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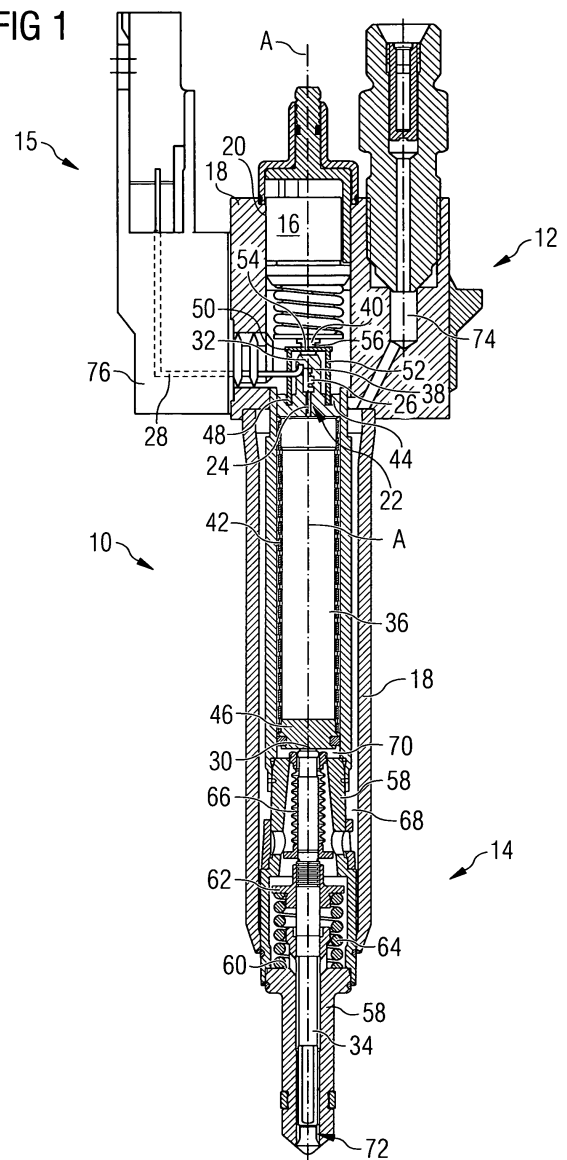
(71) Applicant: **Continental Automotive GmbH**
30165 Hannover (DE)

(72) Inventor: **Polidori, Valerio**
57128 Livorno (IT)

(54) **Actuator arrangement and injection valve**

(57) Actuator arrangement (12), comprising a solid state actuator unit (17) with a central longitudinal axis (A) comprising electrical connecting elements (22) being electrically coupable to a power supply, wherein the solid state actuator unit (17) comprises a first axial end area (30) designed to act as drive side and a second axial end area (32) facing away from the first axial end area (30), a compensator unit (16) being arranged at least partly along the longitudinal axis (A) of the solid state actuator unit (17) facing the second axial end area (32) of the solid state actuator unit (17), and a housing body (18) with a first recess (20), wherein the compensator unit (16) is arranged at least partly within the first recess (20) and is at least partly fixed to the housing body (18) to prevent rotational movement of the compensator unit (16) regarding the longitudinal axis (A). The solid state actuator unit (17) and the compensator unit (16) are designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis (A) between the solid state actuator unit (17) and the compensator unit (16).

FIG 1



Description

[0001] The invention relates to an actuator arrangement and an injection valve.

[0002] Actuator arrangements are in wide spread use, in particular injection valves for instance for internal combustion engines comprise actuator arrangements, which comprise solid state actuator units. In order to inject fuel, the solid state actuator unit is energized so that a fluid flow through the fluid outlet portion of the injection valve is enabled.

[0003] 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 a range of up to 200 bar or in the case of diesel engines in a range of up to 2,000 bar. In order to enable fast response times electric energy needs to be transmitted to or from the actuator arrangement in a very fast way.

[0004] The object of the invention is to create an actuator arrangement that is simply to be manufactured and which enables reliable operation by limiting a rotational movement of a solid state actuator unit of such an actuator arrangement.

[0005] This object is achieved by the features of the independent claims. Advantageous embodiments of the invention are given in the sub-claims.

[0006] According to a first aspect the invention is distinguished by an actuator arrangement, comprising a solid state actuator unit with a central longitudinal axis comprising electrical connecting elements being electrically coupable to a power supply, wherein the solid state actuator unit comprises a first axial end area designed to act as drive side and a second axial end area facing away from the first axial end area, a compensator unit being arranged at least partly along the longitudinal axis of the solid state actuator unit facing the second axial end area of the solid state actuator unit, and a housing body with a first recess, wherein the compensator unit is arranged at least partly within the first recess and is at least partly fixed to the housing body to prevent rotational movement of the compensator unit regarding the longitudinal axis. The solid state actuator unit and the compensator unit are designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis between the solid state actuator unit and the compensator unit.

[0007] In this way, a rotational movement of the solid state actuator unit regarding the central longitudinal axis relative to the housing body of the actuator arrangement is prevented. This has the advantage that possible wear within the actuator arrangement caused by rotational movement of solid state actuator unit may be limited. For example, wear of the electric connections between the solid state actuator unit and a power supply caused by undesired movements of the solid state actuator unit may be limited. Thus, reliable operation of the actuator ar-

range may be enabled. Furthermore, the correct arrangement of the solid state actuator unit within the actuator arrangement may be enabled. The housing body may be arranged at least partly along the central longitudinal axis. For instance, the housing body may comprise two parts, wherein the solid state actuator unit may be arranged within a further recess of a further part of the housing body. For example, the compensator unit may be a thermal compensator unit, which is enabled to compensate temperature changes.

[0008] In an advantageous embodiment the solid state actuator unit comprises a first piston comprising a slot being arranged at the second axial end area of the solid state actuator unit and the compensator unit comprises a second piston comprising a protrusion, wherein the slot is designed and arranged such as to at least partly take in the protrusion, the slot and the protrusion being designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis between the solid state actuator unit and the compensator unit.

[0009] By this, rotational movement of the solid state actuator unit relative to the compensator unit and therewith the housing body may be prevented in an especially reliable way to limit possible wear within actuator arrangement caused by rotational movement of solid state actuator unit. Thus, especially reliable operation of the actuator arrangement may be enabled. Moreover, the actuator arrangement may be simply to be manufactured. For example, the first piston may be in contact with the second piston via point contact. For instance, the protrusion may be formed as a front part of a slot-head screwdriver, wherein the slot may comprise the corresponding geometry. For example, the first piston and/or the second piston may comprise steel, for instance stainless steel.

[0010] In a further advantageous embodiment the solid state actuator unit comprises a first piston comprising a protrusion being arranged at the second axial end area of the solid state actuator unit and the compensator unit comprises a second piston comprising a slot, wherein the slot is designed and arranged such as to at least partly take in the protrusion, the slot and the protrusion being designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis between the solid state actuator unit and the compensator unit.

[0011] Therefore, rotational movement of the solid state actuator unit relative to the compensator unit and therewith the housing body may be prevented in an especially reliable way to limit possible wear within actuator arrangement caused by rotational movement of solid state actuator unit. Thus, especially reliable operation of the actuator arrangement may be enabled. Moreover, the actuator arrangement may be simply to be manufactured. For example, the first piston may be in contact with the second piston via point contact. For instance, the slot may comprise the corresponding geometry to the geometry of the protrusion. For example, the first piston and/or

the second piston may comprise steel, for instance stainless steel.

[0012] In a further advantageous embodiment the solid state actuator unit comprises at least one second recess being arranged at the second axial end area of the solid state actuator unit and a locking element being arranged at least partly circumferentially a second piston of the compensator unit comprising at least one rod and at least one third recess, wherein the third recess is at least partly axially overlapping with a protrusion of the second piston and the rod is designed and arranged such as to at least partly protrude into the second recess of the solid state actuator unit, the protrusion of the second piston, the locking element and the solid state actuator unit being designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis between the solid state actuator unit and the compensator unit.

[0013] This enables especially reliable operation of the actuator arrangement. Moreover, the actuator arrangement may be simply to be manufactured. For example the locking element may take in the second piston at its protrusion and enable the positive locking together with the rod and the second recess of the solid state actuator unit. In particular, the third recess of the locking element may comprise the corresponding geometry to the geometry of the protrusion of the second piston of the compensator unit. In addition, the solid state actuator unit may comprise a first piston comprising a slot, wherein the slot is designed and arranged such as to at least partly take in the protrusion of the second piston. Thus, the slot and the protrusion may be designed and arranged such as to form an additional positive locking in rotational direction of the central longitudinal axis between the solid state actuator unit and the compensator unit. For example, the locking element may comprise plastic, steel, aluminium or a combination of copper and tin.

[0014] In a further advantageous embodiment the electrical connecting element of the solid state actuator unit comprises a wire, wherein a clamp is at least partly taking in the wire.

[0015] This has the advantage that a wire may limit possible wear of the electrical connection due to its flexibility for example compared to rigidly connecting pins, at which the pin connection might break. A wire may allow a movement such as a rotational movement of the solid state actuator unit regarding the central longitudinal axis without a wear of the electrical connection. Thus, especially reliable operation of the actuator arrangement may be enabled. Moreover, the wire may enable low production costs. Furthermore, the clamp may allow some kind of fixation of a part of the wire and enable its coupling to a power supply in a simple way. For example, the clamp may be a terminal clamp, for instance a Faston. For instance, the electrical connecting elements may comprise two wires, which may be arranged on opposite sides of the first piston, for example each with a same distance to each of the two second recesses of the solid state

actuator unit.

[0016] In a further advantageous embodiment the actuator arrangement comprises a connector to supply electric energy to the solid state actuator unit, wherein the connector is electrically coupled to the wire of the solid state actuator unit via the clamp.

[0017] This has the advantage that electric energy may be supplied to the solid state actuator unit via a flexible electrical connection by the wire, which may allow some kind of movement of the solid state actuator unit without possible wear. Thus, especially reliable operation of the actuator arrangement may be enabled. For example, the connector may be welded to the clamp.

[0018] According to a second aspect the invention is distinguished by an injection valve with a valve assembly within a further recess of a housing body and an actuator arrangement of the first aspect of the invention, comprising a solid state actuator unit within the further recess, wherein the solid state actuator unit is being designed for acting on the valve assembly.

[0019] Exemplary embodiments of the invention are explained in the following with the help of schematic drawings. These are as follows:

Figure 1 a longitudinal section through an injection valve with a first embodiment of an actuator arrangement,

Figure 2 a three-dimensional view of an exemplary embodiment of a locking element,

Figure 3 a three-dimensional view of a part of a second embodiment of the actuator arrangement, and

Figure 4 a three-dimensional view of a part of a solid state actuator unit.

[0020] Elements of the same design and function that appear in different illustrations are identified by the same reference characters.

[0021] Figure 1 shows an injection valve 10 that may be used as a fuel injection valve for an internal combustion engine. The injection valve 10 comprises an actuator arrangement 12, a valve assembly 14 and a connector 15. The actuator arrangement 12 comprises a compensator unit 16, a solid state actuator unit 17 with a central longitudinal axis A and a housing body 18.

[0022] In this exemplary embodiment, the injection valve 10 comprises a two-part housing body 18 with a tubular shape being arranged at the central longitudinal axis A. The housing body 18 comprises a first recess 20 which is at least partly axially led through the housing body 18. The compensator unit 16 is arranged at least partly within the first recess 20 and is at least partly fixed to the housing body 18 to prevent rotational movement of the compensator unit 16 regarding the longitudinal axis A. For example, the compensator unit 16 may be fixed to the housing body 18 by welding.

[0023] The solid state actuator unit 17 with the central longitudinal axis A may be arranged at least partly within the first recess 20 of the housing body 18 and comprises electrical connecting elements 22 being electrically coupleable to a power supply. For instance, the solid state actuator unit 17 may comprise two electrical connecting elements 22. For example, the electrical connecting element 22 comprises a wire 24, wherein a clamp 26 is at least partly taking in the wire 24. For instance, the electrical connecting elements 22 might be coupled by weldings, in particular resistance weldings, or soldered connections to an electric conductor 28, which is supplied with electric energy.

[0024] The solid state actuator unit 17 comprises a first axial end area 30 designed to act as drive side and a second axial end area 32 facing away from the first axial end area 30. On the drive side of the solid state actuator unit 17 facing the first axial end area 30 optional actuating elements are arranged such as a valve needle 34. The solid state actuator unit 17 comprises a solid state actuator 36. The solid state actuator 36 changes its length in axial direction depending on a control signal applied to it such as electric energy supplied to it. The solid state actuator unit 17 is typically a piezo actuator unit. It may however also be any other solid state actuator unit known to the person skilled in the art such as a magnetostrictive actuator unit. Moreover, the solid state actuator unit 17 may comprise a first piston 38 being arranged at the second axial end area 32 of the solid state actuator unit 17.

[0025] The compensator unit 16 is arranged at least partly along the longitudinal axis A of the solid state actuator unit 17 facing the second axial end area 32 of the solid state actuator unit 17. For example, the compensator unit 16 may comprise a second piston 40, which may be mechanically coupled to the first piston 38 of the solid state actuator unit 17. For instance, the solid state actuator unit 17 may be in contact with the second piston 40 via point contact between the first piston 38 and the second piston 40. The compensator unit 16 enables to set an axial preload force on the solid state actuator unit 17 via the first piston 38 of the solid state actuator unit 17. For instance, the compensator unit 16 may be a thermal compensator unit, which is enabled to compensate temperature changes.

[0026] An actuator housing enclosing the solid state actuator 36 of the solid state actuator unit 17 may comprise a spring tube 42, a top cap 44 and a bottom cap 46. Part of the top cap 44 may form at least part of the second axial end area 32. Part of the bottom cap 46 may form at least part of the first axial end area 30 comprising the drive side of the solid state actuator unit 17. The solid state actuator unit 17 further comprises the first piston 38, which is coupled to the top cap 44 or may in one piece form part of the top cap 44. It may apply an axial preload force on the solid state actuator unit 17.

[0027] For example, the solid state actuator unit 17 comprises at least one second recess 48 being arranged at the second axial end area 32 of the solid state actuator

unit 17. For example, the solid state actuator unit 17 may comprise two second recesses 48, which may be arranged on opposite sides regarding the first piston 38 of the solid state actuator unit 17. For instance, the top cap 44 may comprise the second recesses 48. Furthermore, the solid state actuator unit 17 comprises a locking element 50 being arranged at least partly circumferentially the second piston 40 of the compensator unit 16. The locking element 50 comprises at least one rod 52, for example two rods 52, being designed and arranged such as to at least partly protrude into the second recess 48 of the solid state actuator unit 17. Moreover, the locking element 50 comprises at least one third recess 54 (figure 2), wherein the third recess 54 is at least partly axially overlapping with a protrusion 56 of the second piston 40 of the compensator unit 16. In particular, the protrusion 56 of the second piston 40, the locking element 50 and the solid state actuator unit 17 are designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis A between the solid state actuator unit 17 and the compensator unit 16. By coupling the solid state actuator unit 17 to the compensator unit 16 via positive locking in rotational direction regarding the central longitudinal axis A and by fixing the compensator unit 16 at least partly to the housing body 18, a rotational movement of the solid state actuator unit 17 regarding the central longitudinal axis A relative to the housing body 18 of the actuator arrangement 12 may be prevented. This has the advantage that for example wear of the electric connections between the solid state actuator unit 17 and a power supply caused by undesired movements of the solid state actuator unit 17 may be limited. Thus, reliable operation of the actuator arrangement 12 may be enabled.

[0028] The valve assembly 14 comprises a valve body 58 and the valve needle 34. The valve body 58 has a valve body spring rest 60 and the valve needle 34 comprises a valve needle spring rest 62, both spring rests 60, 62 supporting a spring 64 being arranged between the valve body 58 and the valve needle 34. Between the valve needle 34 and the valve body 58 a bellow 66 is arranged, which is sealingly coupling the valve body 58 with the valve needle 34. By this a fluid flow between a further recess 68, in which the solid state actuator unit 17 may be at least partly arranged, and a chamber 70 is prevented. Furthermore, the bellow 66 is formed and arranged in a way that the valve needle 34 is actuable by the solid state actuator unit 17.

[0029] A fluid outlet portion 72 is closed or open depending on the axial position of a valve needle 34. By changing its length, the solid state actuator 36 can exert a force to the valve needle 34. The force from the solid state actuator 36 being exerted to the valve needle 34 in an axial direction allows or prevents a fluid flow through the fluid outlet portion 72. Furthermore, the injection valve 10 has a fluid inlet portion 74, which is arranged in the housing body 18 and which for instance is coupled to a not shown fuel connector. In this example, the fuel con-

nector is designed to be connected to a high pressure fuel chamber of an internal combustion engine, wherein the fuel is stored under high pressure, for example, under the pressure above 200 bar.

[0030] The compensator unit 16, which is in this example a thermal compensator unit, is enabled to set an axial preload force on the solid state actuator unit 17 to compensate changes of the fluid flow through the fluid outlet portion 72 in the case of temperature changes of the injection valve 10.

[0031] The valve assembly 14 is arranged in the injection valve 10 facing the first axial end area 30 on the drive side of the solid state actuator unit 17 in a part of the further recess 68 of the housing body 18 of the injection valve 10 along the longitudinal axis A.

[0032] The injection valve 10 further comprises the connector 15 with a non-conductive connector body 76 in which the electric conductor 28 is arranged. For example, the electric conductor 28 of the connector 15 may comprise copper and tin, for instance CuSn_6 . Electric energy can be supplied to the electric conductor 28 of the connector 15. The electric conductor 28 of the connector 15 is electrically coupled to the electrical connecting elements 22, for example to the wire 24 of the solid state actuator unit 17 via the clamp 26. For example, the clamp 26 may be a terminal clamp, for instance a Faston. Consequently, electric energy can be simply supplied to the solid state actuator 36 via the connector 15. The electrical connecting element 22 of the solid state actuator unit 17, for example the wire 24, may be arranged in optional direction, for instance in axial direction of the solid state actuator unit 17.

[0033] For instance, the wire 24 may limit wear of the electrical connection due to its flexibility for example compared to rigidly connecting pins, at which the pin connection might break. The wire 24 may allow a movement such as a rotational movement of the solid state actuator unit 17 regarding the central longitudinal axis A without a possible wear of the electrical connection. Thus, especially reliable operation of the actuator arrangement 12 may be enabled. Furthermore, the clamp 26 may allow some kind of fixation of a part of the wire 24 and enable its coupling to a power supply in a simple way.

[0034] In the following, the function of the injection valve 10 will be described in detail:

[0035] The fluid is led from the fluid inlet portion 74 through the housing body 18 to the fluid outlet portion 72.

[0036] The valve needle 34 prevents a fluid flow through the fluid outlet portion 72 in the valve body 58 in a closing position of the valve needle 34. Outside of the closing position of the valve needle 34, the valve needle 34 enables the fluid flow through the fluid outlet portion 72.

[0037] The solid state actuator 36 may change its axial length if it is energized. By changing its length the solid state actuator 36 may exert a force on the valve needle 34. The valve needle 34 is able to move in axial direction out of the closing position. Outside the closing position

of the valve needle 34 there is a gap between the valve body 58 and the valve needle 34 at an axial end area of the injection valve 10 facing away from the solid state actuator 36. The spring 64 can force the valve needle 34 via the valve needle spring rest 62 towards the solid state actuator 36. In the case the solid state actuator 36 is de-energized, the solid state actuator 36 shortens its length. The spring 64 can force the valve needle 34 to move in axial direction in its closing position. It is depending on the force balance between the force on the valve needle 34 caused by the solid state actuator 36 and the force on the valve needle 34 caused by the spring 64 whether the valve needle 34 is in its closing position or not.

[0038] Figure 2 shows a three-dimensional view of an exemplary embodiment of the locking element 50. The locking element 50 comprises at least one rod 52 and at least one third recess 54. For instance, the locking element 50 may comprise two rods 52 and one third recess 54. In this case, the solid state actuator unit 17 may comprise two second recesses 48, wherein the rods 52 are designed and arranged such as to at least partly protrude into the second recesses 48 of the solid state actuator unit 17 (figure 1). The third recess 54 of the locking element 50 may comprise the corresponding geometry to the geometry of the protrusion 56 of the second piston 40 of the compensator unit 16 (figure 1). For example, the locking element 50 may be arranged at least partly circumferentially the second piston 40 of the compensator unit 16 (figure 1), wherein the third recess 54 is at least partly axially overlapping with the protrusion 56 of the second piston 40. Thus, the locking element 50 may take in the second piston 40 at its protrusion 56 and enable the positive locking together with the rod 52 and the second recess 48 of the solid state actuator unit 17. For instance, the locking element 50 comprises plastic, steel, aluminium or a combination of copper and tin.

[0039] Figure 3 shows a three-dimensional view of a part of a second embodiment of the actuator arrangement 12. For example, injection valves for instance for internal combustion engines may comprise the actuator arrangement 12. The actuator arrangement 12 comprises the compensator unit 16 and the solid state actuator unit 17.

[0040] The solid state actuator unit 17 with the central longitudinal axis A comprises the electrical connecting elements 22 being electrically coupable to a power supply, for instance two electrical connecting elements 22. Each of the electrical connecting elements 22 comprise the wire 24, wherein the clamp 26 is at least partly taking in the wire 24. Moreover, the solid state actuator unit 17 comprises the first piston 38.

[0041] The compensator unit 16 is arranged at least partly along the longitudinal axis A of the solid state actuator unit 17 and comprises the second piston 40, which may be mechanically coupled to the first piston 38 of the solid state actuator unit 17. For example, the first piston 38 may be in contact with the second piston 40 via point contact. The compensator unit 16 enables to set an axial

preload force on the solid state actuator unit 17 via the first piston 38 of the solid state actuator unit 17. For instance, the compensator unit 16 may be a thermal compensator unit, which is enabled to compensate temperature changes.

[0042] The second piston 40 of the compensator unit 16 comprises the protrusion 56 and the first piston 38 of the solid state actuator unit 17 comprises a slot 78, wherein the slot 78 is designed and arranged such as to at least partly take in the protrusion 56. The slot 78 and the protrusion 56 are designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis A between the solid state actuator unit 17 and the compensator unit 16. By this, rotational movement of the solid state actuator unit 17 relative to the compensator unit 16 and therewith the housing body 18 (figure 1) may be prevented in an especially reliable way for example to limit possible wear within the actuator arrangement 12 caused by rotational movement of solid state actuator unit 17. Thus, especially reliable operation of the actuator arrangement 12 may be enabled. For instance, the first piston 38 and/or the second piston 40 may comprise steel, for example stainless steel.

[0043] In a further exemplary embodiment, the solid state actuator unit 17 comprises the first piston 38 comprising a protrusion 56' and the compensator unit 16 comprises the second piston 40 comprising a slot 78'. The slot 78' is designed and arranged such as to at least partly take in the protrusion 56'. Moreover, the slot 78' and the protrusion 56' are designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis A between the solid state actuator unit 17 and the compensator unit 16.

[0044] Figure 4 shows a three-dimensional view of a part of the solid state actuator unit 17. The solid state actuator unit 17 comprises the electrical connecting elements 22 being electrically coupable to a power supply, for instance two electrical connecting elements 22. Each of the electrical connecting elements 22 comprise the wire 24, wherein the clamp 26 is at least partly taking in the wire 24. Moreover, the solid state actuator unit 17 comprises the first piston 38 and the first piston 38 comprises a slot 78, wherein the slot 78 is designed and arranged such as to at least partly take in the protrusion 56 of the compensator unit 16 (figure 3).

[0045] The invention is not restricted to the explained embodiments. For example, the first piston 38, the second piston 40 and the locking element 50 may comprise alternative shapes. Further, the protrusion 56, 56' and the slot 78, 78' may comprise alternative shapes.

Claims

1. Actuator arrangement (12), comprising

- a solid state actuator unit (17) with a central longitudinal axis (A) comprising electrical con-

necting elements (22) being electrically coupable to a power supply, wherein the solid state actuator unit (17) comprises a first axial end area (30) designed to act as drive side and a second axial end area (32) facing away from the first axial end area (30),

- a compensator unit (16) being arranged at least partly along the longitudinal axis (A) of the solid state actuator unit (17) facing the second axial end area (32) of the solid state actuator unit (17), and

- a housing body (18) with a first recess (20), wherein the compensator unit (16) is arranged at least partly within the first recess (20) and is at least partly fixed to the housing body (18) to prevent rotational movement of the compensator unit (16) regarding the longitudinal axis (A),

wherein the solid state actuator unit (17) and the compensator unit (16) are designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis (A) between the solid state actuator unit (17) and the compensator unit (16).

2. Actuator arrangement (12) according to claim 1, wherein the solid state actuator unit (17) comprises a first piston (38) comprising a slot (78) being arranged at the second axial end area (32) of the solid state actuator unit (17) and the compensator unit (16) comprises a second piston (40) comprising a protrusion (56), wherein the slot (78) is designed and arranged such as to at least partly take in the protrusion (56), the slot (78) and the protrusion (56) being designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis (A) between the solid state actuator unit (17) and the compensator unit (16).

3. Actuator arrangement (12) according to claim 1, wherein the solid state actuator unit (17) comprises a first piston (38) comprising a protrusion (56') being arranged at the second axial end area (32) of the solid state actuator unit (17) and the compensator unit (16) comprises a second piston (40) comprising a slot (78'), wherein the slot (78') is designed and arranged such as to at least partly take in the protrusion (56'), the slot (78') and the protrusion (56') being designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis (A) between the solid state actuator unit (17) and the compensator unit (16).

4. Actuator arrangement (12) according to one of the preceding claims, wherein the solid state actuator unit (17) comprises at least one second recess (48) being arranged at the second axial end area (32) of the solid state actuator unit (17) and a locking ele-

ment (50) being arranged at least partly circumferentially a second piston (40) of the compensator unit (16) comprising at least one rod (52) and at least one third recess (54), wherein the third recess (54) is at least partly axially overlapping with a protrusion (56) of the second piston (40) and the rod (52) is designed and arranged such as to at least partly protrude into the second recess (48) of the solid state actuator unit (17), the protrusion (56) of the second piston (40), the locking element (50) and the solid state actuator unit (17) being designed and arranged such as to form a positive locking in rotational direction of the central longitudinal axis (A) between the solid state actuator unit (17) and the compensator unit (16).

5. Actuator arrangement (12) according to one of the preceding claims, wherein the electrical connecting element (22) of the solid state actuator unit (17) comprises a wire (24), wherein a clamp (26) is at least partly taking in the wire (24).
6. Actuator arrangement (12) according to one of the preceding claims, wherein the actuator arrangement (12) comprises a connector (15) to supply electric energy to the solid state actuator unit (17), wherein the connector (15) is electrically coupled to the wire (24) of the solid state actuator unit (17) via the clamp (26).
7. Injection valve (10) with a valve assembly (14) within a further recess (68) and an actuator arrangement (12) according to one of the preceding claims, comprising a solid state actuator unit (17) within the further recess (68), wherein the solid state actuator unit (17) is designed for acting on the valve assembly (14).

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FIG 1

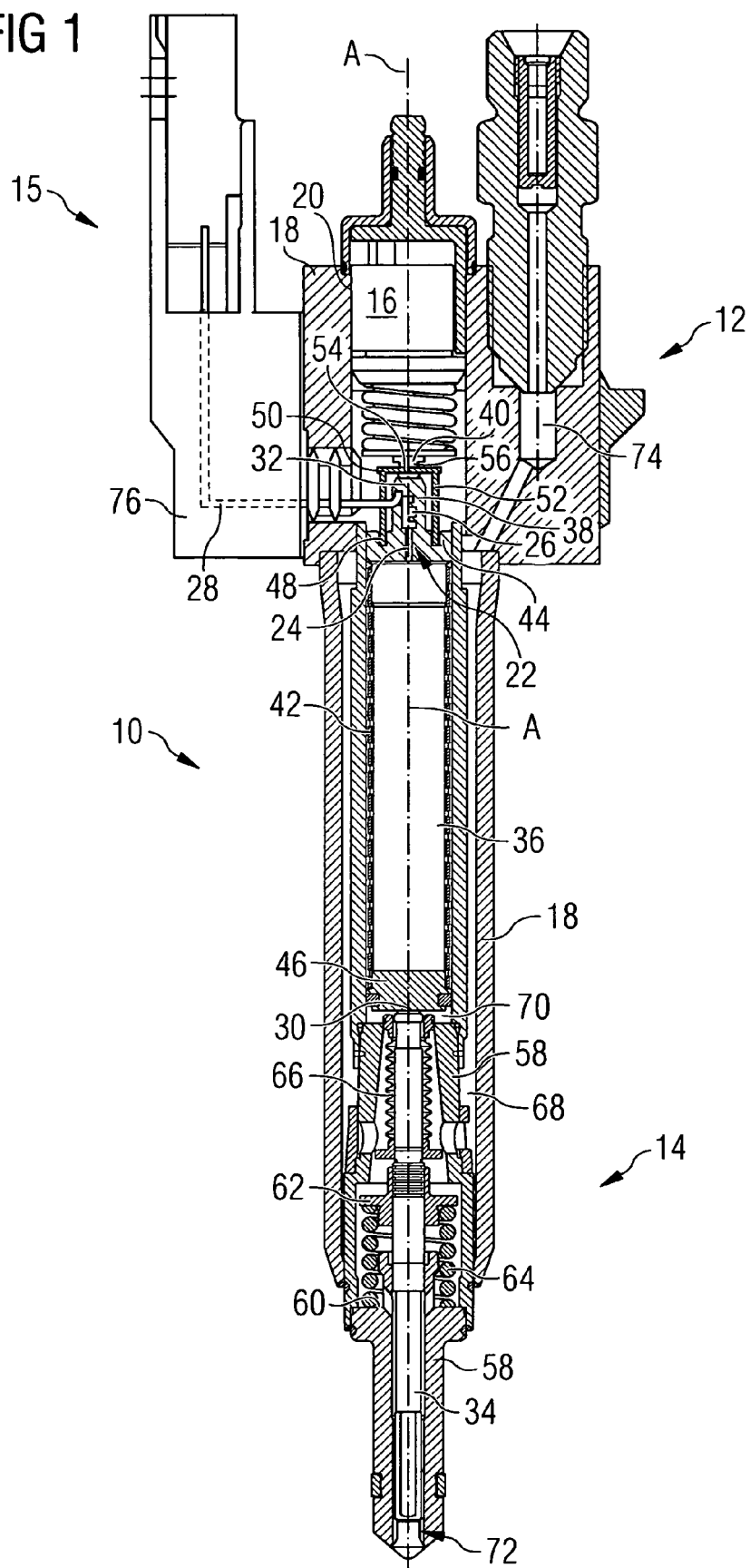


FIG 2

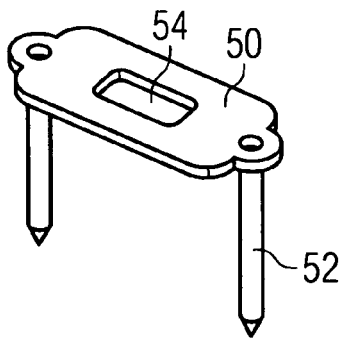


FIG 3

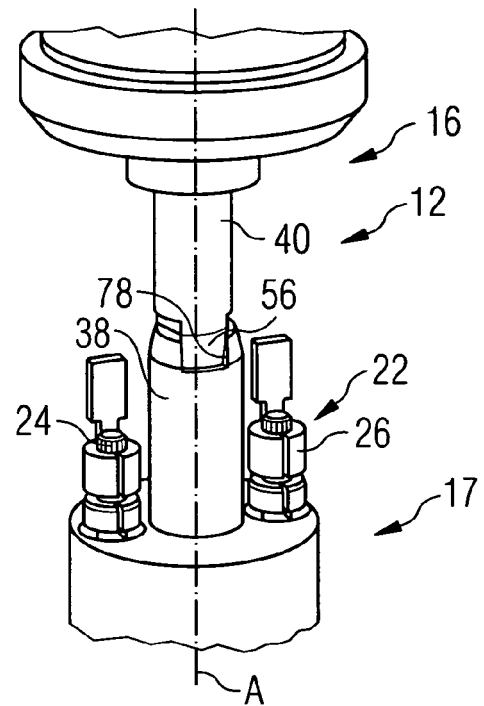
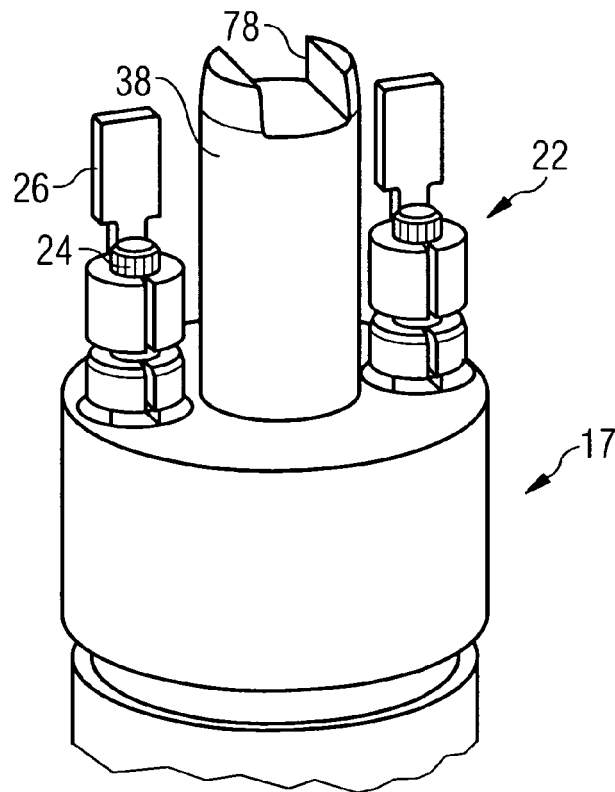


FIG 4





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 08 00 6823

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 10 2006 019308 A1 (BOSCH GMBH ROBERT [DE]) 31 October 2007 (2007-10-31) * paragraphs [0026], [0027]; figure 3 *	1,7	INV. F02M51/06 F02M61/16
A	WO 2005/026528 A (SIEMENS AG [DE]; BACHMAIER GEORG [DE]; FISCHER BERNHARD [DE]; GOTTLIEB) 24 March 2005 (2005-03-24) * page 9, line 25 - page 10, line 21; figure 1a *	1,5-7	
A	EP 1 865 191 A (SIEMENS AG [DE]) 12 December 2007 (2007-12-12) * paragraph [0036]; figures *	1,7	
A	US 7 311 273 B2 (AGNERAY ANDRE [FR] ET AL) 25 December 2007 (2007-12-25) * column 5, line 59 - column 6, line 9; figures *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			F02M
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 23 September 2008	Examiner Landriscina, V
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 00 6823

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23-09-2008

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102006019308 A1	31-10-2007	WO 2007124971 A1	08-11-2007
WO 2005026528 A	24-03-2005	NONE	
EP 1865191 A	12-12-2007	NONE	
US 7311273 B2	25-12-2007	EP 1623107 A2	08-02-2006
		FR 2854664 A1	12-11-2004
		WO 2004101985 A2	25-11-2004
		JP 2006528747 T	21-12-2006
		US 2006278735 A1	14-12-2006

EPO FORM P0459

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