

(19)



(11)

EP 2 703 634 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

05.03.2014 Bulletin 2014/10

(51) Int Cl.:

F02M 51/06 (2006.01)

F02M 61/16 (2006.01)

F02M 65/00 (2006.01)

(21) Application number: **12182913.9**

(22) Date of filing: **04.09.2012**

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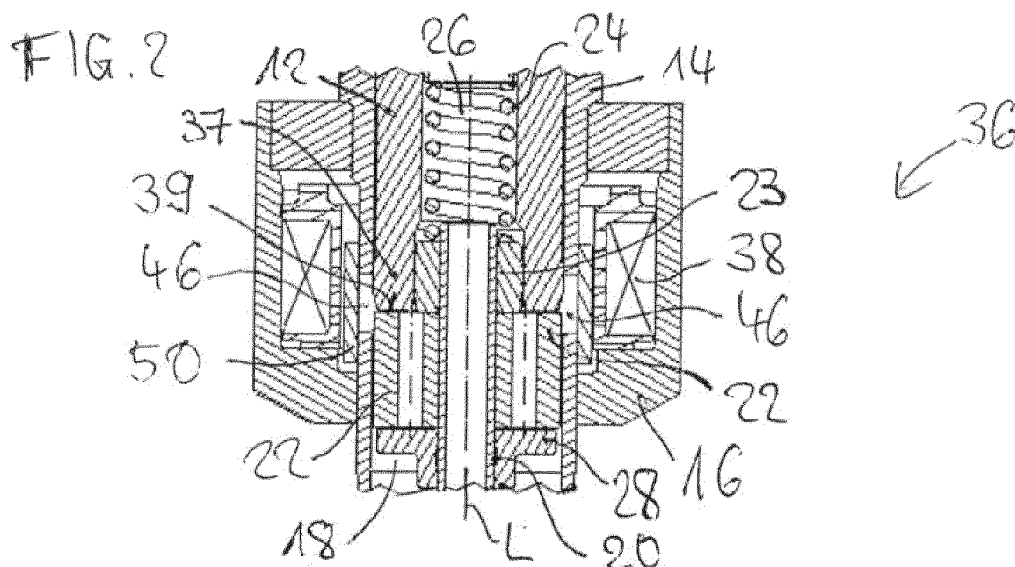
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(54) **Valve assembly for an injection valve and injection valve**

(57) The invention relates to a valve assembly (11) for an injection valve (10), with a valve body (14) including a central longitudinal axis (L), the valve body (14) 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 out-

let portion (40) in further positions, and an electro-magnetic actuator unit (36) being designed to actuate the valve needle (20). The actuator unit (36) comprises a coil (38) and an armature (22). The armature (22) is arranged in the cavity (18) of the valve body (14) and the coil (38) is arranged outside the valve body (14). At least one aperture (46) is arranged in the valve body (14) and the at least one aperture (46) extends between the coil (38) and the armature (22).



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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 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 more than 2000 bar.

[0005] The object of the invention is to create a valve assembly 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, with 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 actuator unit comprises a coil and an armature. The armature is arranged in the cavity of the valve body and the coil is arranged outside the valve body.

[0008] At least one aperture is arranged in the valve body and the at least one aperture extends between the coil and the armature. In particular, the coil, the aperture and the armature overlap in a side view along a radial direction perpendicular to the longitudinal axis.

[0009] The valve body may comprise or consist of a magnetizable material, in particular a magnetizable metal or alloy. At least a portion of the valve body may be comprised by a magnetic circuit that is generated by the electromagnetic actuator in operation.

[0010] The valve assembly has the advantage that a magnetic flux between the cavity of the valve body and

the outside of the valve body may be obtained through the at least one aperture. Consequently, the movement of the armature and/or the valve needle may be detected by electrical -in particular electromagnetic - means in a secure and/or reliable manner. In particular, the amplitude of the signal which is detectable outside of the valve body may be increased as compared to a valve body without the aperture. Consequently, the closing position and the further positions of the valve needle in which the fluid flow is released through the fluid outlet portion may be detected by electrical means particularly precisely.

[0011] In an advantageous embodiment the electromagnetic actuator unit comprises a pole piece, and the armature comprises a stop surface facing the pole piece and is designed to limit the axial movement of the armature relative to the pole piece. The at least one aperture is arranged between the coil and the stop surface of the armature. This has the advantage that the movement of the armature may be detected very sensitively by electrical means. Consequently, very small fluid flows or fluid flow changes through the fluid outlet portion may be controlled.

[0012] In one embodiment, the axial position of the stop surface overlaps with the axial extension of the aperture at least when the valve assembly is in a closed state and/or when the valve assembly is in an opened state. In a preferred embodiment, the valve assembly is configured in such way that the armature retains an axial position within the axial extension of the at least one aperture during operation of the valve assembly.

[0013] In a further advantageous embodiment the at least one aperture is covered by at least one cover element, the at least one cover element being of a nonmagnetic material or a plurality of non-magnetic materials. This has the advantage that the at least one cover element does not influence the signal to detect the position of the valve needle. Furthermore, a safe containment of the fluid in the valve body may be obtained. Additionally, the at least one cover element contributes to a high structural stability of the valve body.

[0014] In a further advantageous embodiment the at least one cover element is shaped as a ring being arranged outside the valve body. This has the advantage that the cover element may cover the at least one aperture in a manner that a safe containment of the fluid in the valve body may be obtained.

[0015] In a further advantageous embodiment the at least one cover element is coupled to the valve body by a welded joint. This has the advantage that the at least one cover element may be securely coupled to the valve body.

[0016] 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.

[0017] 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 in a longitudinal section view,
- Figure 2, an enlarged view of parts of the injection valve in a longitudinal section view, and
- Figure 3, a valve body of the injection valve in a perspective view.

[0018] Elements of the same design and function that appear in different illustrations are identified by the same reference character.

[0019] Figure 1 shows an injection valve 10 that is suitable for dosing fluids and which comprises a valve assembly 11 and an inlet tube 12. The injection valve 10 may be in particular suitable for dosing fuel to an internal combustion engine.

[0020] The valve assembly 11 comprises a valve body 14 with a central longitudinal axis L 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.

[0021] The cavity 18 takes in a valve needle 20 and an armature 22. A guide element 23 is arranged axially adjacent to the armature 22. The guide element 23 is fixedly coupled to the valve needle 14. The guide element 23 is formed as a collar around the valve needle 14. A main spring 24 is arranged in a recess 26 provided in the inlet tube 12. The recess 26 is part of the cavity 18. The main spring 24 is mechanically coupled to the guide element 23. The guide element 23 is in contact with an inner side of the inlet tube 12 and can guide the valve needle 14 in axial direction inside the inlet tube 12. The main spring 24 is arranged and designed to act on the valve needle 20 to move the valve needle 20 in axial direction in its closing position.

[0022] The cavity 18 takes in a disc element 28. The disc element 28 is fixedly coupled to the valve needle 14. The disc element 28 may limit the movement of the armature 22 in axial direction.

[0023] A filter element 30 is arranged in the inlet tube 12. The filter element 30 may filter the fluid from particles or other pollutions and forms a further seat for the main spring 24.

[0024] In a closing position of the valve needle 20 it sealingly rests on a seat plate 32 by this preventing a fluid flow through an 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.

[0025] 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. Furthermore, the electro-magnetic actuator unit 36 comprises a coil 38. The coil 38 is arranged outside the valve body 14. Preferably, the coil 38 is arranged circumferentially outside the valve body 14. Preferably, the housing 16 receives the coil 38.

[0026] The electro-magnetic actuator unit 36 comprises

es the armature 22. The armature 22 is arranged in the cavity 18 and is axially movable relative to the valve needle 20. The armature 22 has a stop surface 39. The stop surface 39 of the armature 22 faces the pole piece 37 and may limit an axial movement of the armature 22 relative to the pole piece 37.

[0027] The housing 16, the pole piece 37, the armature 22 and parts of the valve body 14 are forming an electromagnetic circuit.

[0028] A fluid outlet portion 40 is a part of the cavity 18 near the seat plate 32. The fluid outlet portion 40 communicates with a fluid inlet portion 42 being provided in the valve body 14.

[0029] At least one aperture 46 is arranged in the valve body 14. In the shown embodiment, three apertures 46 are arranged circumferential relative to the valve body 14. The apertures 46 extend in radial direction between the armature 22 and the coil 38, in particular between the area of the stop surface 39 of the armature 22 and the coil 38. Preferably, the apertures 46 are arranged evenly relative to the circumference of the valve body 14. In particular, the apertures 46 have identical dimensions and are evenly spaced.

[0030] The apertures 46 are covered by at least one cover element 50. The at least one cover element 50 is coupled to the valve body 14. Preferably, the at least one cover element 50 is formed as a ring element. This enables a secure coverage of the apertures 46.

[0031] Furthermore, a high mechanical stability of the valve body 14 may be obtained. Preferably, the at least one cover element 50 is coupled to the valve body 14 by a welded joint. The at least one cover element 50 is of a nonmagnetic material or a plurality of non-magnetic materials.

[0032] In the following, the function of the injection valve 10 is described in detail:

[0033] The fluid is led through the inlet tube 12 to the fluid inlet portion 42 of the valve assembly 11 and further towards the fluid outlet portion 40.

[0034] The valve needle 20 prevents a fluid flow through the fluid outlet portion 40 in the valve body 14 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.

[0035] If 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 may move in axial direction away from the fluid outlet portion 40. The axial movement of the armature 22 away from the fluid outlet portion 40 may be limited by the pole piece 37. The armature 22 takes the guide element 23 and 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 a fluid path is formed between the seat plate 32 and the valve needle 20 and fluid can pass

through the injection nozzle 34.

[0036] In the case that 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 and the force on the valve needle 20 caused by the main spring 24 whether the valve needle 20 moves in its closing position or not. On its way to the closing position, the valve needle 20 takes the armature 22 with it in axial direction towards the fluid outlet portion 40 by means of mechanical interaction via the guide element 23, for example.

[0037] During the movement of the armature 22 in axial direction away from and towards the fluid outlet portion 40 during the above mentioned opening and closing events, the apertures 46 overlap with the stop surface 39 when viewed in a side view in a radial direction perpendicular to the longitudinal axis L.

[0038] For a control of the injection valve 10 under ballistic operating conditions, an electrical feedback signal may be used to detect the closing position of the valve needle 20 and further positions in which the fluid may be released through the fluid outlet portion 40. With this signal it is possible to control a minimum of fuel quantities. The apertures 46 being arranged in the valve body 14 extending in radial direction between the coil 38 and the armature 22 allows to reduce the surface of the valve body 14. Consequently, an appropriate magnetic flux between the coil 38 and the armature 22, in particular between the area of the stop surface 39 of the armature 22 and the coil 38 may be obtained. By this a proper electrical feedback signal for the detection of the different positions of the valve needle 20 may be obtained to control the closing function of the injection valve 10.

erture (46) extends between the coil (38) and the armature (22).

2. Valve assembly (11) according to claim 1, wherein the electro-magnetic actuator unit (36) comprises a pole piece (37), and the armature (22) comprises a stop surface (39) facing the pole piece (37) and being designed to limit an axial movement of the armature (22) relative to the pole piece (37), and the at least one aperture (46) is arranged between the coil (38) and the stop surface (39) of the armature (22).
3. Valve assembly (11) according to claim 1 or 2, wherein the at least one aperture (46) is covered by at least one cover element (50), the at least one cover element (50) being of a nonmagnetic material or a plurality of non-magnetic materials.
4. Valve assembly (11) according to claim 3, wherein the at least one cover element (50) is shaped as a ring being arranged outside the valve body (14).
5. Valve assembly (11) according to claim 3 or 4, wherein the at least one cover element (50) is coupled to the valve body (14) by a welded joint.
6. Valve assembly (11) according to one of the preceding claims, wherein the valve body (14) comprises a magnetizable material.
7. Injection valve (10) with a valve assembly (11) according to one of the preceding claims.

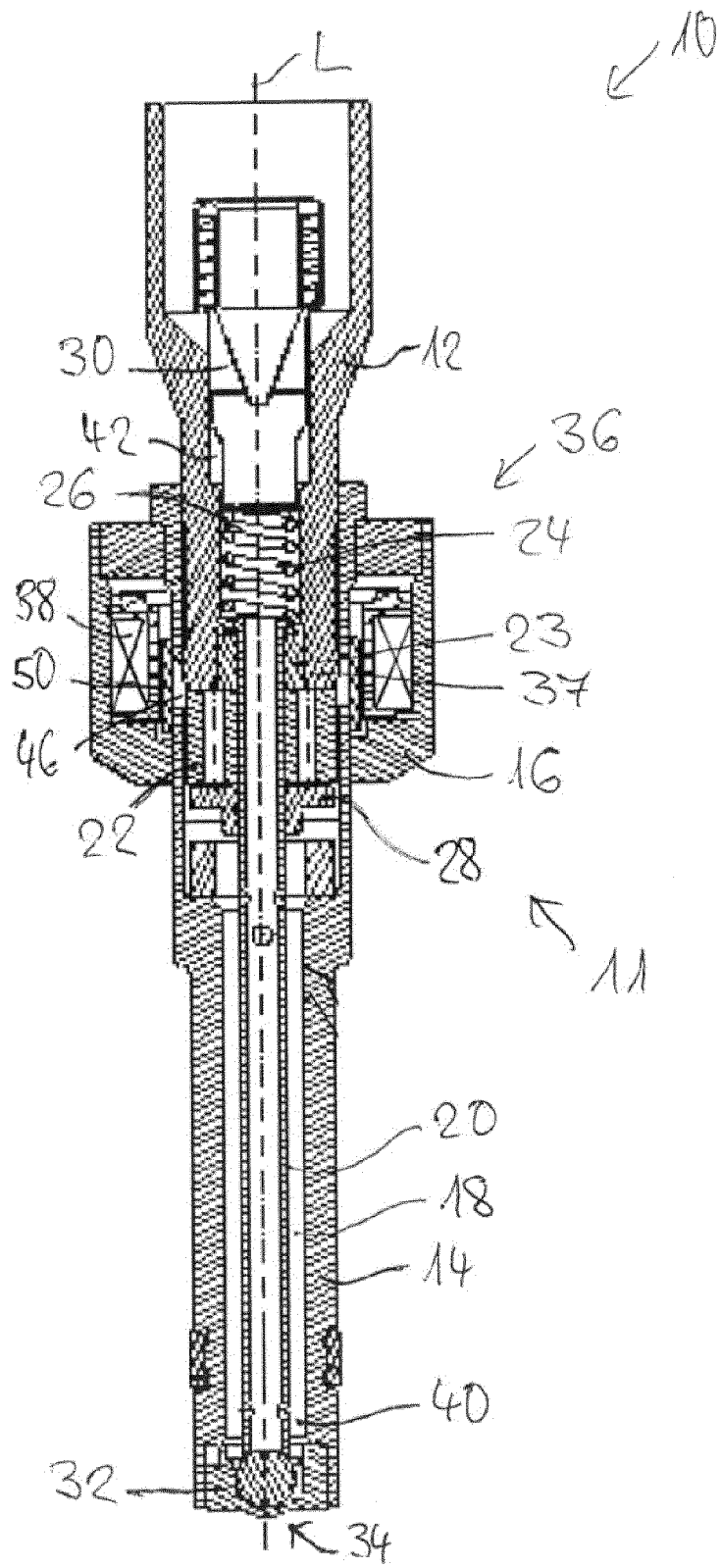
Claims

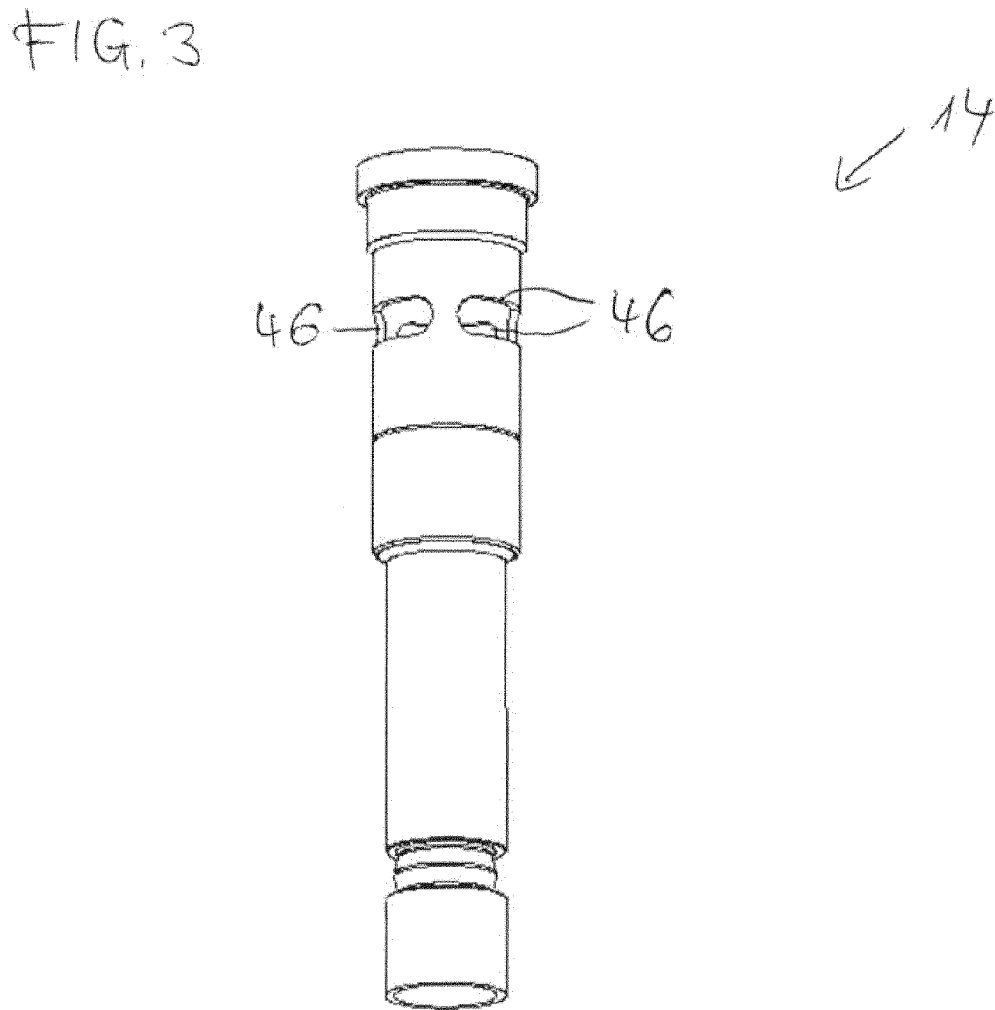
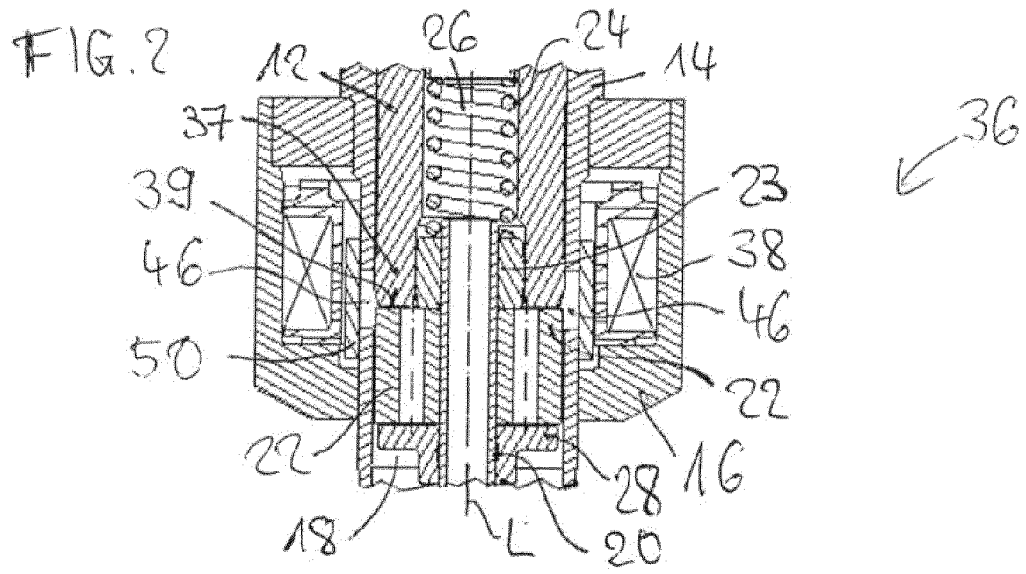
1. Valve assembly (11) for an injection valve (10), with

- a valve body (14) including a central longitudinal axis (L), the valve body (14) 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 actuator unit (36) comprising a coil (38) and an armature (22), the armature (22) being arranged in the cavity (18) of the valve body (14) and the coil (38) being arranged outside the valve body (14),

wherein at least one aperture (46) is arranged in the valve body (14) and the at least one ap-

FIG. 1







EUROPEAN SEARCH REPORT

Application Number
EP 12 18 2913

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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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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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