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

(11) **EP 2 375 051 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.10.2011 Bulletin 2011/41

(51) Int Cl.:
F02M 51/06 *(2006.01)* *F02M 63/00* *(2006.01)*

(21) Application number: **10003831.4**

(22) Date of filing: **09.04.2010**

(84) Designated Contracting States:
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:
AL BA ME RS

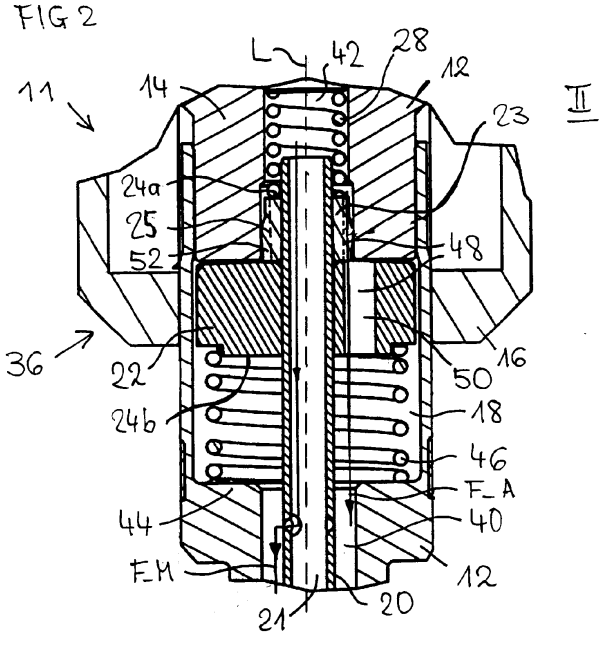
(71) Applicant: **Continental Automotive GmbH**
30165 Hannover (DE)

(72) Inventors:
- **Agresta, Antonio**
  Pisa (IT)
- **Mechi, Marco**
  Vada (LI) (IT)
- **Gargiulo, Luigi**
  Pisa (IT)
- **Varchetta, Salvatore**
  56038 Ponsacco (IT)
- **Iannaccone, Nicola**
  56123 Pisa (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 (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 electromagnetic actuator unit (36), The electro-magnetic actuator unit (36) is designed to actuate the valve needle (20). The electro-magnetic actuator unit (36) comprises an armature assembly (22, 23) axially movable in the cavity (18). The armature assembly (22, 23) has a first axial end (24a) facing the fluid inlet portion (42) and a second axial end (24b) facing the fluid outlet portion (40). The armature assembly (22, 23) comprises at least one aperture (48) extending from the first axial end (24a) of the armature assembly (22, 23) to the second axial end (24b) to enable a hydraulic coupling between the fluid inlet portion (42) and the fluid outlet portion (40). Furthermore, the invention relates to an injection valve (10) with a valve assembly (11).

FIG 2



EP 2 375 051 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 up to 2000 bar.

[0005] The object of the invention is to create a valve assembly which facilitates a reliable and precise function.

[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 comprises a cavity with a fluid inlet portion and a fluid outlet portion. The valve assembly comprises a valve needle axially movable in the cavity. The valve needle 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 assembly comprises an electro-magnetic actuator unit being designed to actuate the valve needle. The electro-magnetic actuator unit comprises an armature assembly axially movable in the cavity. The armature assembly has a first axial end facing the fluid inlet portion and a second axial end facing the fluid outlet portion. The armature assembly comprises at least one aperture extending from the first axial end of the armature assembly to the second axial end to enable a hydraulic coupling between the fluid inlet portion and the fluid outlet portion.

[0008] This has the advantage that a pressure balance between the fluid inlet portion and the fluid outlet portion can be obtained. Consequently, pressure oscillations in the fluid outlet portion can be kept small, and mass flow oscillations during the opening of the valve needle which are depending on the pressure oscillations can be kept small as well. Therefore, the valve assembly has a good linear behavior even in the case that the opening period of the valve needle is very short. Consequently, a high stability of the fluid spray at the fluid outlet portion of the valve assembly can be obtained.

[0009] In an advantageous embodiment the armature assembly comprises an armature and a retainer. The retainer is separate from the armature. This has the advantage that the valve assembly can be assembled in a simple manner.

[0010] In a further advantageous embodiment a through hole is arranged in the armature and the through hole is part of the aperture. This has the advantage that the through hole can be manufactured in a single manufacturing process in a simple manner.

[0011] In a further advantageous embodiment the retainer comprises a flat forming a recess in the retainer, and the recess is part of the aperture. This has the advantage that the recess can be manufactured in a single manufacturing process in a simple manner.

[0012] In a further advantageous embodiment the at least one through hole and the at least one recess are dimensioned in a manner that a given minimum fluid flow through an auxiliary fluid line through the recesses of the retainer and the through holes of the armature is enabled. This has the advantage that the pressure oscillations in the fluid outlet portion can be kept small. Additionally, an impact surface between the retainer and the armature can keep a sufficient size in view of the durability of the retainer and the armature and the volume of the armature can be sufficient to maintain the necessary magnetic properties.

[0013] 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.

[0014] 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 the valve assembly in a section II of Figure 1 in a longitudinal section view, and

Figure 3, an armature assembly of the injection valve with in a perspective view.

[0015] Elements of the same design and function that appear in different illustrations are identified by the same reference character.

[0016] An injection valve 10 that is in particular suitable for dosing fuel to an internal combustion engine comprises in particular a valve assembly 11. The valve assembly 11 comprises a valve body 12 with a central longitudinal axis L. The valve body 12 comprises an inlet tube 14. 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 and an armature assembly. 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. 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.

[0017] The armature assembly 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 armature 22 is separate from the valve needle 20 and is axially movable relative to the valve needle 20. The retainer 23 is formed as a collar around the valve needle 20. The retainer 23 is in contact with an inner surface of the inlet tube 14 and can guide the valve needle 20 in axial direction inside the inlet tube 14. The retainer 23 has at least one flat 25. Preferably, the retainer 23 has a plurality of flats 25 (see Figure 3).

[0018] 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.

[0019] 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.

[0020] 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.

[0021] 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 coil 38, which is preferably arranged inside the housing 16 and overmolded. Furthermore, the electro-magnetic actuator unit 36 comprises the armature 22. The housing 16, the inlet tube 14, parts of the valve body 12 and the armature 22 are forming an electromagnetic circuit.

[0022] 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, in particular in the inlet tube 14.

[0023] A step 44 is arranged in the valve body 12. 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.

[0024] The armature assembly has a first axial end 24a which faces the fluid inlet portion 42. Furthermore, the armature assembly has a second axial end 24b which faces the fluid outlet portion 40. At least one aperture 48 is arranged in the armature assembly. Preferably, the armature assembly 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 assembly. The apertures 48 are hydraulically coupling the fluid inlet portion 42 with the fluid outlet portion 40. Each of the apertures 48 consists of at least one through hole 50 and at least one recess 52. The through holes 50 are arranged in the armature 22. The recesses 52 are formed by the flats 25 and are arranged in the retainer 23 (Figure 3).

[0025] In the following, the function of the injection valve 10 is described in detail:

[0026] The fluid is led from the fluid inlet portion 42 towards the fluid outlet portion 40.

[0027] 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.

[0028] In the case when the electro-magnetic actuator unit 36 with the coil 38 gets energized the actuator unit 36 may effect a 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 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.

[0029] 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 with the coil 38 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. During the closing of the valve needle 20 the armature 22 can move relative to the valve needle 20 and the retainer 23 in axial direction and can detach from the retainer 23. The movement of the armature 22 is dampened by the armature spring 46 which finally forces the armature 22 to come again into contact with the retainer 23.

[0030] 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. Furthermore, fluid can flow from the fluid inlet portion 42 via an auxiliary fluid

line F_A through the recesses 52 of the retainer 23 and the through holes 50 of the armature 22 to the fluid outlet portion 40 (Figure 2).

[0031] The apertures 48 with the recesses 52 of the retainer 23 and the through holes 50 can balance the pressure between the fluid inlet portion 42 and the fluid outlet portion 40. Therefore, the pressure fluctuations in the fluid outlet portion 40 may be kept small. Therefore, mass flow fluctuations of the fluid which depend on the pressure fluctuations may be small as well. Consequently, the fluid spray leaving the fluid outlet portion 40 via the injection nozzle 34 may have a high stability. Due to this, the number of scrapped injection valves 10 on the assembly line may be kept small. Furthermore, a long-term uniformity of the injected fluid mass and of the spray may be achieved during the operation of the injection valve 10.

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 an armature assembly (22, 23) axially movable in the cavity (18), the armature assembly (22, 23) having a first axial end (24a) facing the fluid inlet portion (42) and a second axial end (24b) facing the fluid outlet portion (40),
   wherein the armature assembly (22, 23) comprises at least one aperture (48) extending from the first axial end (24a) of the armature assembly (22, 23) to the second axial end (24b) to enable a hydraulic coupling between the fluid inlet portion (42) and the fluid outlet portion (40).

2. Valve assembly (11) according to claim 1, wherein the armature assembly (22, 23) comprises an armature (22) and a retainer (23), the retainer (23) being separate from the armature (22).

3. Valve assembly (11) according to claim 2, wherein at least one through hole (50) is arranged in the armature (22) and the through hole (50) is part of the least one aperture (48).

4. Valve assembly (11) according to claim 2 or 3, wherein the retainer (23) comprises at least one flat (25) forming a recess (52) in the retainer (23) and the recess (52) is part of the least one aperture (48).

5. Valve assembly (11) according to claim 4, wherein the at least one through hole (50) and the at least one recess (52) are dimensioned in a manner that a given minimum fluid flow through an auxiliary fluid line (F_A) through the recesses (52) of the retainer (23) and the through holes (50) of the armature (22) is enabled.

6. Injection valve (10) with a valve assembly (11) according to one of the preceding claims.

Fig. 1

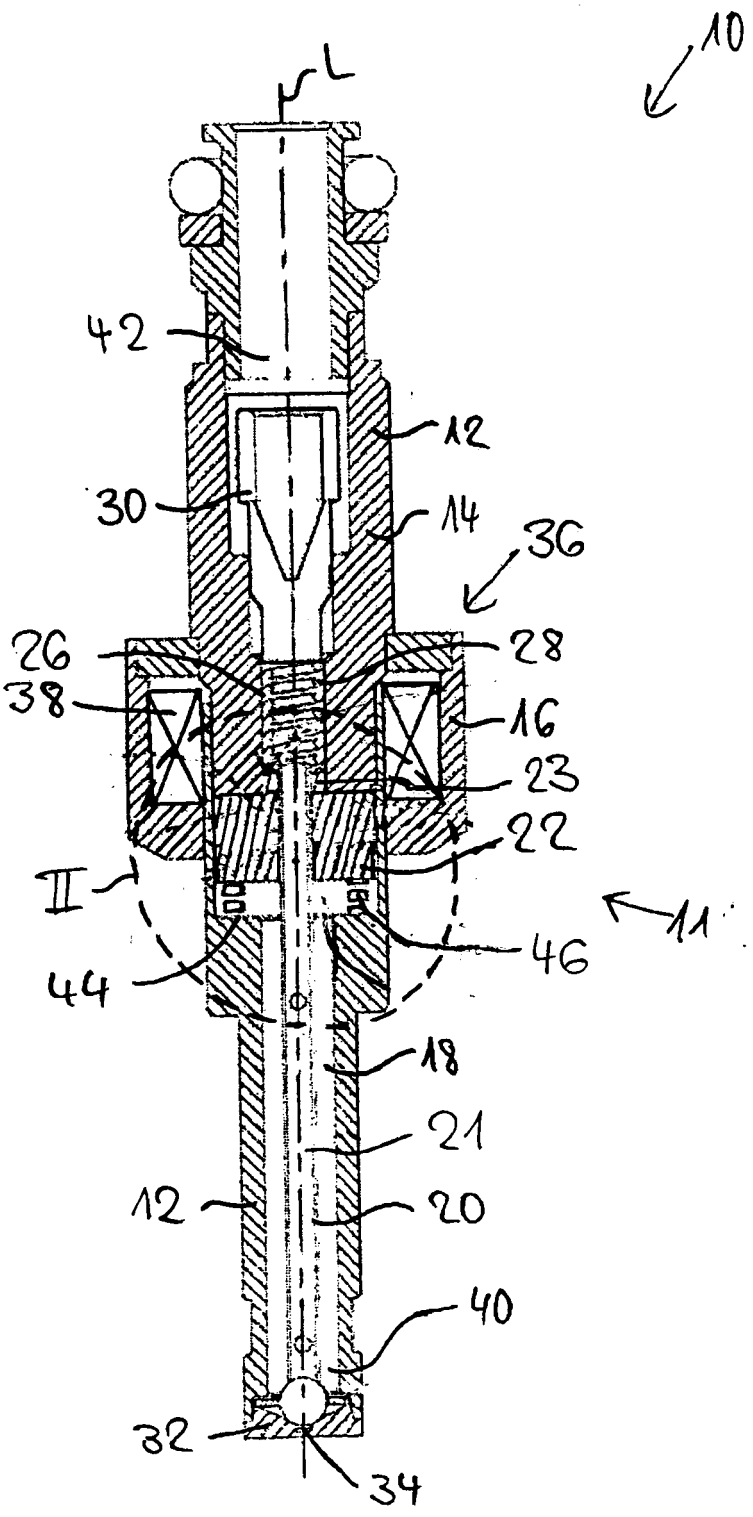


FIG 2

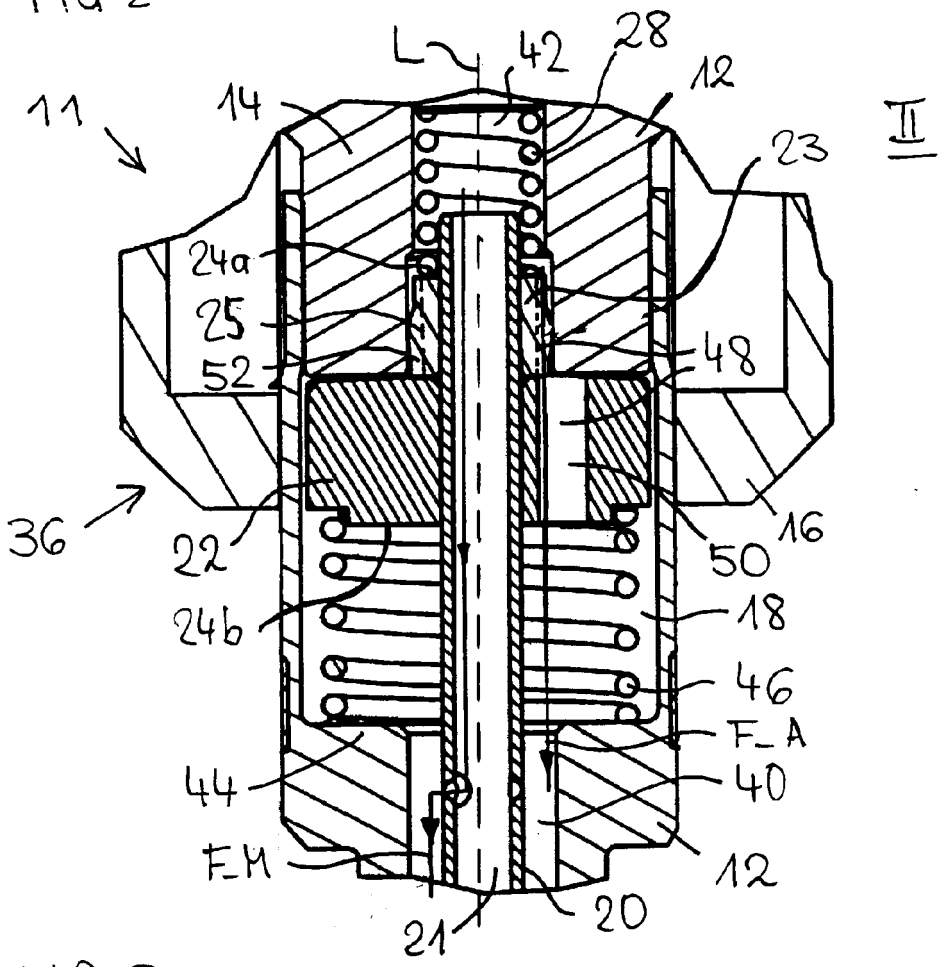
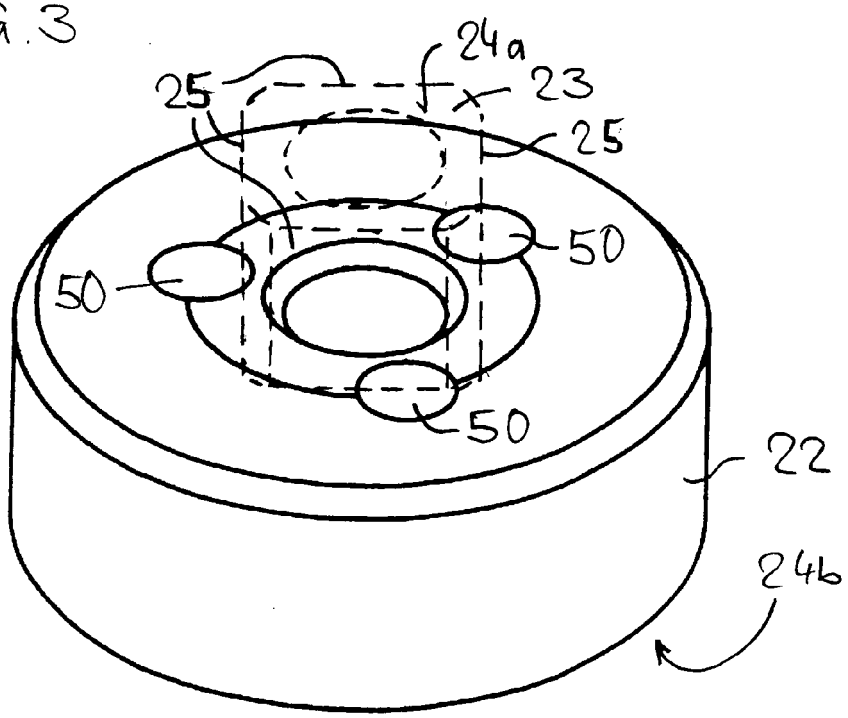

L
42
28
12
11
14
II
23
24a
25
52
48
36
22
16
50
24b
18
46
F_A
44
40
F_M
12
21
20

FIG 3


24a
25
23
25
50
50
50
22
24b

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 10 00 3831

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 01/06113 A1 (BOSCH GMBH ROBERT [DE]; REITER FERDINAND [DE]) 25 January 2001 (2001-01-25) * page 8; figure 2 * * abstract *	1-6	INV. F02M51/06 ADD. F02M63/00
X	US 2004/011899 A1 (DANTES GUNTER [DE] ET AL DANTES GUENTER [DE] ET AL) 22 January 2004 (2004-01-22) * paragraph [0016] - paragraph [0023]; figure 1 * * abstract *	1-6	
X	EP 0 905 371 A2 (MAGNETI MARELLI SPA [IT]) 31 March 1999 (1999-03-31) * paragraph [0016]; figure 2 * * abstract *	1-6	
X	US 2008/264389 A1 (FOCHTMAN JAMES PAUL [US] ET AL) 30 October 2008 (2008-10-30) * abstract; figure 1 *	1-6	

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	26 July 2010	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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 00 3831

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.

26-07-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0106113 A1	25-01-2001	CN 1318133 A	17-10-2001
		DE 19932763 A1	18-01-2001
		EP 1114249 A1	11-07-2001
		JP 2003504558 T	04-02-2003
		US 6494389 B1	17-12-2002
US 2004011899 A1	22-01-2004	WO 03001052 A1	03-01-2003
		DE 10130208 A1	02-01-2003
		EP 1402173 A1	31-03-2004
		JP 4225893 B2	18-02-2009
		JP 2004521253 T	15-07-2004
EP 0905371 A2	31-03-1999	IT BO970575 A1	24-03-1999
US 2008264389 A1	30-10-2008	DE 112006001508 T5	30-04-2008
		JP 2008544145 T	04-12-2008
		WO 2006138665 A2	28-12-2006

EPO FORM P0459

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