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

(11) EP 2 426 350 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
07.03.2012 Bulletin 2012/10

(51) Int Cl.:
F02M 51/06 *(2006.01)* ***F02M 61/18*** *(2006.01)*

(21) Application number: **10175062.8**

(22) Date of filing: **02.09.2010**

(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 SE SI SK SM TR
Designated Extension States:
BA ME RS

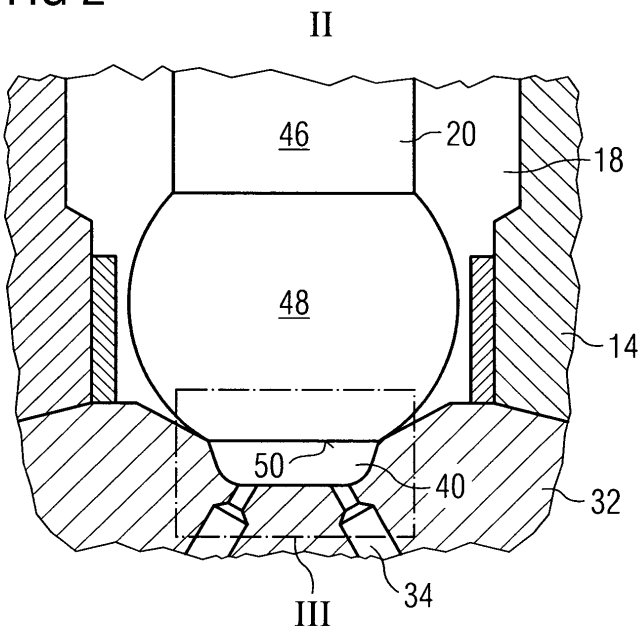
(71) Applicant: **Continental Automotive GmbH**
30165 Hannover (DE)

(72) Inventors:
- **Agresta, Antonio**
  56122, Pisa (IT)
- **Mechi, Marco**
  57016, Vada (LI) (IT)
- **Gargiulo, Luigi**
  56127, Pisa (IT)
- **Iannaccone, Nicola**
  56123, Pisa (IT)
- **Gestri, Luca**
  56023, S.Lorenzo alle Corti (PI) (IT)

(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 (14) including a central longitudinal axis (A), the valve body (14) comprising a cavity (18) with a fluid inlet portion (42) and a fluid outlet portion (40), and 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. The valve needle (20) has a valve needle tip (48) being essentially designed as a ball. The valve needle tip (48) comprises a flat surface section (50) facing the fluid outlet portion (40). The flat surface section (50) is designed in a manner that the valve needle tip (48) receives a given hydraulic pressure force from the fluid outlet portion (40) while the valve needle (20) leaves the closing position. The invention further relates to an injection valve (10) with a valve assembly (11) and an actuator unit (36). The actuator unit (36) is designed to act on the valve assembly (11) .

FIG 2



EP 2 426 350 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 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 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 facilitate a reliable and precise function of the injection valve.

[0006] These objects are 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 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, and a valve needle axially movable in the cavity. The valve needle has a valve needle tip. The valve needle tip prevents a fluid flow through the fluid outlet portion in a closing position and releases the fluid flow through the fluid outlet portion in further positions. The valve needle tip comprises a flat surface section facing the fluid outlet portion. The flat surface section is designed in a manner that the valve needle tip receives a given hydraulic pressure force from the fluid outlet portion while the valve needle leaves the closing position.

[0008] This has the advantage that the pressure in the fluid outlet portion during an opening process of the valve needle can be large. Consequently, the valve may be opened with a high velocity. Furthermore, the mass flow through the fluid outlet portion may be kept independent of a lift of the valve needle during the opening process of the valve needle. Additionally, the minimum mass flow rate through the fluid outlet portion can be kept very small.

[0009] In an advantageous embodiment the valve needle tip is essentially shaped as a ball. This has the advantage that the flat surface section on the valve needle tip can be manufactured in a simple and precise manner.

[0010] 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 and an actuator unit. The actuator unit is designed to act on the valve assembly.

[0011] 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 an enlarged view of section II of the valve assembly of Figure 1, and

Figure 3 a further enlarged view of section III of Figure 2.

[0012] Elements of the same design and function that appear in different illustrations are identified by the same reference character.

[0013] An injection valve 10 that is in particular suitable for dosing fuel to an internal combustion engine comprises in particular a valve assembly 11 and an inlet tube 12.

[0014] The valve assembly 11 comprises a valve body 14 with a central longitudinal axis A and a housing 16. The housing 16 is partially arranged around the valve body 14. A cavity 18 is arranged in the valve body 14.

[0015] The cavity 18 takes in a valve needle 20 and an armature 22. A main spring 24 is arranged in a recess 26 provided in the inlet tube 12. The main spring 24 is mechanically coupled to the armature 22. The armature 22 can guide the valve needle 14 in axial direction inside the inlet tube 12.

[0016] A filter element 30 is arranged in the inlet tube 12 and forms a further seat for the main spring 24. During the manufacturing process of the injection valve 10 the filter element 30 can be axially moved in the inlet tube 12 in order to preload the main spring 24 in a desired manner. By this the main spring 24 exerts a force on the valve needle 20 towards an at least one injection nozzle 34 of the injection valve 10.

[0017] In a closing position of the valve needle 20 it sealingly rests on a seat plate 32 by this 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.

[0018] The valve assembly 11 is provided with an actuator unit 36 that is preferably an electro-magnetic actuator. The electromagnetic actuator unit 36 comprises a coil 38, which is preferably arranged inside the housing 16. Furthermore, the electro-magnetic actuator unit 36 comprises the armature 22. The armature 22 is axially movable in the cavity 18

[0019] A fluid outlet portion 40 and a fluid inlet portion 42 are provided in the valve body 14. The fluid outlet portion 40 is in hydraulic communication with the fluid inlet portion 42.

[0020] The housing 16, the inlet tube 12, the armature 22 and the valve body 14 are forming an electromagnetic circuit.

[0021] An armature spring 44 which is preferably a coil spring is fixedly coupled to the valve body 14. The armature spring 44 forms a soft stop element for the armature 22.

[0022] The valve needle 20 has a valve needle shaft 46 which is shaped as a hollow cylinder. Furthermore, the valve needle 20 has a valve needle tip 48. The valve needle tip 48 is essentially shaped as a ball and is fixedly coupled to the valve needle shaft 46. Preferably, the valve needle tip 48 is coupled to the valve needle shaft 46 by welding.

[0023] The valve needle tip 48 has a flat surface section 50. The flat surface section 50 faces the fluid outlet portion 40 and consequently, the injection nozzles 34.

[0024] In the following, the function of the injection valve 10 is described in detail:

[0025] Fluid is led from the fluid inlet portion 42 towards the fluid outlet portion 40.

[0026] The valve needle 20 prevents a fluid flow through the fluid outlet portion 40 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.

[0027] 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 with a lift L. Consequently, outside of the closing position of the valve needle 20 a gap between the seat plate 32 and the valve needle tip 48 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 at least one injection nozzle 34.

[0028] In the case when the actuator unit 36 is de-energized the main spring 24 can force the valve needle 20 to move in axial direction in its closing position. It is depending on the force balance between the force on the valve needle 20 caused by the actuator unit 36 with the coil 38 and the force on the valve needle 20 caused by the main spring 24 whether the valve needle 20 is in its closing position or not.

[0029] In the case that the valve needle 20 leaves the closing position the flat surface section 50 of the valve needle tip 48 receives a hydraulic pressure force from the fluid in the fluid outlet portion 40 which is a counteracting force to the hydraulic pressure of the fluid which enters the fluid inlet portion 42.

[0030] Surprisingly, it has been found that the valve needle tip 48 with the flat surface section 50 enables a higher hydraulic force acting on the valve needle tip 48 due to the fluid pressure of the fluid in the fluid outlet portion 40 compared with a valve needle tip 48 being completely shaped as a ball, i.e. having no flat surface section 50. Therefore, the valve needle 20 may be opened with a shorter opening time assuming that the preload of the main spring 24 is fixed. A further advantage of the flat surface section 50 is that the mass flow through the fluid outlet portion 40 is only slightly dependent from the lift L of the valve needle 20 at high values of the lift L near a design specification of the lift L. Consequently, the flat surface section 50 of the valve needle tip 48 allows the acceptance of a high tolerance of the lift L of the valve needle 20. A further advantage of the flat surface section 50 is that the minimum mass flow rate through the fluid outlet portion 40 and the at least one injection nozzle 34 can be kept very small with the same maximum opening pressure of the injection valve 10. A further advantage is that the maximum opening pressure of the injection valve 10 can increase with the same minimum mass flow rate through the fluid outlet portion 40 and the at least one injection nozzle 34.

Claims

1. Valve assembly (11) for an injection valve (10), comprising

   - a valve body (14) including a central longitudinal axis (A), the valve body (14) comprising a cavity (18) with a fluid inlet portion (42) and a fluid outlet portion (40), and
   - a valve needle (20) axially movable in the cavity (18), the valve needle (20) having a valve needle tip (48), the valve needle tip (48) 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,

   wherein the valve needle tip (48) comprises a flat surface section (50) facing the fluid outlet portion (40), the flat surface section (50) being designed in a manner that the valve needle tip (48) receives a given hydraulic pressure force from the fluid outlet portion (40) while the valve needle (20) leaves the closing position.

2. Valve assembly (11) according to claim 1, wherein the valve needle tip (48) is essentially shaped as a ball.

3. Injection valve (10) with a valve assembly (11) according to one of the preceding claims and an actuator unit (36) wherein the actuator unit (36) is designed to act on the valve assembly (11).

FIG 1

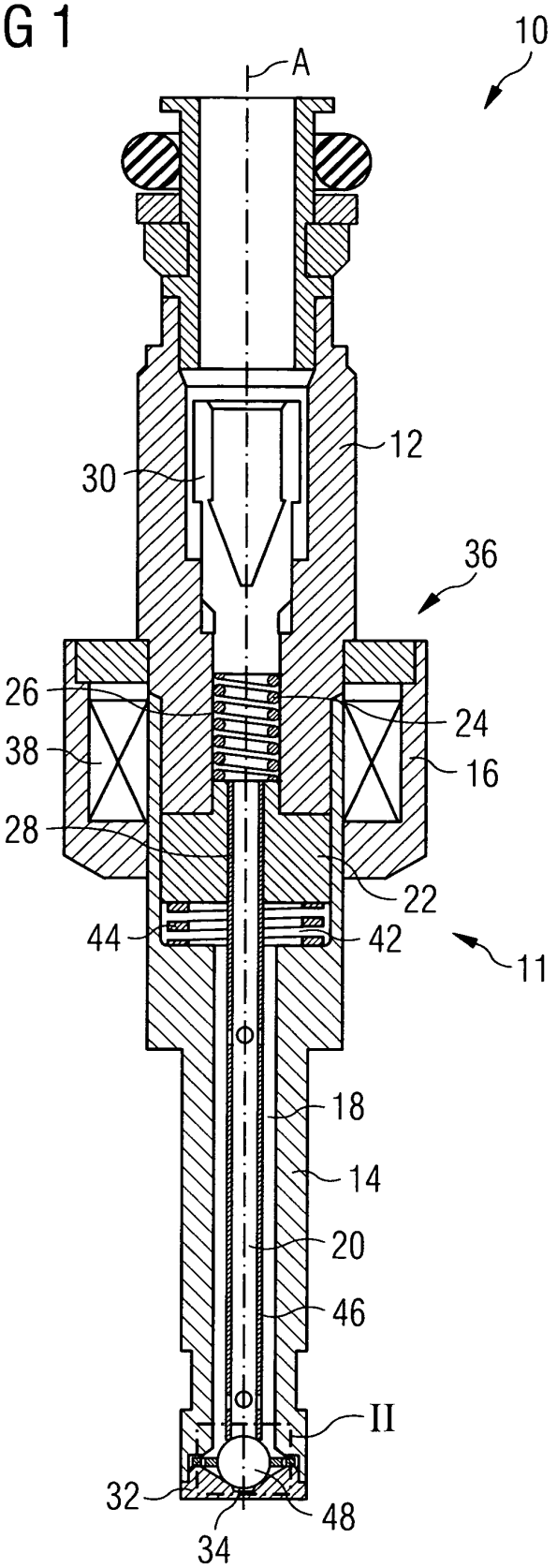


FIG 2

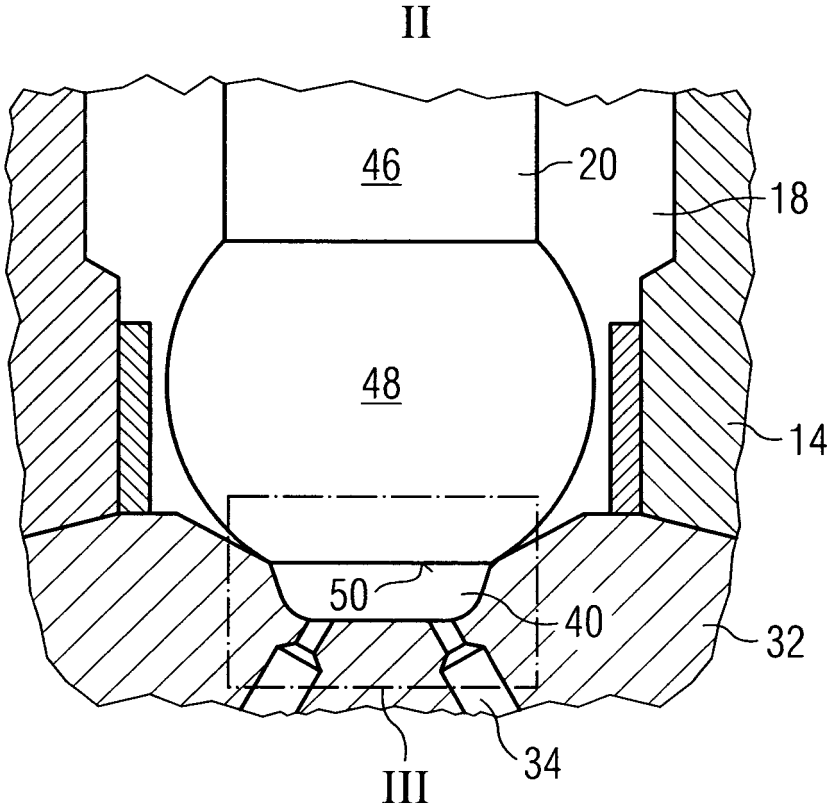
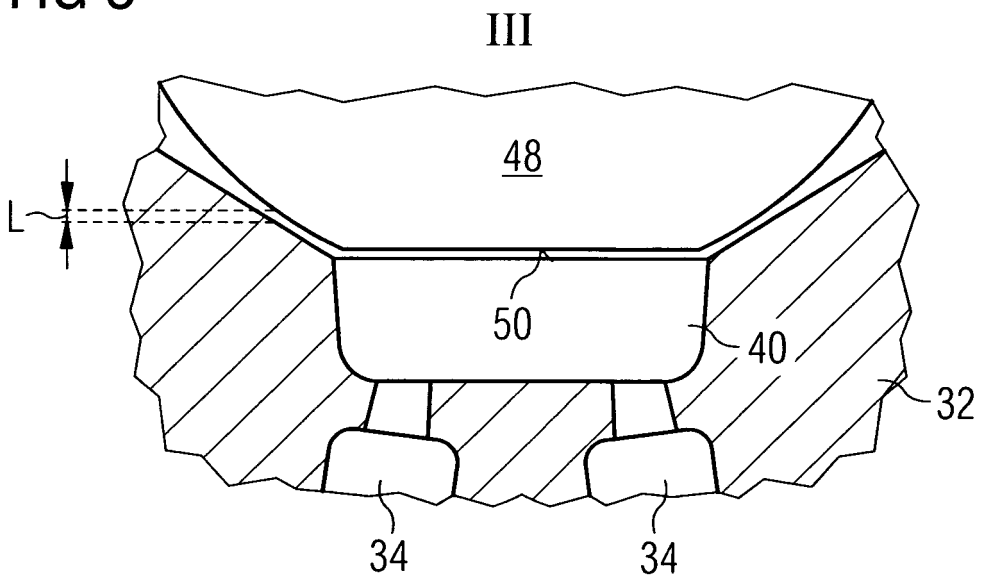


FIG 3



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 10 17 5062

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 2004/188550 A1 (SAITO TAKAHIRO [JP] ET AL) 30 September 2004 (2004-09-30) * paragraph [0023] - paragraph [0045]; figures 1,2 * * abstract * -----	1-3	INV. F02M51/06 F02M61/18
X	DE 101 50 712 A1 (BOSCH GMBH ROBERT [DE]) 17 April 2003 (2003-04-17) * paragraph [0013] - paragraph [0021]; figure 1 * * abstract * -----	1-3	
X	US 2009/090794 A1 (HUNG DAVID LING-SHUN [US] ET AL) 9 April 2009 (2009-04-09) * paragraphs [0020], [0 21], [0023]; figures 3,4 * * abstract * -----	1-3	
X	DE 101 08 940 A1 (AISAN IND [JP]) 20 September 2001 (2001-09-20) * the whole document * -----	1-3	

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
The Hague	8 February 2011	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

2

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 17 5062

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.

08-02-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004188550 A1	30-09-2004	DE 102004013141 A1	21-10-2004
DE 10150712 A1	17-04-2003	WO 03033907 A1	24-04-2003
US 2009090794 A1	09-04-2009	DE 102008049929 A1	07-05-2009
DE 10108940 A1	20-09-2001	JP 3776665 B2	17-05-2006
		JP 2001234834 A	31-08-2001
		US 2001030249 A1	18-10-2001

EPO FORM P0459

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