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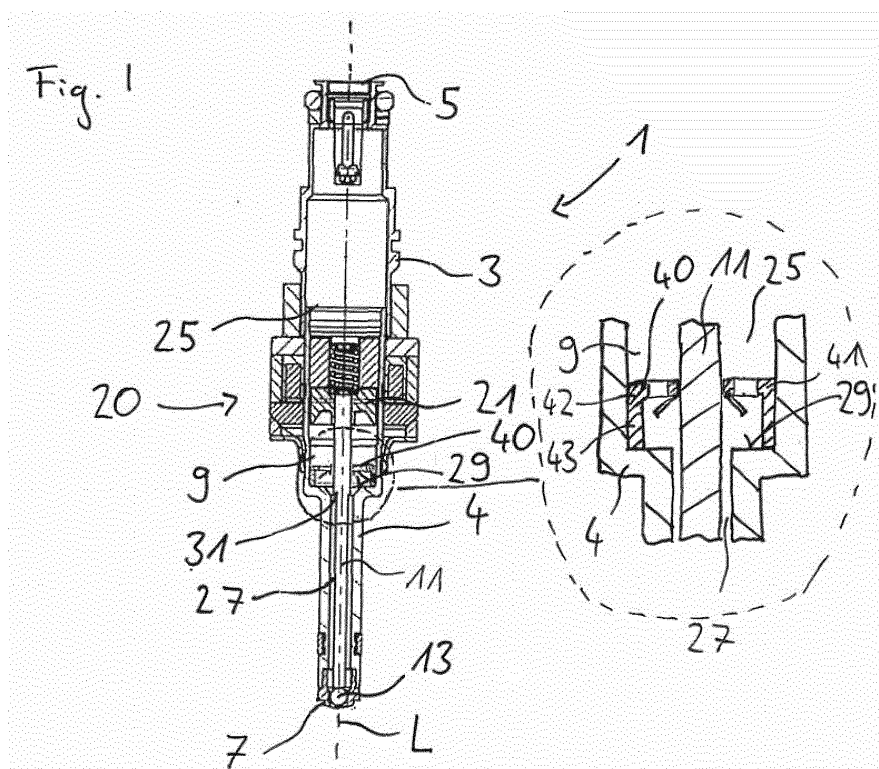
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(54) **VALVE ASSEMBLY FOR AN INJECTION VALVE AND INJECTION VALVE**

(57) Valve assembly (3) for an injection valve (1), comprising
- a valve body (4) with a central longitudinal axis (L) comprising a cavity (9) with a fluid inlet portion (5) and a fluid outlet portion (7), wherein the cavity (9) comprises a first portion (25) extending from the fluid inlet portion (5) to a bottom surface (29) and a second portion (27) extending from a central opening (31) in the bottom surface (29) down towards the fluid outlet portion (7);
- a valve needle (11) axially moveable in the cavity (9), the valve needle (11) preventing a fluid flow through the

fluid outlet portion (7) in a closing position and releasing the fluid flow through the fluid outlet portion (7) in further positions, the valve needle (11) extending through the central opening (31);
- an armature (21) of an electro-magnetic actuator unit (20) being designed to actuate the valve needle (11); wherein a one-way flap valve member (40) is arranged above the central opening (31) in the bottom surface (29) and fixed to the valve body (4) preventing fluid flow in the direction towards the fluid inlet portion (5).



Description

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

[0002] An injection valve for injecting fuel directly or indirectly into a combustion chamber of the vehicle is disclosed in document EP 2 333 297 B1. One typical problem of such injection valves, in particular of high pressure valves, is the generation of pressure waves or pressure pulsations caused by an injection event. Internal pressure pulsations cause problems in particular for multiple injection applications, because when pressure conditions inside the injector are not stable or not known at the time of opening of the valve, the amount of injected fuel cannot be controlled.

[0003] Up to now this problem has been solved by separating the armature from the needle to reduce the impact energy at the closing event to support the correct injector closing function. The armature-needle-decoupled design is built up by several components that are assembled with tight tolerances and with precise assembly steps. This leads to an expensive product design.

[0004] It is an object of the present invention to provide a valve assembly which helps solve the above-mentioned problems. Furthermore, it is an object of the present invention to provide an injection valve in which pressure pulsations do not interfere with the injections.

[0005] These objects are achieved by means of the valve assembly and the injection valve according to the independent claims. Advantageous embodiments and developments are specified in the dependent claims, the following description and the drawings.

[0006] According to one aspect of the invention, a valve assembly for an injection valve is provided comprising a valve body with a central longitudinal axis comprising a cavity with a fluid inlet portion and a fluid outlet portion, wherein the cavity comprises a first portion extending from the fluid inlet portion to a bottom surface and a second portion extending from a central opening in the bottom surface down towards the fluid outlet portion.

[0007] The valve assembly further comprises 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, the valve needle extending through the central opening.

[0008] The valve assembly further comprises an armature of an electromagnetic actuator unit being designed to actuate the valve needle. A one-way flap valve member is arranged above the central opening in the bottom surface and fixed to the valve body preventing fluid flow in the direction towards the fluid inlet portion.

[0009] That the one-way flap valve member prevents fluid flow in the direction towards the fluid inlet portion means in particular that the flap valve member provides a fluid passage, enables fluid flow through the fluid passage in the direction towards the fluid outlet portion and

prevents fluid flow through the fluid passage in the direction towards the fluid inlet portion. In addition to the fluid passage, the flap valve member may comprise an opening through which the valve needle extends. In one embodiment the flap valve member is shaped and dimensioned such that all or substantially all fluid has to flow through the fluid passage provided by the flap valve member to reach the fluid outlet portion. That "substantially all fluid has to flow through the fluid passage" means in particular that leakage paths - e.g. through the opening through which the valve needle extends - may exist. However, e.g. 80% of the fluid, preferably 90 % or more of the fluid, flows through the fluid passage provided by the flap valve member.

[0010] The valve assembly has the advantage that a pressure wave generated by a closing event of the injector is not transmitted in the cavity towards the fluid inlet portion. The flap valve member acts as a one-way valve stopping the pressure wave propagating inside the injector. Thus, the injection of fuel can be controlled more accurately.

[0011] According to an embodiment, the flap valve member is supported by the bottom surface. This embodiment has the advantage that the propagation of pressure waves can be blocked without any force transfer to the armature or the needle, which could lead to an uncontrolled reopening of the needle.

[0012] According to an embodiment, the flap valve member has a first part comprising a frame with a number of openings arranged therein, the frame being supported by the bottom surface. The flap valve member furthermore has a second part comprising a flap disc with a number of flaps being designed to cover the openings, the flap disc being fixed to a lower side of the frame.

[0013] This design of the flap valve member has the advantage that it can be easily fitted into the valve body, and the frame can be supported by the bottom surface.

[0014] The frame may comprise an annular wall part comprising an annular wall being arranged coaxially with the valve body around the central longitudinal axis. The frame may furthermore comprise a disc part being arranged perpendicular to the annular wall, the flap disc being fixed to the disc part.

[0015] This embodiment has the advantage that the annular wall part makes room for the flaps to open towards the fluid outlet portion. By means of the annular wall part, a space is created directly above the bottom surface with the central opening, in which the flaps can open. The propagation of pressure waves is thereby confined to the second portion of the cavity and the interior space enclosed by the flap valve member.

[0016] Furthermore, this design of the flap valve member has the advantage that the annular wall part can be used to press-fit the flap valve member with the valve body.

[0017] The flap disc may be made of a flexible material, for example a metal. If the flexible material is a metal and the frame is also made of metal, the flap disc may be

welded to the frame, for example by laser welding.

[0018] Alternatively, the flexible material may be a plastic material.

[0019] These embodiments have the advantage, that the flaps can be bent to open the valve by the fuel pressure itself when the needle opens.

[0020] According to an embodiment, the frame comprises three or more openings and the flap disc comprises three or more flaps, each flap corresponding to one opening. The number of openings and flaps can be varied according to the desired fluid flow through the injector. However, the implementation of at least three flaps has the advantage, that the separate flaps are not too large and do not extend over an angle of more than 120° which could make opening of the flaps more difficult.

[0021] According to an aspect of the invention, a fuel injection valve with the described valve assembly is provided.

[0022] The injection valve has the advantage that pressure pulsations cannot propagate inside the injector to act on the armature and cause the needle to reopen.

[0023] Further advantages, advantageous embodiments and developments of the valve assembly and the injector will become apparent from the exemplary embodiments which are described below in association with the schematic figures.

Figure 1 shows a cross-section through an injection valve according to an embodiment of the invention,

Figure 2 shows a first perspective view of a flap valve member for the injector of figure 1 according to an embodiment of the invention,

Figure 3 shows a second perspective view of the flap valve member according to figure 2,

Figure 4 shows a plan view of the flap valve member according to figure 2,

Figure 5 shows a cross section through the flap valve member according to figure 2 in a closed state and

Figure 6 shows a cross-section through the flap valve member according to figure 2 in an open state.

[0024] Figure 1 shows an injection valve 1 for the injection of fuel into an internal combustion engine. The injection valve 1 comprises a valve assembly 3 with the valve body 4 with a central longitudinal axis L. The valve body 4 comprises a cavity 9 with a fluid inlet portion 5 and fluid outlet portion 7. The cavity 9 comprises a first portion 25 extending from the fluid inlet portion 5 to a bottom surface 29, where the valve body 4 forms a recess, and a second portion 27 extending from a central

opening 31 in the bottom surface 29 down towards the fluid outlet portion 7.

[0025] A valve needle 11 is arranged axially movable in the cavity 9. The valve needle 11 prevents a fluid flow through the fluid outlet portion 7 in a closing position. To achieve this, the needle 11 has a ball 13 welded to its lower end which interacts with a valve seat (not shown in detail) of the valve body 4.

[0026] The injection valve 1 further comprises an electromagnetic actuator unit 20 to actuate the valve needle 11. The actuator unit 20 comprises an armature 21 which may be fixed to the needle 11 or coupled to the needle 11 in some other way to cause the needle 11 to move axially in the cavity 9 in response to a magnetic field.

[0027] When the needle 11 is actuated, a magnetic field acts on the armature 21 to cause it to travel upwards and take the needle 11 with it against the force of a calibration spring. Thus, the ball 13 leaves the valve seat and fuel is released through the fluid outlet portion 7.

[0028] When the magnetic field ceases, the valve needle 11 is moved downwards by the force of the calibration spring and the fluid outlet portion 7 is closed again. The closing event generates a pressure wave that may propagate inside the cavity 9, act on the armature 21 and the needle 11 and cause the injection valve 1 to open again uncontrollably.

[0029] To prevent pressure pulsations from being transmitted in the cavity 9 and in particular from the second portion 27 of the cavity 9 into the first portion 25, a one-way flap valve member 40 is arranged in the cavity 9 directly above the central opening 31 and therefore practically at the boundary between the first portion 25 and the second portion 27.

[0030] The one-way flap valve member 40 is fixed to the valve body 4 as can be seen from the detailed picture on the right hand side of figure 1. The flap valve member 40 comprises a first part 41 with the frame 42 which has an annular wall 43 which is arranged coaxially with the valve body 4 and which may be fixed to the valve body 4 by press fitting. Furthermore, the frame 42 is supported by the bottom surface 29.

[0031] The flap valve member 40 also comprises a number of flaps which are described in more detail with reference to the following figures.

[0032] The flap valve member 40 substantially prevents fluid flow in the direction towards the fluid inlet portion 5 and allows fluid flow in the direction towards the fluid outlet portion 7. Thus, the flap valve member 40 prevents pressure waves coming from the fluid outlet portion 7 to propagate into the first portion 25 of the cavity 9.

[0033] Figures 2 to 6 show different views of the flap valve member 40.

[0034] The flap valve member 40 comprises a first part 41 with a frame 42 which has a number of openings 45 arranged therein. In the example shown in figures 2 to 6, three openings 45 are arranged in a disc part 47 of the frame 42. Furthermore, a central opening 44 is also arranged in the disc part 47. The valve needle 11 extends

through the central opening 44 in the frame 42.

[0035] The frame 42 furthermore comprises an annular wall 43 which extends on one side of the disc part 47 to form a cylindrical wall and which extends coaxially with the valve body 4 and with the needle 11 around the central longitudinal axis L.

[0036] The frame 42 may in particular be formed of a metal, for example steel.

[0037] The flap valve member 40 furthermore comprises a second part 48 with a flap disc 49 which comprises a number of flaps 51 grouped around a central opening 52 and divided from one another by slits 53. The flap disc 49 may in particular be formed by a thin sheet of metal, for example steel. Alternatively, the flap disc 49 may be formed of a plastic material. In each case, the flap disc 49 is designed in a way to enable the flaps 51 to bend due to fuel pressure acting on the flaps 51 from above when the injection valve 1 opens.

[0038] The flap disc 49 is arranged on the lower side 46 of the disc part 47 of the frame 42. The flap disc 49 is fixed to the disc part 47 along diameter of the central opening 52 as indicated by the line 55 shown in figure 2. If the flap disc 49 is made of a metal, the flap disc 49 may be laser welded to the disc part 47 along the line 55.

[0039] Figure 4 shows a plan view of the flap valve member 40 with the second part 48 indicated by dotted lines. From this view it can be seen clearly that the flaps 51 overlap the openings 45. Figures 5 and 6 show a cross-section through the flap valve member 40 along the line A-A of figure 4. Figure 5 shows the flap valve member 40 in a closed position, while figure 6 shows the flap valve member 40 in an open position.

[0040] In figure 5, the flaps 51 cover the openings 45 and will not open under the influence of fluid flow coming from the direction indicated by the arrow 57 because the flaps 51 overlap with the frame 42 and are larger than the openings 45.

[0041] However, when fluid flow coming from the direction indicated by the arrow 59 in figure 6 acts on the flap valve member 40, the flaps 51 open according to the fluid pressure and let fluid flow pass.

Claims

1. Valve assembly (3) for an injection valve (1), comprising

- a valve body (4) with a central longitudinal axis (L) comprising a cavity (9) with a fluid inlet portion (5) and a fluid outlet portion (7), wherein the cavity (9) comprises a first portion (25) extending from the fluid inlet portion (5) to a bottom surface (29) and a second portion (27) extending from a central opening (31) in the bottom surface (29) down towards the fluid outlet portion (7);
- a valve needle (11) axially moveable in the cavity (9), the valve needle (11) preventing a fluid

flow through the fluid outlet portion (7) in a closing position and releasing the fluid flow through the fluid outlet portion (7) in further positions, the valve needle (11) extending through the central opening (31);

- an armature (21) of an electro-magnetic actuator unit (20) for actuating the valve needle (11); wherein a one-way flap valve member (40) is arranged above the central opening (31) in the bottom surface (29) and fixed to the valve body (4) preventing fluid flow in the direction towards the fluid inlet portion (5).

2. Valve assembly (3) according to claim 1, wherein the flap valve member (40) is supported by the bottom surface (29).

3. Valve assembly (3) according to claim 1 or 2, wherein the flap valve member (40) has

- a first part (41) comprising a frame (42) with a number of openings (45) arranged therein, the frame (42) being supported by the bottom surface (29), and
- a second part (47) comprising a flap disc (49) with a number of flaps (51) being designed to cover the openings (45), the flap disc (49) being fixed to a lower side (46) of the frame (42).

4. Valve assembly (3) according to claim 3, wherein the frame (42) comprises

- an annular wall part comprising an annular wall (43) being arranged coaxially with the valve body (4) around the central longitudinal axis (L), and
- a disc part (47) being arranged perpendicular to the annular wall (43), the flap disc (49) being fixed to the disc part (47).

5. Valve assembly (3) according to claim 3 or 4, wherein the flap disc (49) is made of a flexible material.

6. Valve assembly (3) according to claim 5, wherein the flexible material is a metal and the flap disc (49) is welded to the frame (42).

7. Valve assembly (3) according to claim 5, wherein the flexible material is a plastic material.

8. Valve assembly (3) according to any of claims 3 to 7, wherein the frame (42) comprises three or more openings (45) and the flap disc (49) comprises three or more flaps (51), each flap (51) corresponding to one opening (45).

9. Fuel injection valve (1), comprising a valve assembly

(3) according to any of claims 1 to 8.

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Fig. 1

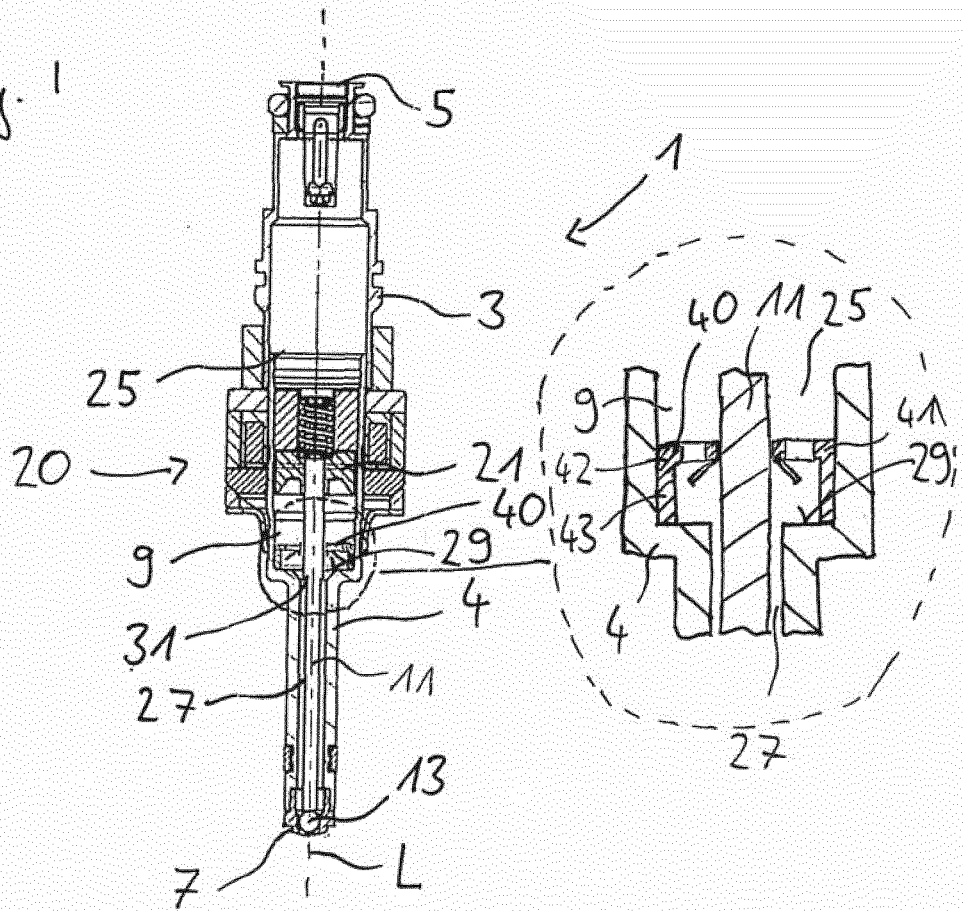


Fig. 2

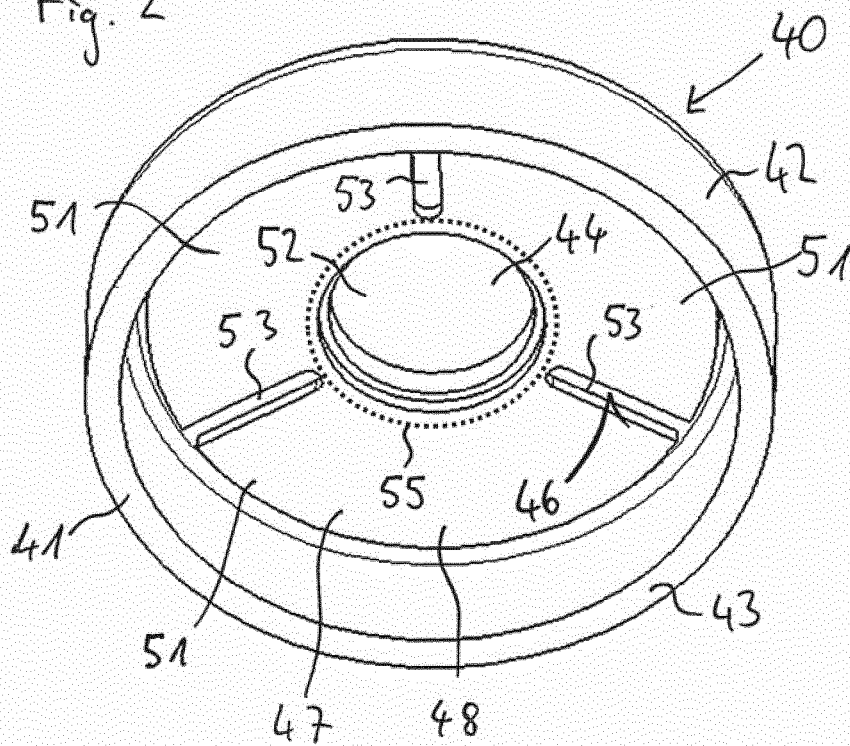


Fig. 3

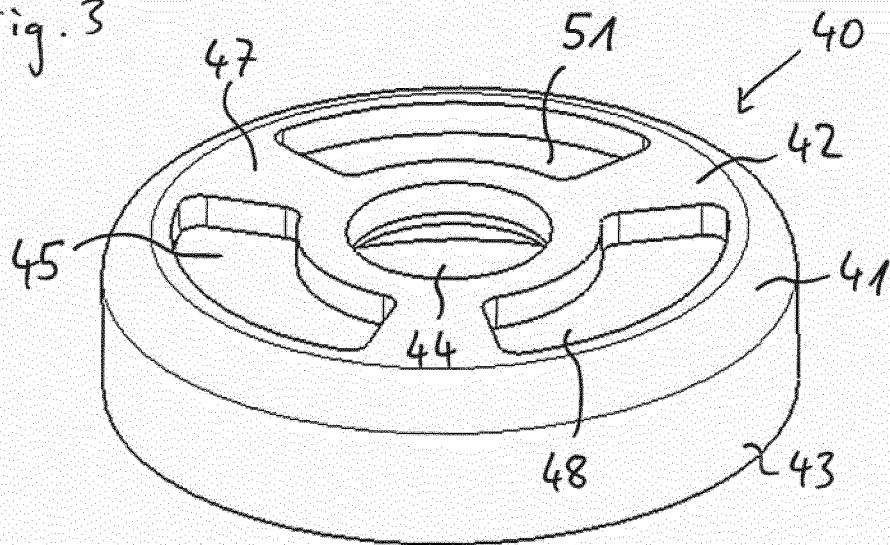
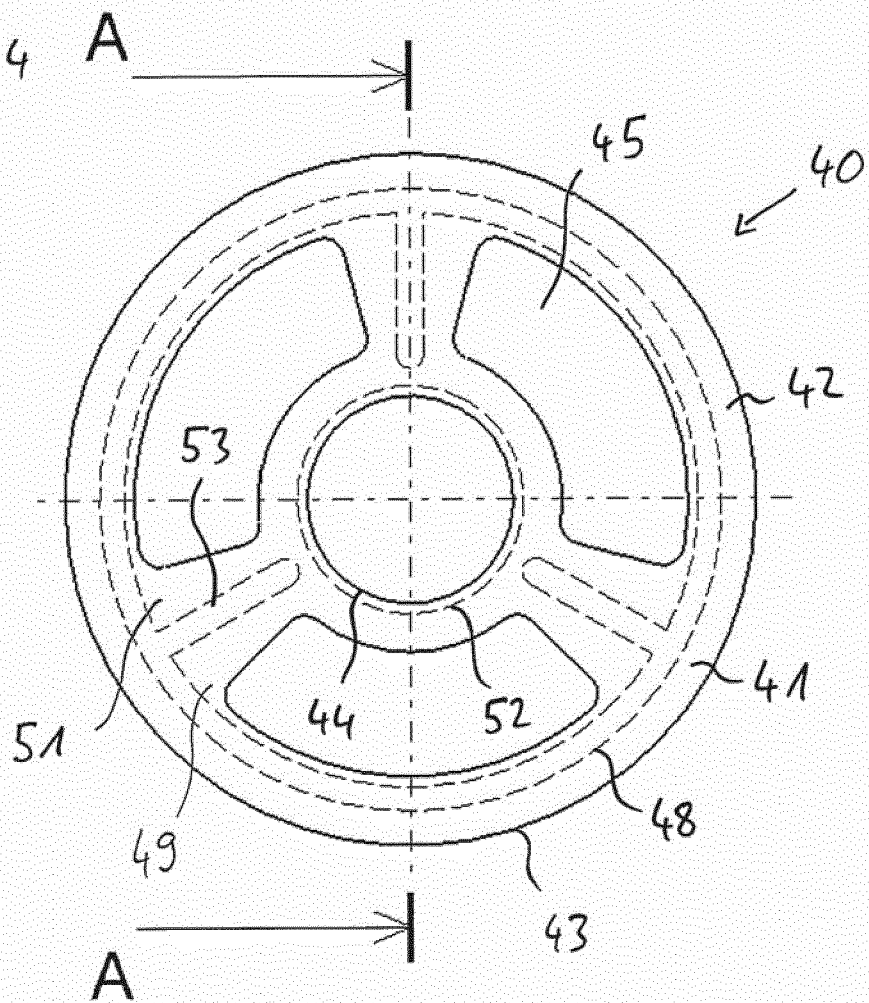
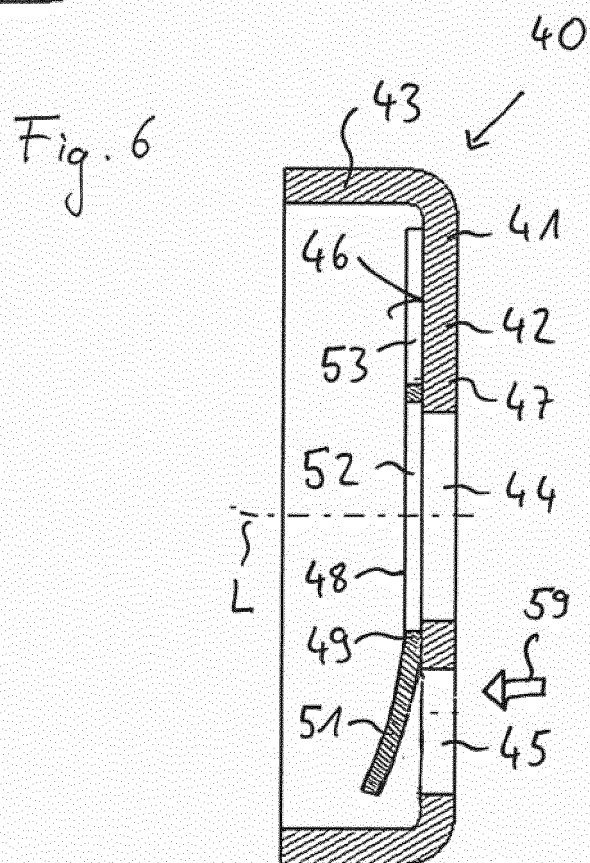
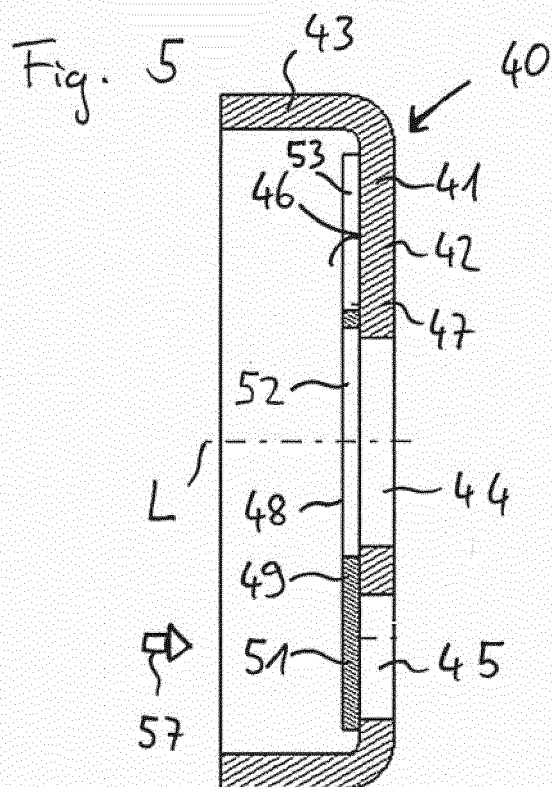


Fig. 4







EUROPEAN SEARCH REPORT

Application Number
EP 17 19 5766

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 15 February 2018	Examiner Hermens, Sjoerd
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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REFERENCES CITED IN THE DESCRIPTION

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