(19) Europäisches Patentamt
European Patent Office
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(11) **EP 2 597 296 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.05.2013 Bulletin 2013/22

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

(21) Application number: **11190294.6**

(22) Date of filing: **23.11.2011**

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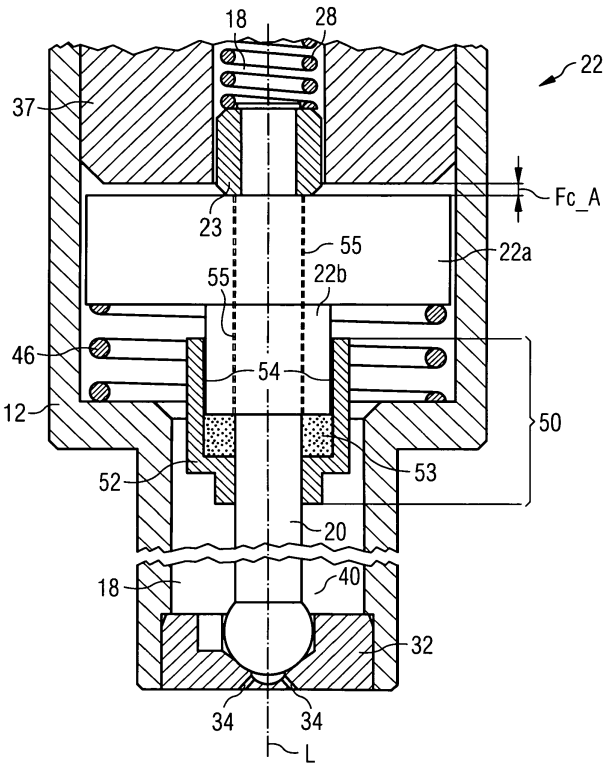
(54) **Valve assembly for an injection valve and injection valve**

(57) The invention relates to a valve assembly (11) for an injection valve (10), with a valve body (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), with 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, with an upper retainer (23) being arranged in the cavity (18) and being fixedly coupled to the valve needle (20), with an electromagnetic actuator unit (36) being designed to actuate the valve needle (20), the actuator unit (36) comprising an armature arrangement (22) which is arranged in the cavity (18) and is axially moveable relative to the valve needle (20), the armature arrangement (22) being designed to be coupled to the upper retainer (23) when the valve needle (20) is actuated to leave the closing position, the armature arrangement (22) being designed and arranged to mechanically decouple from the upper retainer (23) due to its inertia when the valve needle (20) reaches the closing position.

FIG 2



EP 2 597 296 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 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,
an upper retainer being arranged in the cavity and being fixedly coupled to the valve needle, an electro-magnetic actuator unit being designed to actuate the valve needle, the actuator unit comprising an armature arrangement which is arranged in the cavity and is axially moveable relative to the valve needle, the armature arrangement being designed to be coupled to the upper retainer when the valve needle leaves the closing position, and the armature arrangement being designed and arranged to mechanically decouple from the upper retainer due to its inertia when the valve needle reaches the closing position, and an armature spring being arranged in the cavity and being coupled to the armature arrangement axially adjacent to the armature arrangement. The armature spring is arranged to provide a force to the armature arrangement contributing coupling the armature arrangement with the valve needle.

[0008] The armature arrangement comprises an armature portion and a protruding portion, whereby the protruding portion protrudes axially towards the fluid outlet portion. A dampening apparatus is arranged in the cavity axially adjacent to the armature arrangement. The dampening apparatus comprises a cup being fixedly coupled to the valve body and a major part of the protruding portion of the armature arrangement. The major part of the protruding portion of the armature arrangement is arranged inside of the cup, thereby forming a volume inside the cup for being filled with fluid during operation of the valve assembly.

[0009] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings. These are as follows:

Figure 1	shows a traditional injection valve in a longitudinal section view,
Figures 2 to 5	show the valve assembly according to the invention, demonstrated according to different steps of operation.

[0010] Elements of the same design and function that appear in different illustrations are identified by the same reference character.

[0011] Figure 1 shows, just for the purpose of better understanding the invention, a traditional injection valve 10 that is suitable for dosing fluids and which comprises a traditional valve assembly 11 and an inlet tube 14. The injection valve 10 may be in particular suitable for dosing fuel to an internal combustion engine.

[0012] The valve assembly 11 comprises a valve body 12 with a central longitudinal axis L and a housing 16. The housing 16 is partially arranged around the valve body 12. A cavity 18 is arranged in the valve body 12.

[0013] The cavity 18 takes in a valve needle 20 and an armature 22c. An upper retainer 23 is arranged axially adjacent to the armature 22c. The upper retainer 23 is fixedly coupled to the valve needle 20. The upper retainer 23 is formed as a collar around the valve needle 20. A main spring 28 is arranged in a recess 26 provided in the inlet tube 14. The recess 26 is part of the cavity 18. The main spring 28 is mechanically coupled to the upper retainer 23. The upper retainer 23 is in contact with an inner side of the inlet tube 14 and can guide the valve needle 20 in axial direction inside the inlet tube 14. The main spring 28 is arranged and designed to act on the valve needle 20 to move the valve needle 20 in axial direction in its closing position. A filter element 30 is arranged in the inlet tube 14 and forms a further seat for the main spring 28.

[0014] 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. That part of the valve needle 20 resting on the seat plate 32 may be formed like a ball. The injection nozzle 34 may be, for

example, an injection hole. However, it may also be of some other type suitable for dosing fluid.

[0015] 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. Furthermore, the electro-magnetic actuator unit 36 comprises, with this traditional valve assembly, the armature 22c. The armature 22c is arranged in the cavity 18 and axially movable relative to the valve needle 20. The housing 16, the valve body 12, the inlet tube 14 and the armature 22c are forming an electromagnetic circuit.

[0016] 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 12.

[0017] An armature spring 46 which is preferably a coil spring is arranged in the cavity 18 and is fixedly coupled to the valve body 12. The armature spring 46 is arranged axially adjacent to the armature 22c. The armature spring 46 is coupled to the armature 22c.

[0018] Fig. 2 shows a valve assembly according to the invention. With this valve assembly the armature 22c of the traditional valve assembly as shown in Fig. 1 is replaced by an armature arrangement 22 comprising an armature portion 22a and a protruding portion 22b. The armature portion 22a and the protruding portion 22b may be made of one piece or of more than one piece. The armature portion 22a functionally corresponds to the armature 22c of the traditional valve assembly. The protruding portion 22b protrudes, from the armature portion 22a, axially towards the fluid outlet portion 40. Axially adjacent to the armature arrangement 22 there is arranged a dampening apparatus 50 comprising a cup 52 and a major part of the protruding portion 22b of the armature arrangement 22. The cup 52 may either be fixedly coupled to the valve needle 20 or to the valve body 12.

[0019] Inside of the cup 52 there is a volume 53 arranged between an end of the protruding portion 22b and in inner bottom surface of the cup 52. During operation of the valve assembly this volume 53 is filled with fluid, typically with fuel, whereby the size of the volume 53 varies during operation of the valve assembly.

[0020] Between an inner side wall of the cup 52 and said major part of the protruding portion 22b of the armature arrangement 22 there is arranged a first clearance 54, through which fluid may pass during operation of the valve assembly. A second clearance 55 is arranged between the valve needle 20 and an inner side wall of the armature arrangement 22. Also through this second clearance 55 fluid may pass during operation of the valve assembly.

[0021] In the following, the function of the valve assembly 11 and of the injection valve 10 is described in detail:

[0022] The fluid is led through the inlet tube 14 to the fluid inlet portion 42 of the valve assembly 11 and further towards the fluid outlet portion 40.

[0023] 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.

[0024] Fig. 2 shows the valve assembly 11 in the closing position. The actuator unit 36 is de-energized. The armature spring 46 presses the armature arrangement 22 towards the upper retainer 23 and the main spring 28 presses the valve needle 20 via the upper retainer 23 into its closing position. The volume 53 is filled with fluid.

[0025] Next, and this is shown in Fig. 3, the electro-magnetic actuator unit 36 with the coil 38 gets energized. This creates an electro-magnetic force onto the armature arrangement 22. The armature arrangement 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 arrangement 22 takes the upper retainer 23 and the valve needle 20 with it, until it is stopped by the pole piece 37. This action is called functional armature stroke, and it is shown in the Fig. 2 to 5, labeled with the reference symbol Fc_A. Accordingly, the valve needle 20 moves in axial direction out from 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. In the embodiment of the invention, which is shown in the drawings, the cup 52 is fixedly coupled to the valve needle 20. Accordingly, the size of the volume 53 is not changed due to the upward movement of the valve needle 20, compared with the size of the volume 53, when the valve needle 20 rests in its closing position.

[0026] Next, and this is shown in the Fig. 4 and 5, the actuator unit 36 is de-energized. As can be seen from Fig. 4, the main spring 24 forces the valve needle 20 to move in axial direction into its closing position, thereby moving the armature arrangement 22 towards the seat plate 32 and compressing the armature spring 46. When the valve needle 20 reaches its closing position, it is stopped. However, the armature arrangement 22 decouples from the upper retainer 23 and continues to move towards the seat plate 32 because of its inertia; it drifts away from the upper retainer 23. This drift is called free armature stroke; the amount thereof is shown in Fig. 4, labeled with the reference symbol Fr_A, and the direction thereof is shown by dashed arrows, directed towards the seat plate 32. Due to this drift the size of the volume 53 in the dampening apparatus 50 is reduced to a reduced volume 53a, thereby pressing part of the fluid (symbolically shown in Fig. 4 as "escaped fluid" 53b) out from the dampening apparatus 50. This escaping is established due to leakage paths 56 along the first clearance 54 and the second clearance 55. These leakage paths 56 are shown in Fig. 4 by means of small arrows, directed towards the upper retainer 23 and horizontally in parallel to the main surfaces of the armature portion 22a.

[0027] In the course of this procedure the armature

spring 46 is compressed more and more and develops increasing forces acting in the direction of the pole piece 37. Finally these forces exceed the forces applied by the inertia of the armature arrangement 22. Consequently the armature spring 46 pushes the armature arrangement 22 back towards the armature arrangement 22 until the armature arrangement 22 abuts the upper retainer 23, as shown in Fig. 5.

[0028] During movement of the armature arrangement 22 towards the upper retainer 23 the volume 53 in the dampening apparatus 50 increases again until it reaches its former size. This causes fluid to pass the leakage paths 56 in the reverse direction, compared with the situation herein before; the dampening apparatus 50 is "refilled" again.

[0029] The big advantage of this valve assembly and of the respective injection valve is, that in an embodiment, where the cup 52 is fixedly coupled to the valve body 12, abutting of the armature arrangement 22 against the upper retainer 23 and the pole piece 37 (in this situation the volume 53 increases and drift of fuel occurs into the cup 52), when the valve needle 20 leaves its closing position, as well as abutting of the valve needle 20 against the seat plate 32 when reaching its closing position, is hydraulically dampened by the flow of fluid through the leakage paths 56. Thus it is avoided, that in the closing phase of the valve needle the valve needle bouncingly bumps towards the seat plate and thus reopens in an undesired manner the flow path to the injection nozzle for a short time. Reopening, however, would create unwanted emissions. Additionally, in the opening phase of the valve needle 20, bouncingly bumping of the armature arrangement 22 against the upper retainer 23 and against the pole piece 32 is also avoided. Such a bouncingly bumping would lead to a small movement of the valve needle 20 for a short time in direction of the seat plate, what, accordingly, would also create unwanted emissions. In an embodiment, where the cup 52 is fixedly coupled to the valve needle 20, as shown in the figures, dampening occurs only in the closing phase of operation.

Claims

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

- 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,
- an upper retainer (23) being arranged in the cavity (18) and being fixedly coupled to the valve needle (20),
- an electro-magnetic actuator unit (36) being designed to actuate the valve needle (20), the actuator unit (36) comprising an armature arrangement (22) which is arranged in the cavity (18) and is axially moveable relative to the valve needle (20), the armature arrangement (22) being designed to be coupled to the upper retainer (23) when the valve needle (20) is actuated to leave the closing position, and the armature arrangement (22) being designed and arranged to mechanically decouple from the upper retainer (23) due to its inertia when the valve needle (20) reaches the closing position, and
- an armature spring (46) being arranged in the cavity (18) and being coupled to the armature arrangement (22) axially adjacent to the armature arrangement (22), the armature spring (46) being arranged to provide a force to the armature arrangement (22) contributing coupling the armature (22) with the valve needle (20),

wherein the armature arrangement (22) comprises an armature portion (22a) and a protruding portion (22b),the protruding portion (22b) protruding axially towards the fluid outlet portion (40), and
wherein a dampening apparatus (50) is arranged in the cavity (18) axially adjacent to the armature arrangement (22),
the dampening apparatus (50) comprising a cup (52) being fixedly coupled to the valve body (12) and a major part of the protruding portion (22b) of the armature arrangement (22),
the major part of the protruding portion (22b) of the armature arrangement (22) being arranged inside of the cup (52), thereby forming a volume (53) inside the cup (52) for being filled with fluid.

2. Valve assembly (11) according to claim 1, wherein the cup (52) is fixedly coupled to the valve body (12).

3. Valve assembly (11) according to claim 1, wherein the cup (52) is fixedly coupled to the valve needle (20).

4. Valve assembly (11) according to one of the preceding claims, wherein the protruding portion (22b) is fixedly coupled to the armature portion (22a).

5. Valve assembly (11) according to one of the claims 1 to 3, wherein the protruding portion (22b) and the armature portion (22a) are made of one piece.

6. Valve assembly (11) according to one of the preceding claims, wherein a first clearance (54) is arranged between the cup (52) and the part of the protruding portion (22b) being arranged inside the cup (52) for passing of fluid.

7. Valve assembly (11) according to one of the preceding claims, wherein a second clearance (55) is arranged between the armature arrangement (22) and the valve needle (20) for passing of fluid.

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

FIG 1

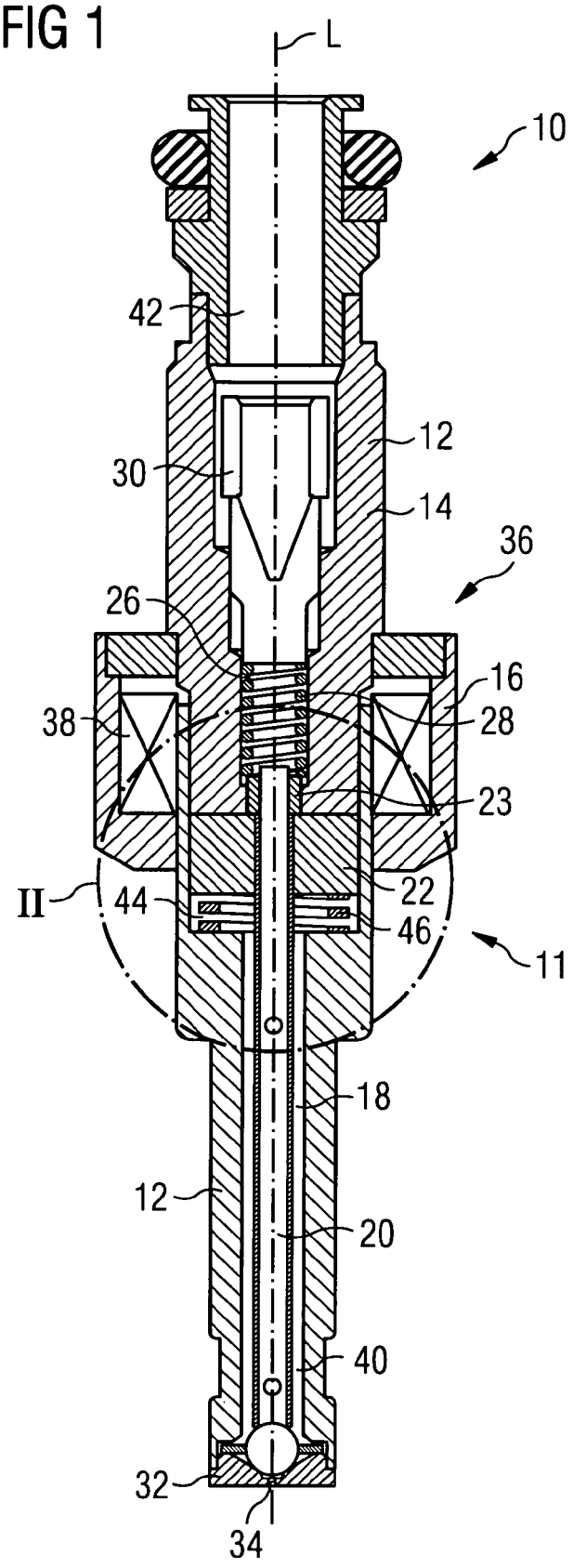


FIG 2

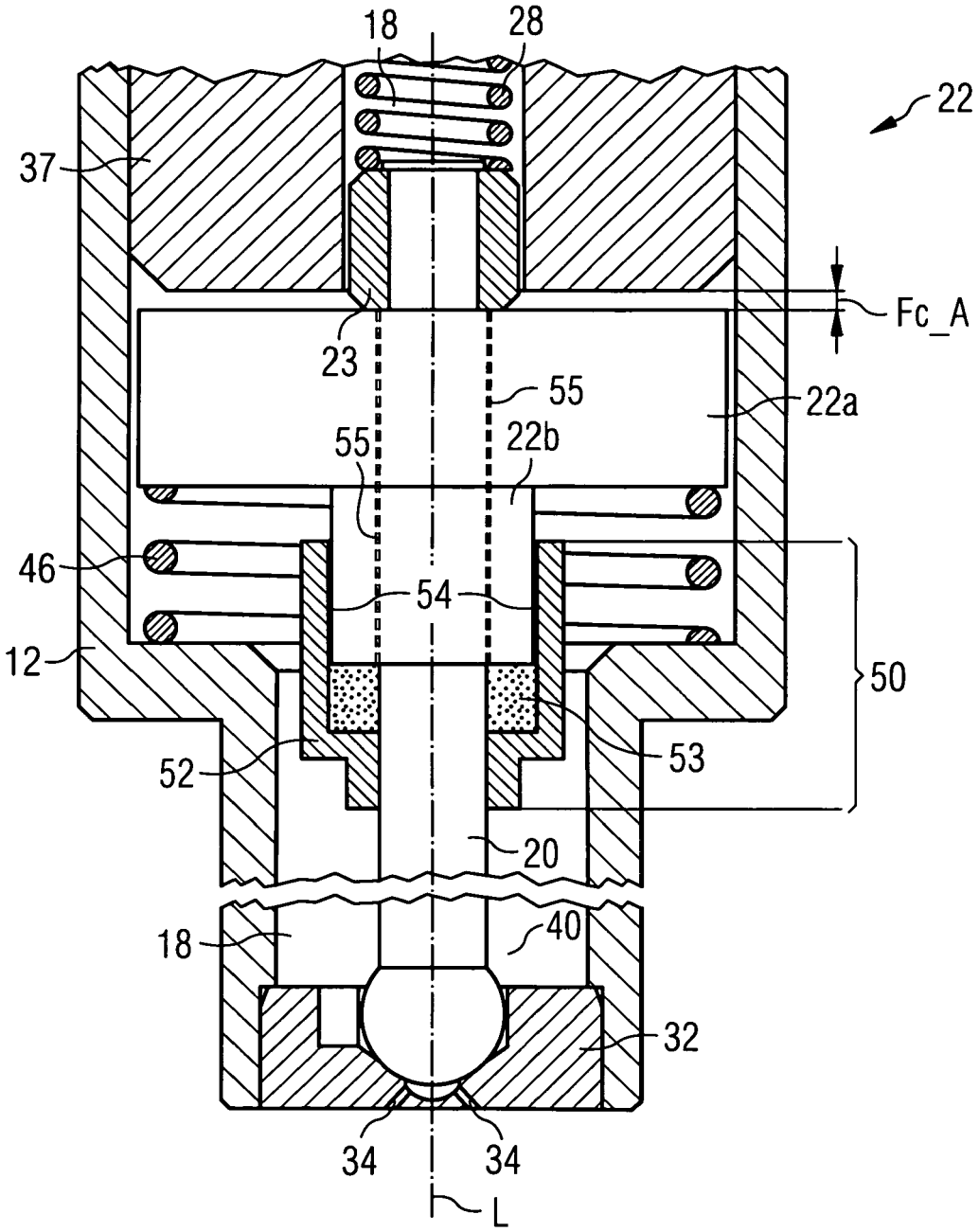


FIG 3

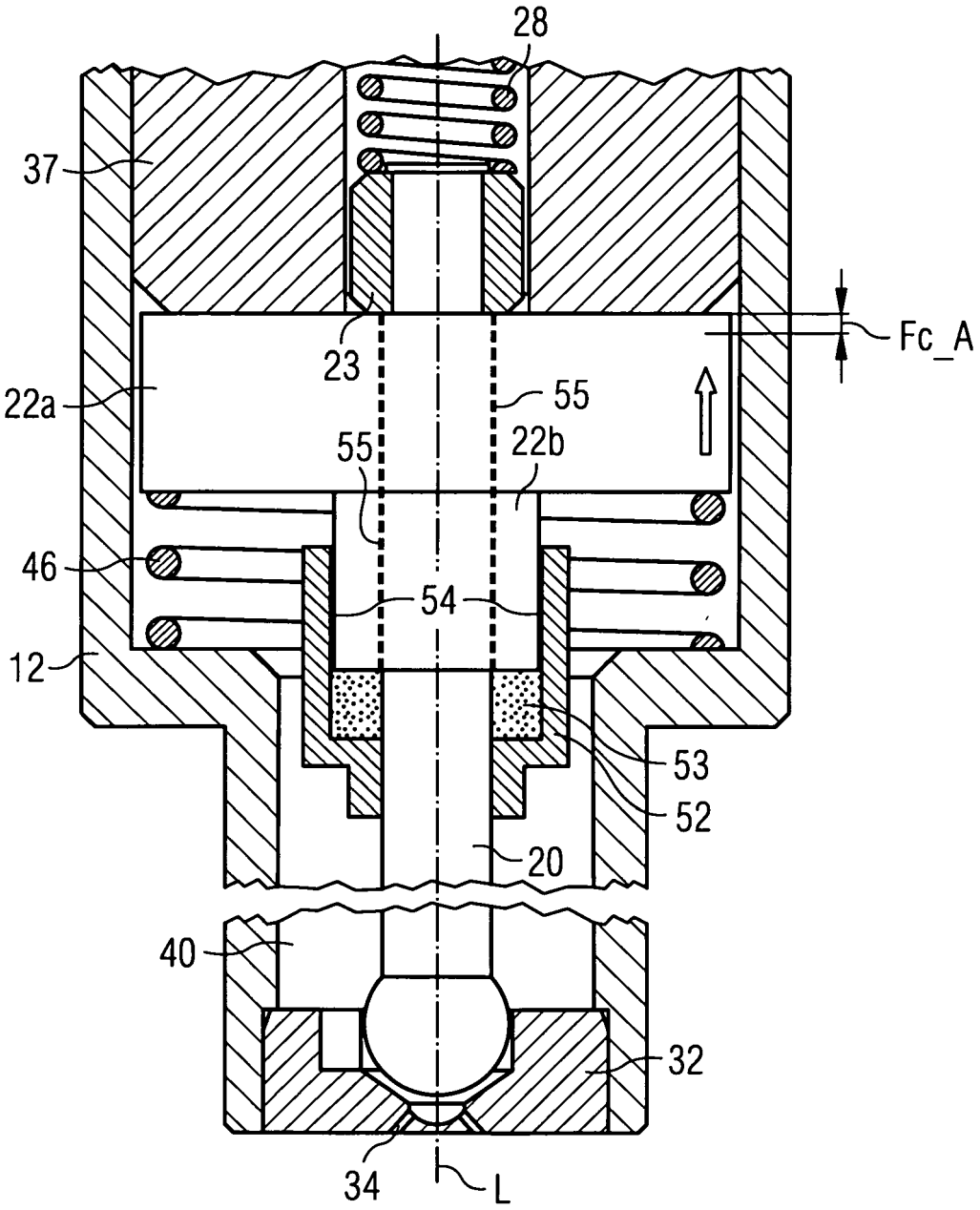


FIG 4

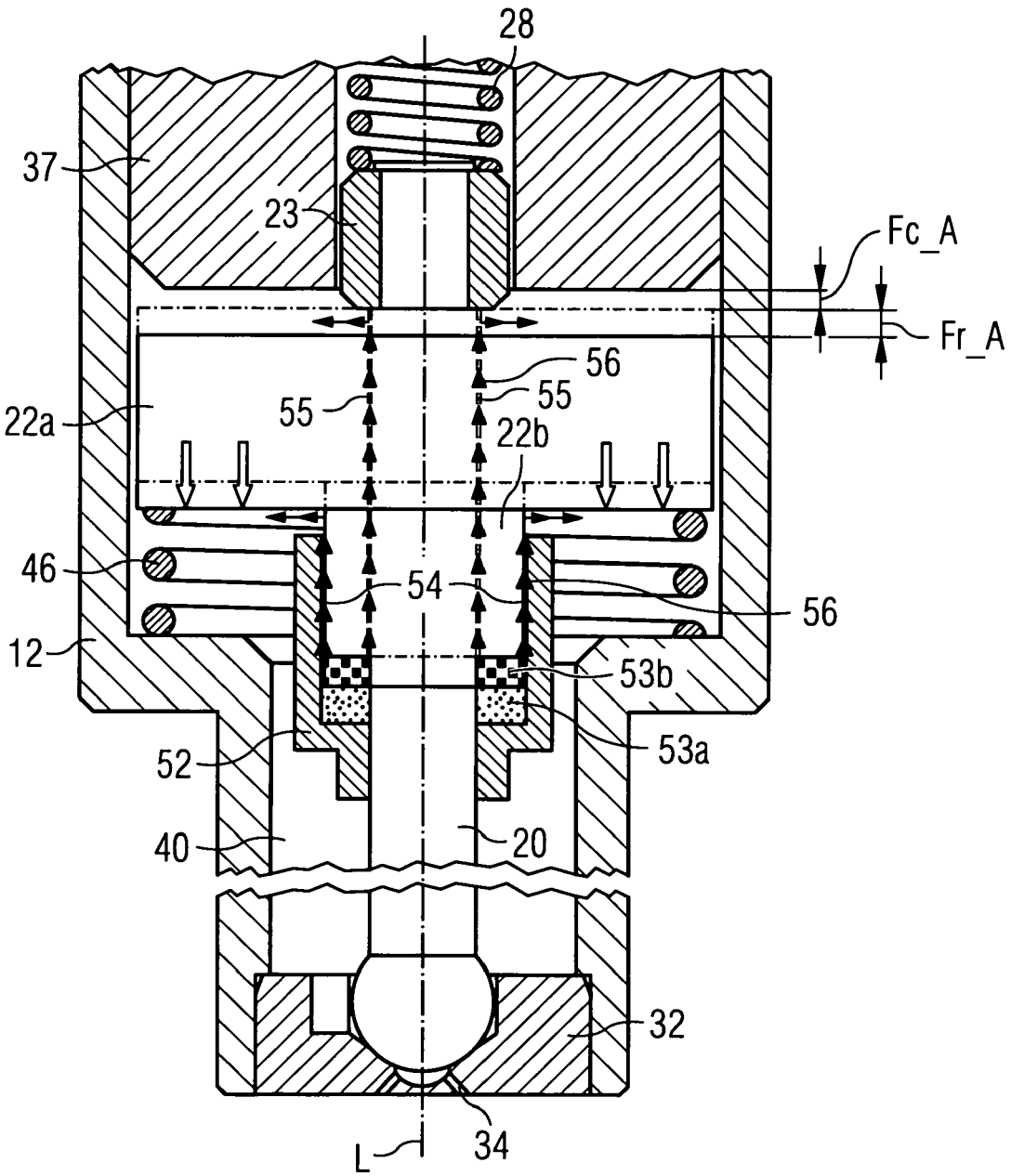
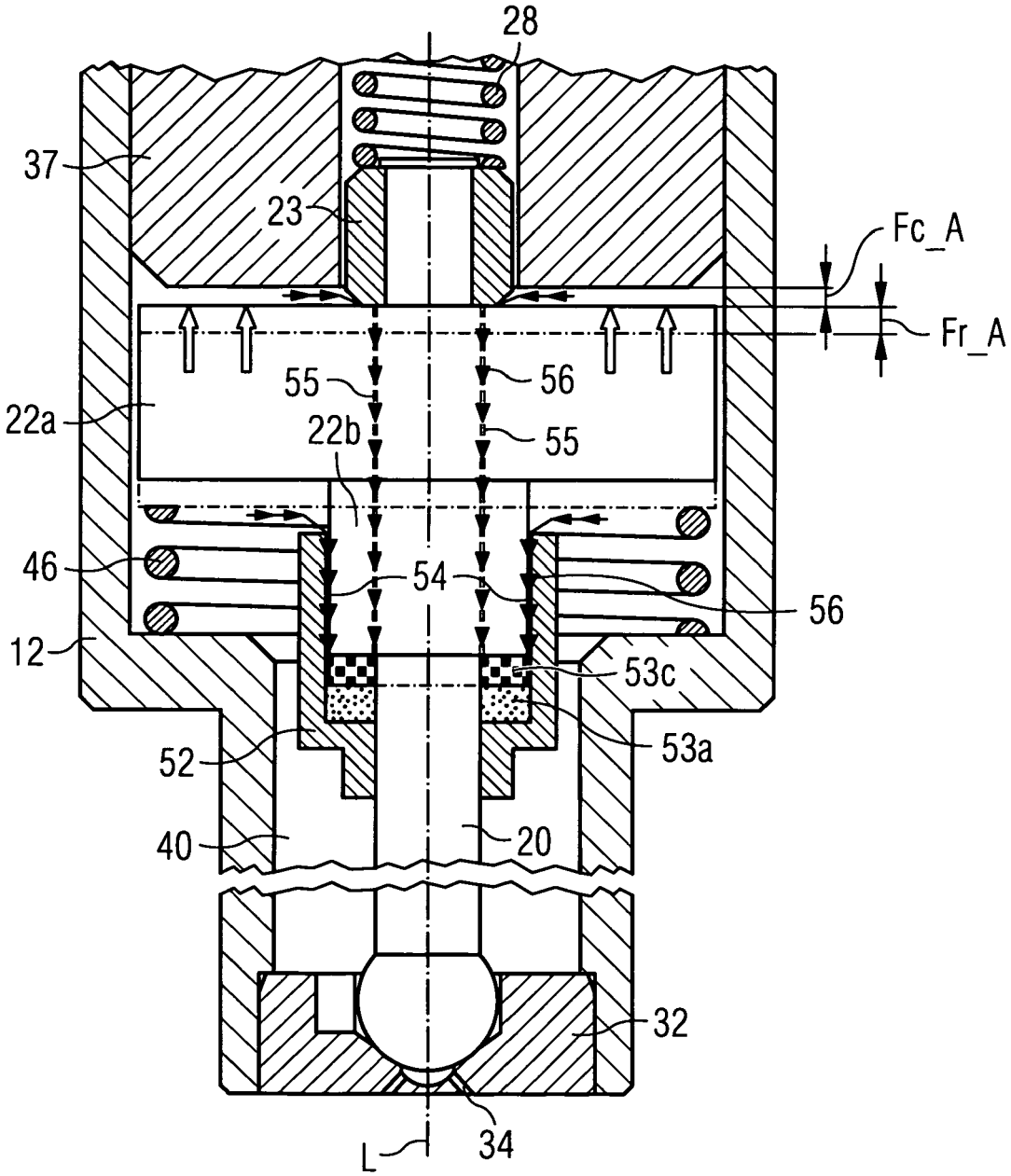


FIG 5



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EUROPEAN SEARCH REPORT

Application Number
EP 11 19 0294

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			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
Munich	29 March 2012	Landriscina, V

CATEGORY OF CITED DOCUMENTS

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