * page 6, lines 16-21 * -----	1-3	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			F02M
Place of search Munich		Date of completion of the search 17 January 2013	Examiner Landriscina, V
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	

2
EPO FORM 1503 03/82 (F04C01)

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

EP 12 18 2002

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-01-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009127355 A1	21-05-2009	DE 102008043419 A1	28-05-2009
		JP 4453745 B2	21-04-2010
		JP 2009127446 A	11-06-2009
		US 2009127355 A1	21-05-2009

WO 03018994 A1	06-03-2003	AT 319928 T	15-03-2006
		DE 10140795 A1	06-03-2003
		EP 1425508 A1	09-06-2004
		JP 2005500471 A	06-01-2005
		US 2004035955 A1	26-02-2004
		WO 03018994 A1	06-03-2003

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 10257896 A1 [0005]
- DE 19950761 A1 [0006]
- DE 19927900 A1 [0007]
- DE 19849210 A1 [0008]