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

(11) EP 1 793 120 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.06.2007 Bulletin 2007/23

(51) Int Cl.:
F02M 61/04 *(2006.01)* *F02M 63/00* *(2006.01)*

(21) Application number: **05026380.5**

(22) Date of filing: **02.12.2005**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

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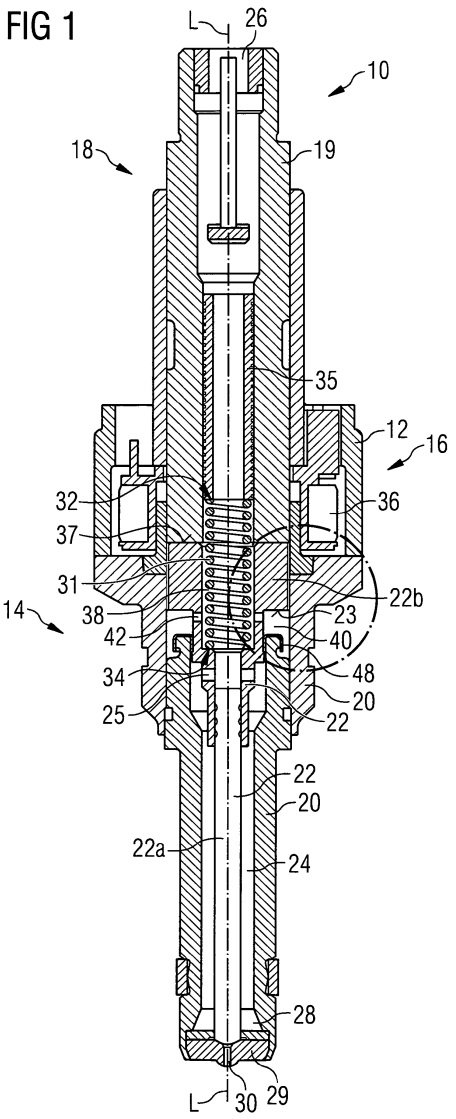
(54) Valve assembly for an injection valve

(57) Valve assembly (14) for an injection valve (10) which comprises a valve body (20) including a central longitudinal axis (L) and comprises a cavity (24) with a fluid outlet portion (28). The valve assembly comprises a valve needle (22) axially movable in the cavity (24), the valve needle (22) has a front surface (37) turned away from the fluid outlet portion (28) and a recess (38) which is arranged in direction of the central longitudinal axis (L) from the front surface (37) over a portion of the axial length of the valve needle (22). The valve needle (22) is preventing a fluid flow through the fluid outlet portion (28) in a closing position and is releasing the fluid flow through the fluid outlet portion (28) in further positions. The valve needle has a surface (23) facing the fluid outlet portion (28), one component of the normal of the surface (23) extending in parallel to the central longitudinal axis (L).

FIG 1



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Description

[0001] The invention relates to a valve assembly for an injection valve and an injection valve for a combustion chamber of a combustion engine.

[0002] Injection valves are in widespread use, in particular for internal combustion engines where they may be arranged in order to dose fluid into an intake manifold of the internal combustion engine or directly into the combustion chamber of a cylinder of the internal combustion engine.

[0003] Injection valves are manufactured in various forms in order to satisfy the various needs for the various combustion engines. Therefore, for example, their length, their diameter, and also various elements of the injection valve being responsible for the way the fluid is dosed may vary in a wide range. In addition to that, injection valves may accommodate an actuator for actuating a needle of the injection valve, which may, for example, be an electromagnetic actuator or a piezoelectric 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 the case of a gasoline engine in the range of up to 200 bar and in the case of a diesel engine in the range of up to 2 000 bar, for example.

[0005] The object of the invention is to create a valve assembly which may be manufactured in a simple way and which facilitates a reliable and precise function.

[0006] This object is 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 outlet portion, a valve needle axially movable in the cavity, the valve needle having a front surface turned away from the fluid outlet portion and a recess which is arranged in direction of the central longitudinal axis from the front surface over a portion of the axial length of the valve needle, 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 the valve needle having a surface facing the fluid outlet portion, one component of the normal of the surface extending in parallel to the central longitudinal axis. The valve assembly comprises a main fluid line enabling the fluid flow through the fluid outlet portion comprising the recess of the valve needle and the cavity of the valve body, a chamber arranged between the surface of the valve needle and the valve body in direction of the central longitudinal axis, and a channel forming a single hydraulic coupling of the chamber with the main fluid line and forming a throttle element for the fluid flow between the chamber and the main fluid line.

[0008] The chamber is coupled with the main fluid line via the channel which is the only hydraulic connection path between the chamber and the main fluid line. Therefore a fluid flow between the chamber and the main fluid line can only occur via the channel.

[0009] One advantage of this valve assembly is that the chamber with the fluid in combination with the channel is acting as a dampening element during the movement of the valve needle. In the case of an upward movement of the valve needle the volume of the chamber is increasing and fluid has to flow from the main fluid line to the chamber through the channel. In the case of a downward movement of the valve needle the volume of the chamber is decreasing and the fluid has to flow from the chamber to the main fluid line through the channel. As the channel is formed as a throttle element the fluid flow between the chamber and the main fluid line can be retarded and consequently the velocity of the movement of the valve needle can be reduced. Due to that the movement of the valve needle can be dampened because it is coupled with a time consuming fluid flow through the channel from the chamber to the main fluid line or reverse. Consequently, the chamber with the fluid contained in the chamber in combination with the channel acts as a hydraulic dampening element.

[0010] A further advantage of the valve assembly is that during the movement of the valve needle into the closing position an anti-bounce effect occurs. This is due to the fact that the movement of the valve needle can be dampened and therefore an optimal closing velocity of the valve needle can be obtained by dimensioning the cross section area of the channel and the volume of the chamber appropriately.

[0011] In an advantageous embodiment of the invention the chamber is arranged axially symmetric relative to the central longitudinal axis.

[0012] This allows an axially symmetrical distribution of the damping forces of the valve needle during the opening and closing movement.

[0013] In a further advantageous embodiment of the invention the valve assembly comprises a return fluid line communicating with the chamber and a sealing element is arranged between the chamber and the return fluid line.

[0014] This results in an improvement of the damping effect during the opening and the closing movement of the valve needle. By the sealing element the fluid flow between the chamber and the return fluid line can be limited. Therefore, in the case of the movement of the valve needle the fluid flow through the channel between the chamber and the main fluid line can prevail compared to the fluid flow between the chamber and the return fluid line and an optimal closing velocity of the valve needle can be obtained by dimensioning the cross section area of the channel and the volume of the chamber in an adequate manner.

[0015] In a further advantageous embodiment of the invention an end section of the channel orientated away from the chamber comprises a chamfer.

[0016] This allows the improvement of the fluid flow through the channel from the main fluid line to the chamber in the case of the opening movement of the valve needle as the fluid characteristics can be improved near the edge of the end section of the channel by the chamfer.

[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 with a valve assembly in a longitudinal section view,

Figure 2 a part of one embodiment of the valve assembly of the injection valve in a longitudinal section view, and

Figure 3 a part of a further embodiment of the valve assembly of the injection valve in a longitudinal section view.

[0018] Elements of the same design and function that appear in different illustrations are identified with a same reference characters.

[0019] An injection valve 10 (figure 1) may be used as a fuel injection valve for a combustion chamber of an internal combustion engine and comprises a valve assembly 14, an actuator unit 16 and a fuel connector 18. The fuel connector 18 is designed to be connected to a high-pressure fuel chamber of the internal combustion engine, the fuel is stored under high pressure, for example, under the pressure of about 200 bar in the case of a gasoline engine or of about 2000 bar in the case of a diesel engine.

[0020] The fuel connector 18 has an inlet tube 19 and is fixed to a housing 12 of the actuator unit 16 on one of its free ends.

[0021] On its upper end the fuel connector 18 comprises a fluid inlet portion 26.

[0022] The valve assembly 14 comprises a valve body 20 with a central longitudinal axis L and a cavity 24 which is axially led through the valve body 20.

[0023] The valve assembly 14 further comprises a valve needle 22 taken in the cavity 24 of the valve body 20. The valve needle 22 comprises an end section 22a and an armature 22b. Alternatively the valve needle 22 may be made in one piece or the valve needle 22 may comprise further parts. The armature 22b is fixed to the end section 22a of the valve needle 22. Furthermore, the valve needle 22 has a front surface 37 turned away from a fluid outlet portion 28 of the cavity 24 and a recess 38 which is arranged in direction of the central longitudinal axis L from the front surface 37 over a portion of the axial length of the valve needle 22. The armature 22b has openings 25 which couple the recess 38 of the valve needle 22 and the cavity 24 of the valve body 20 hydraulically. The recess 38 of the valve needle 22, the openings 25 and the cavity 24 of the valve body 20 are parts of a main fluid line which allows a fluid flow from the fluid inlet portion 26 to the fluid outlet portion 28.

[0024] The valve needle 22 comprises a surface 23 facing the fluid outlet portion 28. One component of the normal of the surface 23 is extending in parallel to the central longitudinal axis L. The surface 23 is preferably located on the armature 22b and borders a chamber 40 together with the valve body 20.

[0025] On one of the free ends of the cavity 24 of the valve body 20 the fluid outlet portion 28 is formed which is closed or opened depending on the axial position of the valve needle 22. In a closing position of the valve needle 22 it rests sealingly on a seat 29 thereby preventing a fluid flow through at least one injection nozzle 30 in the valve body 20. The injection nozzle 30 may be for example an injection hole, but it may also be of some other type suitable for dosing fluid. The seat 29 may be made in one part with the valve body 20 or may also be a separate part from the valve body 20.

[0026] A spring 31 is arranged in the recess 38 of the valve needle 22 preferably to rest on a first spring rest 32 and a second spring rest 34 of the valve needle 22. By this the spring 31 is mechanically coupled to the valve needle 22. An adjusting tube 35 is provided in the recess 38 of the valve needle 22. The adjusting tube 35 comprises the first spring rest 32 for the spring 31 and may be moved axially during the manufacturing process of the injector in order to preload the spring 31 in a desired way.

[0027] The injector is provided with a drive, that is preferably an electromagnetic drive, comprising a coil 36, which is preferably extrusion-coated, the valve body 20, the armature 22b and the inlet tube 19 all forming an electromagnetic circuit. The armature 22b preferably has a large diameter compared to the diameter of the end section 22a of the valve needle 22. The large diameter enables a proper electromagnetic flow through the armature 22b which contributes to a proper controllability of the end section 22a of the valve needle 22.

[0028] If the coil 36 is energized this results in an electromagnetic force acting on the valve needle 22. The electromagnetic force acts against the mechanical force obtained from the spring 31. By appropriately energizing the coil 36, the valve needle 22, in particular the end section 22a of the valve needle 22, may in that way be moved away from its closing position which results in a fluid flow through the injection nozzle 30. After a predetermined time the coil 36 may be de-energized again.

[0029] Figures 2 and 3 show a section of the valve assembly 14 in an enlarged detailed view. Between the valve body 20 and the valve needle 22 the chamber 40 is arranged which is coupled hydraulically with the recess 38 of the valve needle 22 by a channel 42. Preferably the chamber 40 is arranged axially symmetric relative to the central longitudinal axis L. The channel 42 has preferably a circular cross section shape with a diameter D.

[0030] The valve needle 22 comprises preferably a sealing element 44, which is preferably made of plastics, in particular made of rubber, and can reduce the fluid

flow from the chamber 40 to an return fluid line 46 between the valve body 20 and the valve needle 22. The sealing element 44 can be avoided if the valve body 20 and the valve needle 22 are dimensioned in an appropriate manner to reduce the fluid flow from the chamber 40 to the return fluid line 46.

[0031] The sealing element 44 has preferably to be dimensioned in a way that the fluid flow from the chamber 40 to the return fluid line 46 is much smaller than the fluid flow from the chamber 40 to the recess 38 via the channel 42.

[0032] The valve body 20 comprises a protrusion 47 which limits the chamber 40 at its lower end. The protrusion 47 of the valve body 20 has a sealing layer 48 which provides a sealing between the valve body 20 and the valve needle 22 which can avoid a leak fluid flow from the chamber 40 to the fluid outlet portion 28.

[0033] Figures 2 and 3 show the valve needle 22 in a position when it is moved away from its closing position in maximum. This can result in a fluid flow through the injection nozzle 30. Furthermore, a lowest level 50 of the armature 22b is shown if the valve needle 22 is in its closing position. This results in a working lift W which represents the vertical difference between the maximum opening position and the closing position of the valve needle 22 defined by the lowest level 50 of the armature 22b. Consequently, the chamber 40 has a volume difference 54 between the maximum position and the minimum position of the valve needle 22.

[0034] In the embodiment of figure 3 an end section 58 of the channel 42 orientated away from the chamber 40 comprises a chamfer 56 which facilitates the fluid flow between the recess 38 of the valve needle 22 and the chamber 40.

[0035] In the following the function of the injection valve 10 is described in detail:

> The fluid may flow from the fluid inlet portion 26 of the fuel connector 18 through the inlet tube 19 and the adjusting tube 35 to the recess 38 of the valve needle 22. Through the openings 25 in the armature 22b of the valve needle 22 the fluid may flow to the cavity 24 of the valve body 20 and the fluid outlet portion 28. If the valve needle 22 allows a fluid flow through the fluid outlet portion 28 in an opening position the fluid may flow through the injection nozzle 30.

[0036] If the valve needle 22 is moving upward from its closing to an opening position fluid may flow from the recess 38 of the valve needle 22 through the channel 42 to the chamber 40. The fluid flow through the channel 42 depends on the diameter D of the channel 42 and the volume of the chamber 40. Thus the chamber 40 in combination with the channel 42 may reduce the velocity of the valve needle 22. This affects the movement of the whole valve needle 22. Therefore it is possible to adjust the movement of the valve needle 22 by adjusting the diameter D of the channel 42 and the volume of the chamber 40. By this a damping effect can be achieved which affects the movement of the valve needle 22. This contributes to a precise dosing of the fluid.

[0037] If the valve needle 22 is moving downward from an opening position to the closing position the volume of the chamber 40 has to be reduced and fluid can flow from the chamber 40 through the channel 42 to the recess 38 of the valve needle 22. The closing movement of the valve needle 22 is influenced dependent on the quantity of the fluid flow from the chamber 40 to the recess 38 through the channel 42. Therefore, the movement of the valve needle 22 may be adjusted by adjusting the diameter D of the channel 42 and the volume of the chamber 40. This may create a damping effect which influences the movement of the valve needle 22 and therefore contributes to a precise dosing of the fluid.

[0038] As the opening and closing movement of the valve needle 22 is affected by the chamber 40 and the channel 42 according to their geometry, oscillations of the valve needle 22 may be reduced and therefore a anti-bouncing effect and a more precise dosing of the fluid is achieved.

Claims

1. Valve assembly (14) for an injection valve (10), comprising

- a valve body (20) including a central longitudinal axis (L), the valve body (20) comprising a cavity (24) with a fluid outlet portion (28),
- a valve needle (22) axially movable in the cavity (24), the valve needle (22) having a front surface (37) turned away from the fluid outlet portion (28) and a recess (38) which is arranged in direction of the central longitudinal axis (L) from the front surface (37) over a portion of the axial length of the valve needle (22), the valve needle (22) preventing a fluid flow through the fluid outlet portion (28) in a closing position and releasing the fluid flow through the fluid outlet portion (28) in further positions, and the valve needle having a surface (23) facing the fluid outlet portion (28), one component of the normal of the surface (23) extending in parallel to the central longitudinal axis (L),
- a main fluid line enabling the fluid flow through the fluid outlet portion (28) comprising the recess (38) of the valve needle (22) and the cavity (24) of the valve body (20),
- a chamber (40) arranged between the surface (23) of the valve needle (22) and the valve body (20) in direction of the central longitudinal axis (L), and
- a channel (42) forming a single hydraulic coupling of the chamber (40) with the main fluid line and forming a throttle element for the fluid flow

between the chamber (40) and the main fluid line.

2. Valve assembly (14) according to claim 1 with the chamber (40) being arranged axially symmetric relative to the central longitudinal axis (L).

3. Valve assembly (14) according to one of the preceding claims with the valve assembly (14) comprising a return fluid line (46) communicating with the chamber (40) and a sealing element (44) being arranged between the chamber (40) and the return fluid line (46).

4. Valve assembly (14) according to one of the preceding claims with an end section (58) of the channel (42) orientated away from the chamber (40) comprising a chamfer (56).

5. Injection valve (10) for a combustion chamber of a combustion engine comprising the valve assembly (14) according to one of the preceding claims.

FIG 1

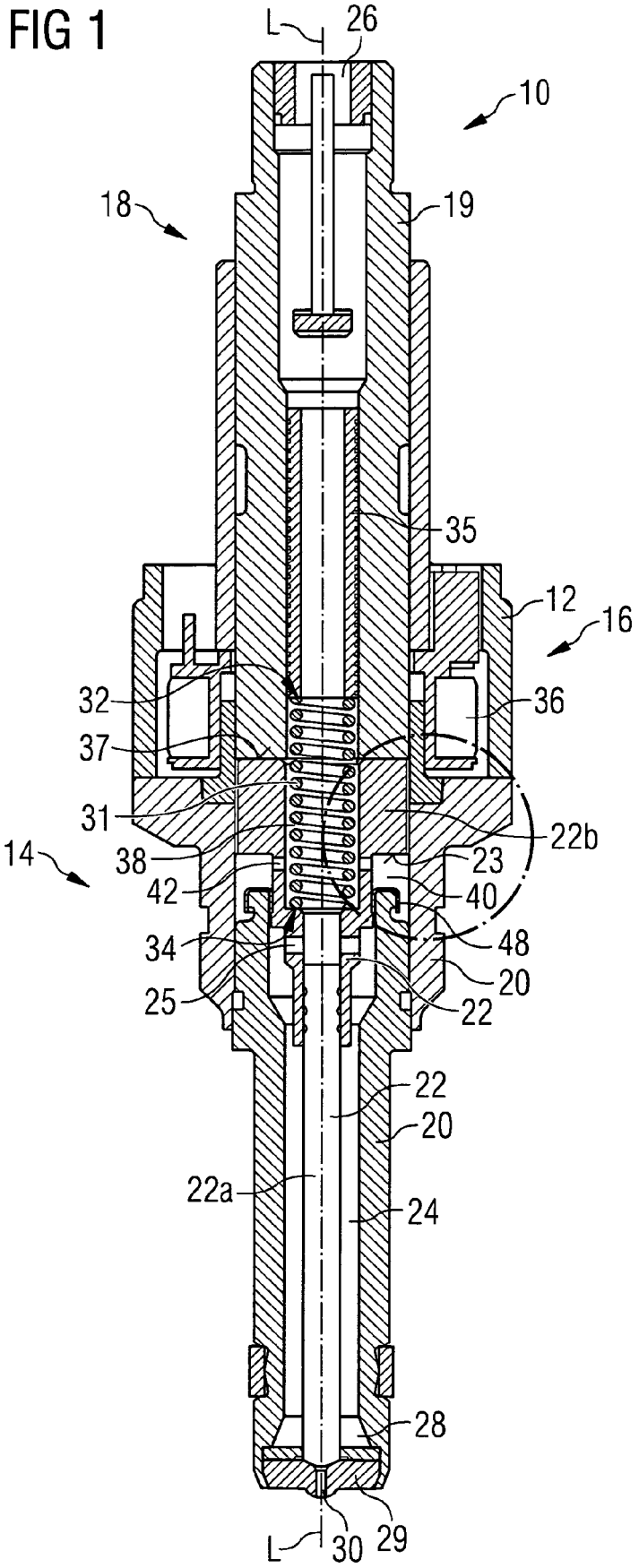
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FIG 2

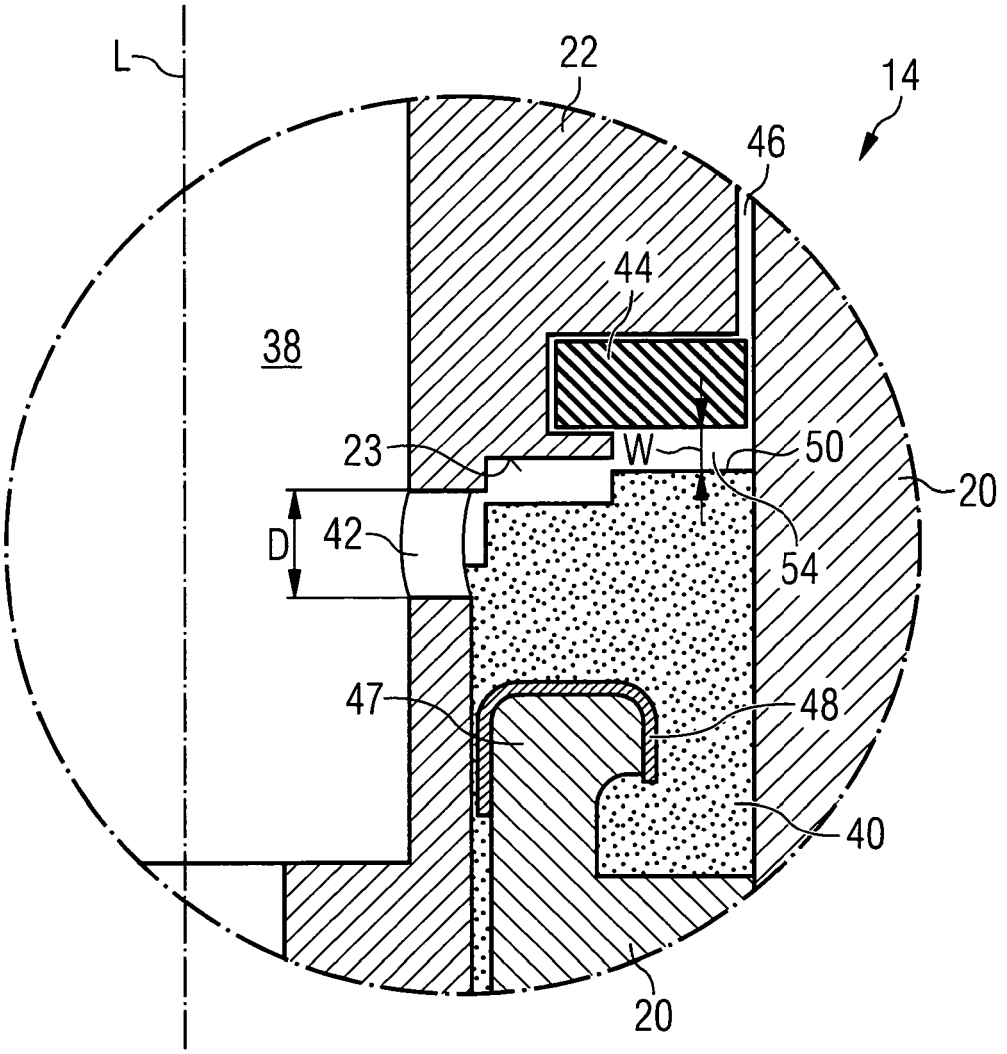
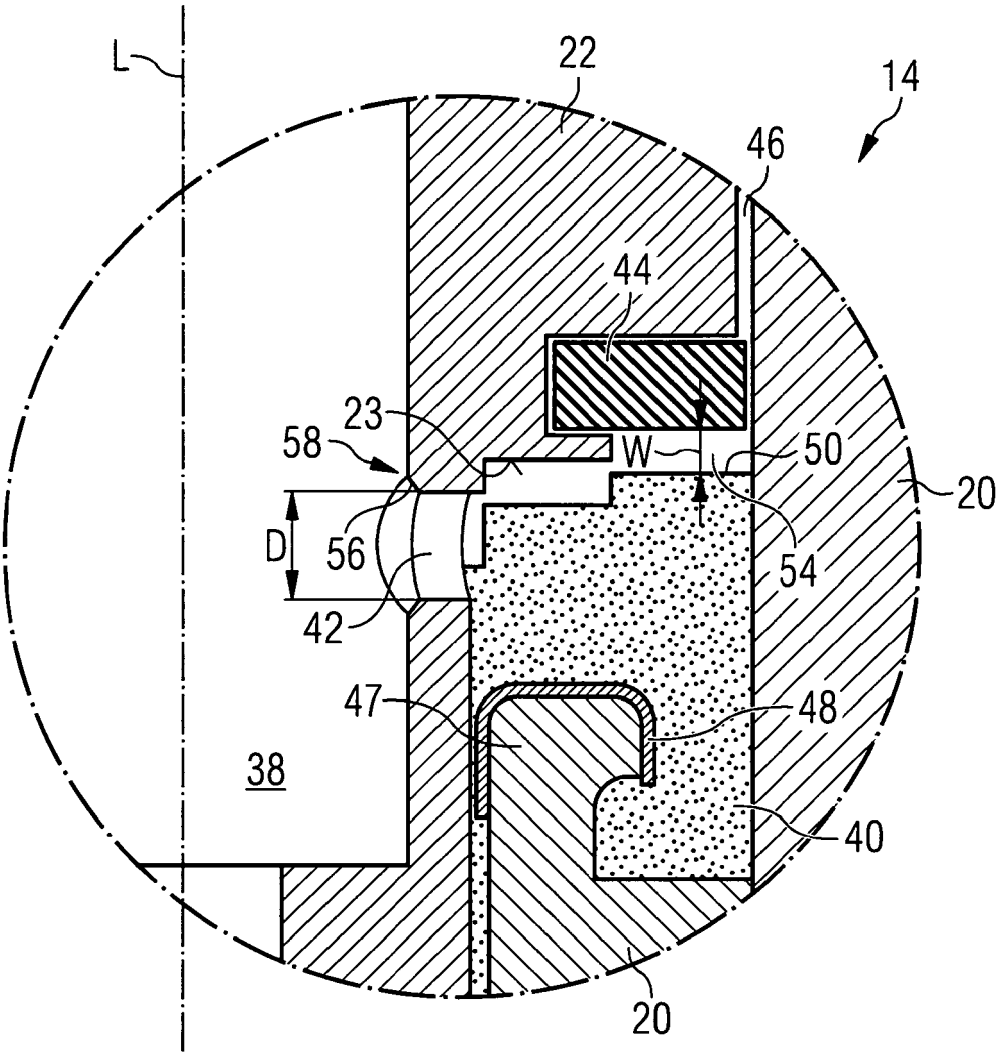


FIG 3



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EUROPEAN SEARCH REPORT

Application Number
EP 05 02 6380

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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
The Hague	6 April 2006	Blanc, S

CATEGORY OF CITED DOCUMENTS

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