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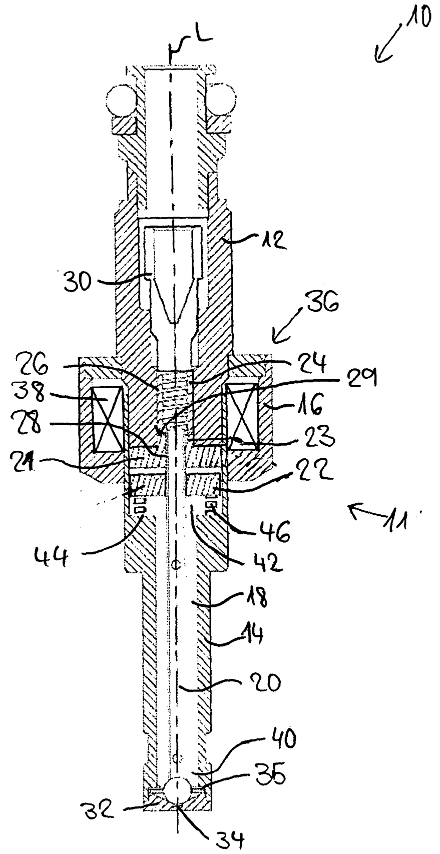
(71) Applicant: **Continental Automotive GmbH**
30165 Hannover (DE)

(72) Inventors:
- **Biasci, Enio**
  56010 Campo (Pisa) (IT)
- **Grandi, Mauro**
  57100 Livorno (IT)
- **Lenzi, Francesco**
  57128 Livorno (IT)
- **Malasoma, Claudio**
  57023 Cecina (LI) (IT)
- **Romeo, Ileana**
  58100 Grossetto (GR) (IT)
- **Soriani, Matteo**
  57121 Livorno (IT)

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

(57) Valve assembly (11) for an injection valve (10), comprising 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). The electro-magnetic actuator unit (36) is designed to actuate the valve needle (20) and comprises an armature (21,22) axially movable in the cavity (18). The armature (21,22) comprises a first armature part (21) being fixedly coupled to the valve needle (20) and a second armature part (22) being axially movable relative to the first armature part (21). The armature (21,22) is designed in way that the second armature part (22) can mechanically decouple from the first armature part (21) due to its inertia when the valve needle (20) reaches the closing position. Injection valve (10) with such a valve assembly (11).

Fig. 1



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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 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 claim. Advantageous embodiments of the invention are given in the sub-claims.

[0007] The invention is distinguished by a valve assembly for an injection valve, comprising a valve body including a central longitudinal axis, the valve body comprising a cavity with a fluid inlet portion and a fluid outlet portion, and a valve needle axially moveable 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. Furthermore, the valve assembly comprises an electromagnetic actuator unit which is designed to actuate the valve needle. The electro-magnetic actuator unit comprises an armature which is axially movable in the cavity. The armature comprises a first armature part being fixedly coupled to the valve needle and a second armature part being axially movable relative to the first armature part. The armature is designed in a way that the second armature part can mechanically decouple from the first armature part due to its inertia when the valve needle reaches the closing position.

[0008] This has the advantage that the first armature part can guide the valve needle in the valve body in a reliable manner and the second armature part can move in the cavity with a limited dependency from the first armature part. Due to the separation of the second armature part from the first armature part it can be avoided that the mass of the second armature part influences the dynamic behavior of the valve needle during the closing process of the injection valve. As the first armature part can have a small mass, the dynamic forces of the valve needle on the valve body can be kept small. Consequently, wearing effects on the valve body due the valve needle can be kept small. Furthermore, the second armature part can contribute to a maximum electromagnetic force on the valve needle during the opening phase of the valve needle and a secure opening of the valve needle can be obtained.

[0009] In an advantageous embodiment the second armature part is arranged relative to the first armature part in axial direction towards the fluid outlet portion. By this a simple arrangement of the first armature part and the second armature part is possible.

[0010] In a further advantageous embodiment the second armature part is axially movable between the first armature part and a stop device. This has the advantage that a defined axial movement range of the second armature part can be obtained.

[0011] In a further advantageous embodiment the stop device comprises a step in the valve body. By this a simple embodiment of the stop device is possible.

[0012] In a further advantageous embodiment the stop device comprises an armature spring fixedly coupled to the valve body. By this a soft, elastic movement of the second armature part and a reliable transmission of the kinetic energy from the second armature part to the stop device are possible.

[0013] In a further advantageous embodiment the armature spring is a coil spring being coupled to the step in the valve body. This has the advantage that a simple shape of the armature spring and a secure arrangement of the armature spring in the cavity of the valve body can be obtained. Furthermore, a reliable transmission of the kinetic energy from the second armature part to the armature spring and further to the valve body can be obtained.

[0014] In a further advantageous embodiment the stop device comprises a protrusion extending in radial direction from the valve needle and being rigidly coupled to the valve needle. This has the advantage that a limited displacement between the first and the second armature part is possible. Furthermore, the shape of the stop element can be very simple.

[0015] In a further advantageous embodiment the second armature part comprises at least two separate parts. By this the wearing effect on the valve body due to the valve needle can be kept very small.

[0016] 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 first embodiment of a valve assembly in a longitudinal section view,

Figure 2, the injection valve with a second embodiment of the valve assembly in a longitudinal section view,

Figure 3, the injection valve with a third embodiment of the valve assembly in a longitudinal section view, and

Figure 4, an enlarged view of a section of an electromagnetic actuator unit of the valve assembly.

[0017] Elements of the same design and function that appear in different illustrations are identified by the same reference character.

[0018] An injection valve 10 that is in particular suitable for dosing fuel to an internal combustion engine comprises in particular a valve assembly 11 and an inlet tube 12.

[0019] 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.

[0020] The cavity 18 takes in a valve needle 20 and an armature 21, 22 which will be described in detail later. The armature 21, 22 has an upper guide 23 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 main spring 24 is mechanically coupled to the upper guide 23 at an axial end 29 of the upper guide 23. The upper guide 23 is in one piece with the armature 21. The upper guide 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. Alternatively, the upper guide 23 is arranged adjacent to an axial end of the valve needle 20 and is fixedly coupled to the valve needle 20.

[0021] A filter element 30 is arranged in the inlet tube 12 and forms a further seat for the main spring 24. During the manufacturing process of the injection valve 10 the filter element 30 can be axially moved in the inlet tube 12 in order to preload the main spring 24 in a desired manner. By this the main spring 24 exerts a force on the valve needle 20 towards an injection nozzle 34 of the injection valve 10.

[0022] 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. In addition to that a lower guide 35 is provided adjacent to the seat plate 32. The lower guide 35 is adapted to guide the valve needle 20 near the injection nozzle 34. The seat plate 32 may be made in one part with the lower guide 35 or a separate part from the lower guide 35.

[0023] 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 21, 22. The armature 21, 22 is axially movable in the cavity 18. The armature 21, 22 has a first armature part 21 and a second armature part 22. The first armature part 21 is fixedly coupled to the valve needle 20. The second armature part 22 is axially movable relative to the first armature part 21. The second armature part 22 is arranged relative to the first armature part 21 in axial direction towards a fluid outlet portion 40 which is a part of the cavity 18 near the seat plate 32. The fluid outlet portion 40 communicates with a fluid inlet portion 42 which is provided in the valve body 14.

[0024] The housing 16, the inlet tube 12, the first armature part 21 and the second armature part 22 are forming an electromagnetic circuit together with the valve body 14.

[0025] The valve assembly 11 has a stop device 44, 46, 48 and the second armature part 22 is axially movable between the first armature part 21 and the stop device 44, 46, 48.

[0026] In the embodiment of Figure 1, the stop device has a step 44 which is arranged in the valve body 14. An armature spring 46 which is preferably a coil spring is fixedly coupled to the step 44 in the valve body 14. The armature spring 46 forms a soft stop element for the second armature part 22 which is axially movable between the first armature part 21 and the armature spring 46.

[0027] In the embodiment of Figure 2, the stop device has a protrusion 48 which extends in radial direction from the valve needle 20. The protrusion 48 is rigidly coupled to the valve needle 20. Preferably, the protrusion 48 is shaped as a ring element. In a further embodiment the protrusion 48 comprises at least two pin elements extending in radial direction. The protrusion 48 forms a rigid stop element for the second armature part 22 which is axially movable between the first armature part 21 and the protrusion 48.

[0028] In the embodiment of Figure 3, the stop device comprises the step 44 in the valve body 14. The step 44 forms a rigid stop element for the second armature part 22 which is axially movable between the first armature part 21 and the step 44.

[0029] In Figure 4, a preferred embodiment of the second armature part 22 is shown with the second armature part 22 being divided in four separate parts 22a, 22b, 22c, 22d. In further embodiments the second armature part 22 can also be divided in two, three or more than four separate parts. Preferably, the separate parts 22a, 22b, 22c, 22d are formed as disks wherein the main plane of the disk is extending in radial direction.

[0030] In the following, the function of the injection valve 10 is described in detail:

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

[0031] 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.

[0032] 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 first armature part 21 and the second armature part 22. The first armature part 21 and the second armature part 22 are attracted by the electro-magnetic actuator unit 36 with the coil 38 and move in axial direction away from the fluid outlet portion 40. The first armature part 21 and the second armature part 22 take the valve needle 20 with them 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 14 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.

[0033] In the case when the actuator unit 36 is de-energized the main spring 24 can force the valve needle 20 to move in axial direction in its closing position. It is depending on the force balance between the force on the valve needle 20 caused by the actuator unit 36 with the coil 38 and the force on the valve needle 20 caused by the main spring 24 whether the valve needle 20 is in its closing position or not.

[0034] When the valve needle 20 reaches the closing position the second armature part 22 mechanically decouples from the first armature part 21. This is because the second armature part 22 can move axially free relative to the first armature part 21 and the inertia of the second armature part 22 enables a movement of the second armature part 22 even in the case that the first armature part 21 is stopped due to that the valve needle 20 is in a fixed position in particular on the seat plate 32.

[0035] The kinetic energy of the second armature part 22 can dissipate into the armature spring 46 and further into the valve body 14 (embodiment of Figure 1) or directly into the valve body 14 (embodiment of Figure 3). Alternatively, as shown in the embodiment of Figure 2, the second armature part 22 can hit the protrusion 48 and the kinetic energy of the second armature part 22 is transmitted into the valve needle 20 in a second step, so that the kinetic energy having an effect o the valve needle 20 is distributed over the time. Consequently, in all the presented embodiments the kinetic energy of the second armature part 22 does not directly contribute to the kinetic energy of the valve needle 20 and the first armature part 21 in the moment when the valve needle 20 reaches its closing position on the seat plate 32.

[0036] As the mass of the first armature part 21 can be kept very small the kinetic energy of the valve needle 20 and the first armature part 21 in the moment when the valve needle 20 reaches its closing position on the seat plate 32 can be kept very small. Consequently, the wearing of the seat plate 32 can be kept small when the valve needle 20 reaches its closing position on the seat plate 32.

Claims

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

- 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 electro-magnetic actuator unit (36) comprising an armature (21, 22) axially movable in the cavity (18),

wherein the armature (21, 22) comprises a first armature part (21) being fixedly coupled to the valve needle (20) and a second armature part (22) being axially movable relative to the first armature part (21), the armature (22) being designed in a way that the second armature part (22) can mechanically decouple from the first armature part (21) due to its inertia when the valve needle (20) reaches the closing position.

2. Valve assembly (11) according to claim 1, wherein the second armature part (22) is arranged relative to the first armature part (21) in axial direction towards the fluid outlet portion (40).

3. Valve assembly (11) according to claim 1 or 2, wherein the second armature part (22) is axially movable between the first armature part (21) and a stop device (44, 46, 48).

4. Valve assembly (11) according to claim 3, wherein the stop device comprises a step (44) in the valve body (14).

5. Valve assembly (11) according to claim 3 or 4, wherein the stop device comprises an armature spring (46) fixedly coupled to the valve body (14).

6. Valve assembly (11) according to claim 5, wherein the armature spring (46) is a coil spring being coupled to the step (44) in the valve body (14).

7. Valve assembly (11) according to one of the claims 3 to 6, wherein the stop device comprises a protrusion (48) extending in radial direction from the valve needle (20) and being rigidly coupled to the valve needle (20).

8. Valve assembly (11) according to one of the preceding claims, wherein the second armature part (22) comprises at least two separate parts (22a, 22b).

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

Fig. 1

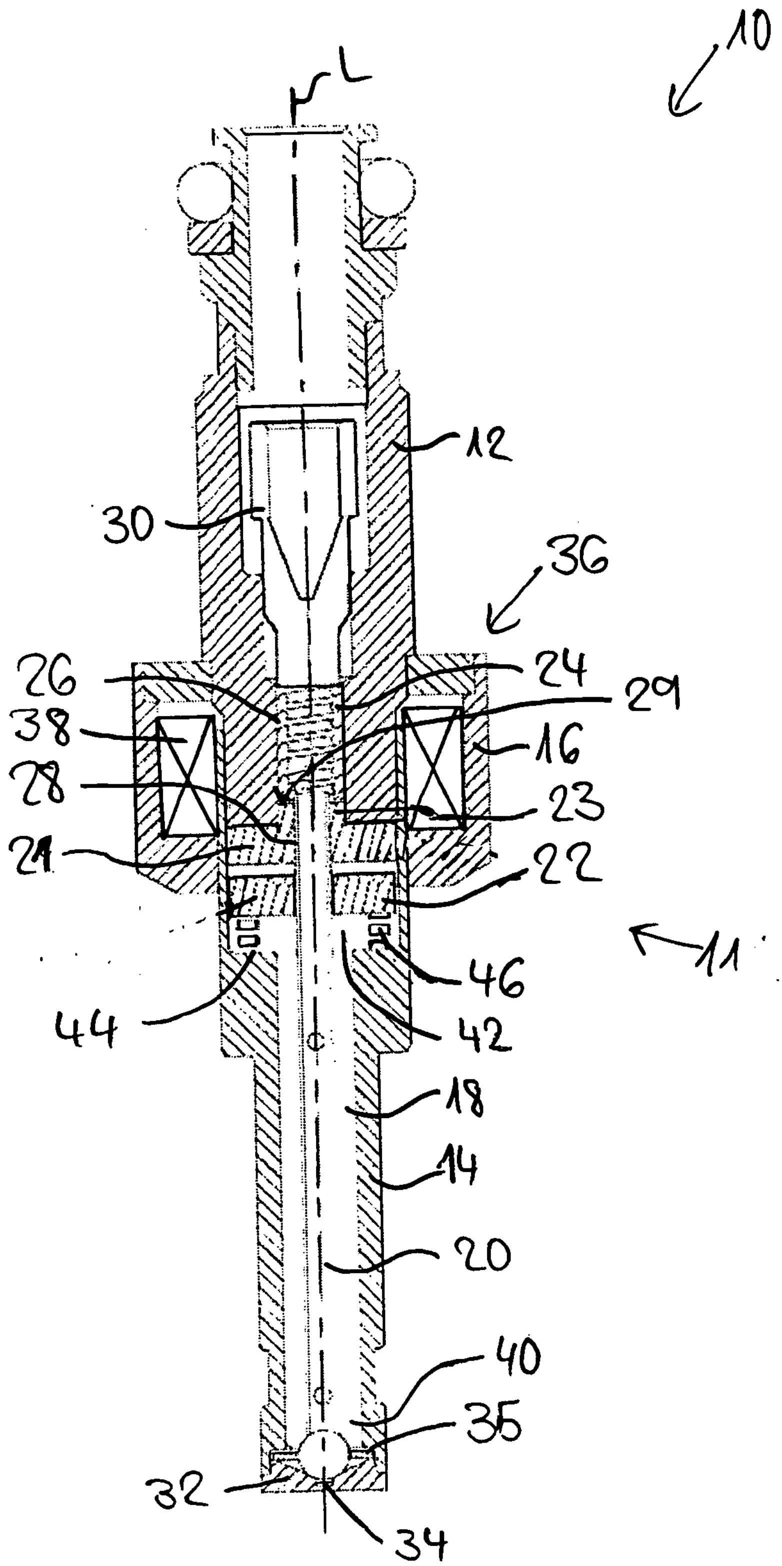


Fig. 2

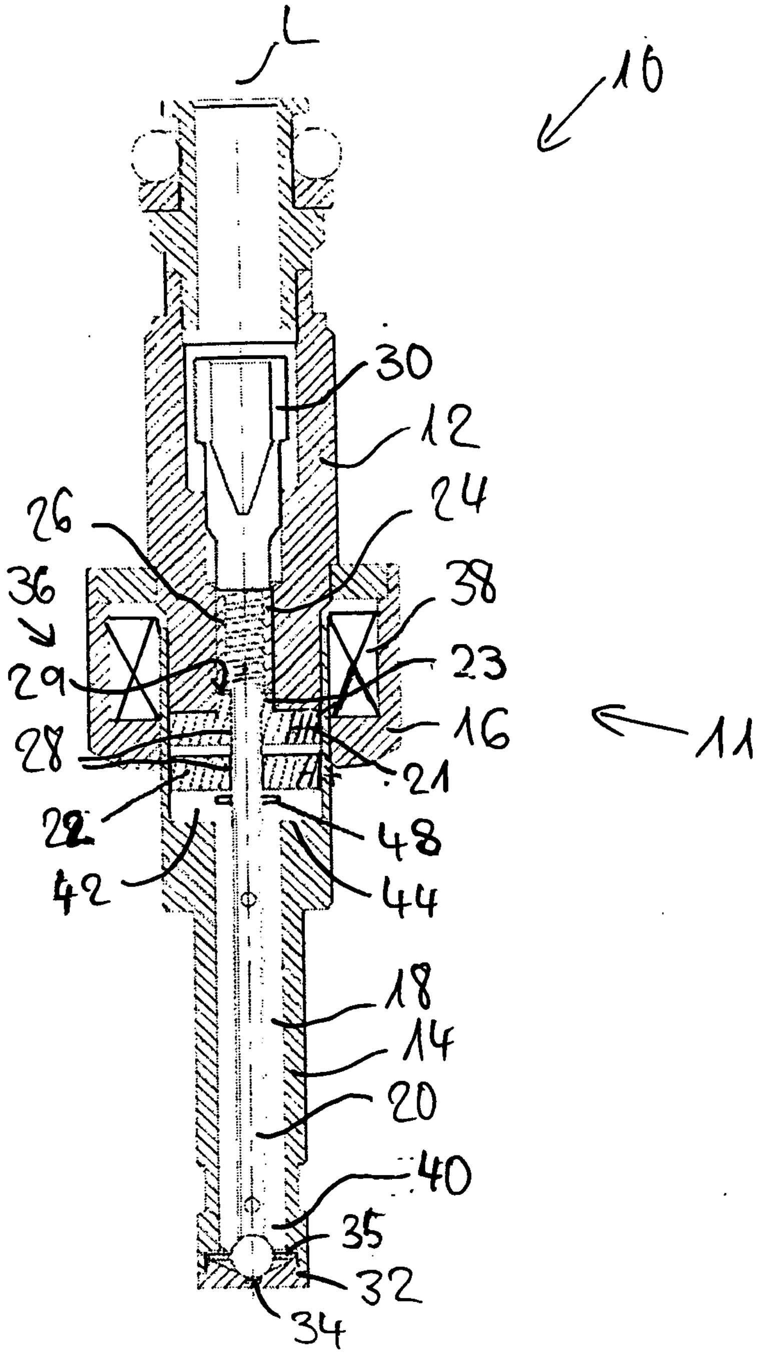


Fig. 3

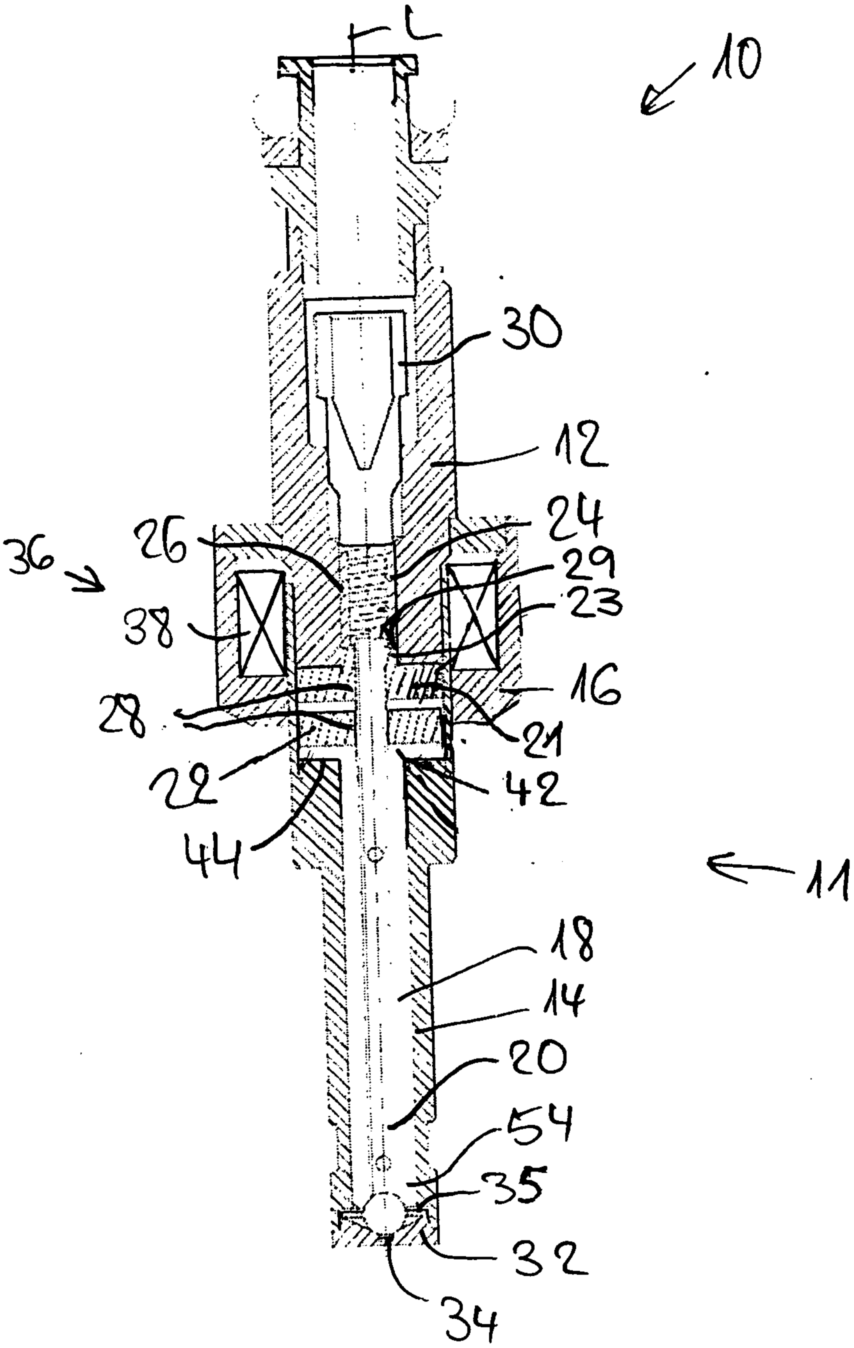
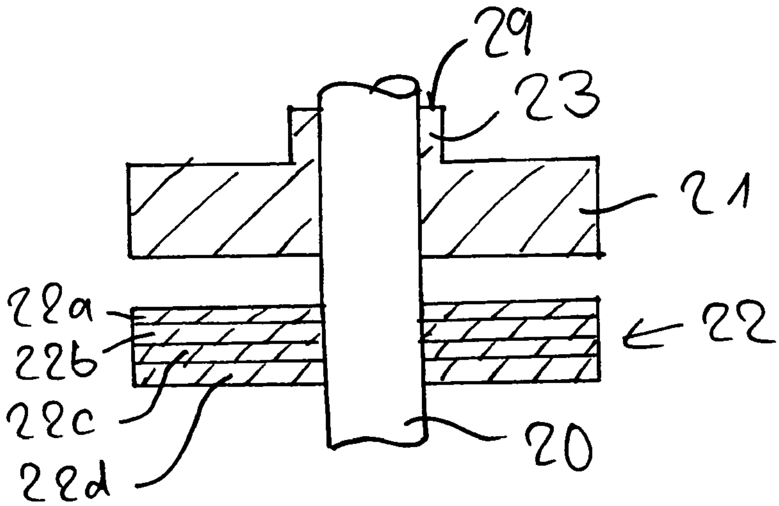


Fig. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 09 00 5323

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	7 October 2009	Landriscina, V

CATEGORY OF CITED DOCUMENTS

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