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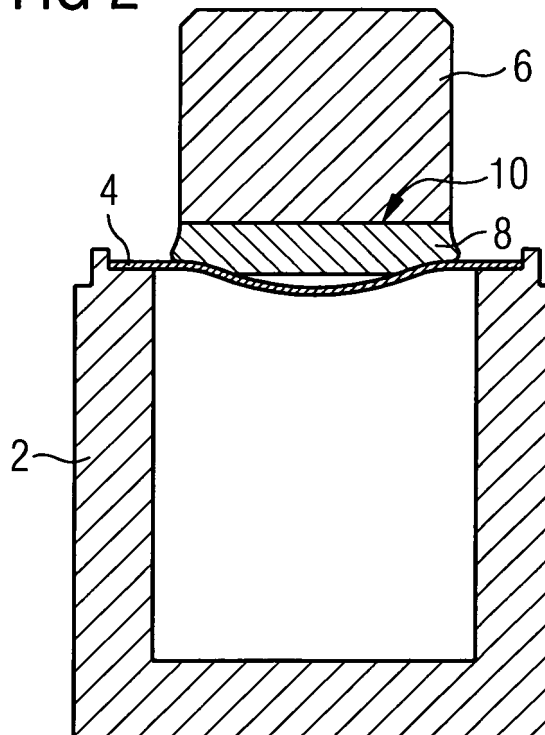
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(54) **Injector, compensation device for the injector and pressure transferring device for the compensation device**

(57) A pressure transferring device comprises a stamp (6) and a sealed fluid chamber (2) which is bordered by a first membrane (4) at one side of the fluid chamber (2). A transferring element (8) is fixed to the

stamp (6) at one axial end of the stamp (6) coupling the stamp (6) with the first membrane (4) of the fluid chamber (2). The transferring element (8) comprises a material which comprises a smaller Young's modulus of elasticity than the material of the first membrane (4).

FIG 2



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Description

[0001] The invention relates to a pressure transferring device comprising a stamp and a sealed fluid chamber which is bordered by a first membrane at one side of the fluid chamber. The invention further relates to a compensation device for an injector comprising the pressure transferring device and to an injector comprising the compensation device.

[0002] DE 103 44 061 A1 discloses an injector with a hydraulic compensation device. The compensation device comprises a hydraulically sealed system which comprises a piston. The piston separates the hydraulically sealed system in a first volume and a second volume. The slowly increasing pressure difference between the first volume and the second volume can be compensated by a fluid flow from the first volume to the second volume or vice-versa.

[0003] The object of the invention is to create a pressure transferring device for a compensation device for an injector which enables a uniformly distributed pressure on a first membrane bordering a fluid chamber of the pressure transferring device.

[0004] The object of the invention is achieved by the independent claims. Advantageous embodiments of the invention are given in the sub-claims.

[0005] The invention is distinguished respectively a first aspect of the invention by a pressure transferring device. The pressure transferring device comprises a stamp and a sealed fluid chamber. The sealed fluid chamber is bordered by a first membrane at one side of the fluid chamber. A transferring element is fixed to the stamp at one axial end of the stamp couples the stamp with the first membrane of the fluid chamber. The transferring element comprises a material which comprises a smaller Young's modulus of elasticity than the material of the first membrane.

[0006] If the stamp acts on the transferring element towards the first membrane, the first membrane and the transferring element deform. Because of the smaller Young's modulus of elasticity of the transferring element, the deformation of the transferring element adjusts at the deformation of the membrane. This contributes to a uniformly distributed pressure on the first membrane bordering the fluid chamber.

[0007] In an advantageous embodiment of the first aspect of the invention the transferring element and the stamp comprise an overlapping area. The transferring element is coupled to the stamp in a central area of the overlapping area. The pressure transferring device comprises a gap between the stamp and the transferring element outside of the central area. The gap enables the bending of the transferring element and contributes to a very good uniform distribution of the pressure.

[0008] In a further advantageous embodiment of the first aspect of the invention, the pressure transferring element or the stamp comprise a dowel pin in the central area and the stamp or respectively the transferring ele-

ment comprises a corresponding mortise for the dowel pin. This enables simply a precise positioning of the transferring element relative to the stamp.

[0009] In a further advantageous embodiment of the first aspect of the invention, the dowel pin is fixed into the corresponding mortise by a press fit. This enables a proper fixing of the transferring element to the stamp without gluing, welding and/or something similar.

[0010] In a further advantageous embodiment of the first aspect of the invention, the stamp comprises a first axial section and a second axial section separated by a step. The first axial section has a bigger diameter than the second axial section and comprises the axial end of the stamp facing towards the transferring element. This enables to use the step as a seat for a spring. This is especially advantageous in conjunction with the pressure transferring device being a part of a compensation device for an injector which comprises a compensation device spring. The step then may form the seat for the compensation device spring and the second axial section may be used to center the compensation device spring in addition to the use of the stamp for fixing and positioning of the transferring element and transferring pressure on the transferring element. The compensation device spring may contribute to a proper compensation of changes in the axial length of the injector by thermal expansion of the injector.

[0011] In a further advantageous embodiment of the invention, the transferring element comprises a synthetic material and the first membrane comprises a metal. The synthetic material may enable a cheap production of the transferring element. If the first membrane comprises the metal and the stamp comprises the synthetic material, this may contribute to an avoiding of a loss of the first membrane by rust and oxidation of the membrane.

[0012] In a further advantageous embodiment of the first aspect of the invention, the pressure transferring device comprises Teflon and/or Nylon. This enables a small Young's modulus of elasticity of the transferring element while the transferring element being very stable and robust.

[0013] In a further advantageous embodiment of the first aspect of the invention, the first membrane comprises steel and/or aluminum. This enables a robust and flexible first membrane.

[0014] The invention is distinguished respectively a second aspect of the invention by the compensation device which comprises the pressure transferring device. The compensation device further comprises a first volume of the fluid chamber and a second volume of the fluid chamber. The first volume is hydraulically coupled with the second volume, at least in a given state of the compensation device. A piston is arranged in the fluid chamber, movable in axial direction. The piston borders at least one of the volumes in axial direction.

[0015] A proper hydraulic coupling of the volumes enables the compensation of a slowly changing pressure on the stamp or the piston by a movement of the piston

changing the capacity of the first and/or respectively the second volume. It further enables the transferring of a fast changing pressure from the stamp to the piston or vice-versa. For example, a throttle, and/or a fluid path with a valve and/or a check valve, and/or a clearance fit of the piston to the fluid chamber may contribute to the proper hydraulic coupling. The given state may comprise a position of the valve and/or respectively the check valve.

[0016] The invention is distinguished related to a third aspect of the invention by a first injector which comprises the compensation device. The first injector comprises an injector body having an injector body recess in which the compensation device is arranged. An actor is coupled to the piston of the compensation device at a first axial and of the actor. A needle body is coupled to the actor at the second axial end of the actor facing away from the piston. The needle body prevents a fluid flow through an injection nozzle of the injector body in a closing position of the needle body and otherwise enables the fluid flow. The compensation device enables the compensation of a thermal expansion of the injector body and so enables a good contact of the actor and the needle body. This contributes to a precise dosing of the fluid by the first injector.

[0017] The invention is distinguished related to a fourth aspect of the invention by a second injector which comprises the compensation device. In the second injector the needle body is coupled to the actor via the compensation device.

[0018] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings.

[0019] These are as follows:

- Figure 1 a first embodiment of a pressure transferring device,
- Figure 2 the first embodiment of the pressure transferring device under pressure,
- Figure 3 a second embodiment of the pressure transferring device,
- Figure 4 the second embodiment of the pressure transferring device under pressure,
- Figure 5 an injector comprising a compensation device,
- Figure 6 a detailed view of the compensation device according to figure 5.

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

[0021] A pressure transferring device (Figure 1) comprises a fluid chamber 2 which is sealed by a first membrane 4. The pressure transferring device further com-

prises a stamp 6 which is coupled to the first membrane 4 by a transferring element 8. The stamp 6 and the transferring element 8 comprise an overlapping area 10. The pressure transferring device may be used for transferring a pressure from the stamp 6 to a fluid in the fluid chamber 2. The pressure may act on the stamp 6 towards the transferring element 8 on a side of the stamp 6 facing away from the transferring element 8. The pressure of the fluid in the fluid chamber 2 may be used for further devices. The further devices may comprise a compensation device 30 (Figure 6). The compensation device 30 may be used for compensating a change of an axial length of an injector 20 (Figure 5) because of a thermal expansion of the injector 20.

[0022] The Young's modulus of elasticity of the transferring element 8 is smaller than the Young's modulus of elasticity of the membrane 4. Because of the smaller Young's modulus of the transferring element 8, the deformation of the transferring element 8 is bigger than the deformation of the membrane 4 under the same pressure. Under pressure this leads to an adjustment of the transferring element 8 to the first membrane 4.

[0023] If the pressure towards the transferring element 8 acts on the stamp 6, the pressure is transferred from the stamp 6 to the membrane 4 by the transferring element 8. Because of the pressure, the membrane 4 deforms (Figure 2). Because of the smaller Young's modulus of elasticity of the transferring element 8, the deformation of the transferring element 8 adjusts at the deformation of the membrane 4. The adjustment of the membrane 4 and the transferring element 8 under pressure leads to a larger contact surface of the transferring element 8 and the membrane 4 related to a transferring element 8 which comprises the same or a bigger Young's modulus of elasticity than the membrane 4. The larger the contact surface is the smaller is pressure per square element. So the smaller Young's modulus of elasticity leads to a smaller pressure per square element and contributes to a very good distribution of the pressure on the membrane 4.

[0024] Preferably the transferring element 8 comprise a synthetic material and the membrane 4 comprises a metal. If the transferring element 8 comprises the synthetic material and the membrane 4 comprises the metal, this may contribute to the avoiding of a loss of the membrane 4 by rust and oxidation. The synthetic material may comprise Teflon and/or Nylon and/or the metal may comprise steel and/or aluminum. Teflon and Nylon are very robust materials while having a small Young's modulus of elasticity related to the Young's modulus of elasticity of steel and aluminum. If the transferring element 8 comprises the synthetic material and the membrane 4 comprises the metal the deformation under pressure may be much smaller than it is illustrated in Figure 2. Further the deformation of the membrane 4 may be much smaller than it is illustrated in Figure 2.

[0025] The transferring element 8 and the stamp 6 may be coupled only in a central area 12 of the overlapping

area 10 (Figure 3). This enables having a gap 14 outside of the central area 12 between the stamp 6 and the transferring element 8.

[0026] If the pressure towards the membrane 4 acts on the stamp 6, the gap 14 enables a bending of the transferring element 8 (FIG. 4). The bending of the transferring element 8 under pressure may contribute to a larger contact surface between the membrane 4 and the transferring element 8 respective to the pressure transferring device without the gap 14. The larger contact surface under pressure contributes to a much better distribution of the pressure on the membrane 4. The properly distributed pressure on the membrane 4 contributes to a proper function of the pressure transferring device and exceeds the lifetime of the pressure transferring device and especially of the membrane 4.

[0027] Preferably the pressure transferring element 8 comprises a dowel pin 16 in the central area 12 and the stamp 6 comprises a corresponding mortise 18 for the dowel pin 16. If the dowel pin 16 is put into the mortise 18, the transferring element 8 is centered and properly positioned related to the stamp 6.

[0028] Preferably the dowel pin 16 and the mortise 18 are formed in such a way that the dowel pin 16 is fixed to the mortise 18 by a press fit. The press fit enables a very simple assembling of the transferring element 8 to the stamp 6. It further enables the avoiding of gluing, welding, or something similar for fixing the transferring element 8 to the stamp 6.

[0029] In an alternative embodiment, the dowel pin 16 may be a part of the stamp 6. Then the corresponding mortise 18 is a part of the transferring element 8. In a further alternative embodiment there may be further dowel pins 16 and further corresponding mortises 18.

[0030] The injector 20 (Figure 5) comprises an injector body 22 with an injector body recess 24. A needle body 26, an actor 28, and a compensation device 30 are arranged in the injector body recess 24 of the injector body 22. The injector 20 may be used for dosing fluid into a combustion chamber or an inlet manifold of an internal combustion engine. The injector 20 is of an outward opening type. In an alternative embodiment the injector 20 may be of an inward opening type.

[0031] For example, the actor 28 is a piezoelectric actuator. The piezoelectric actuator may change its axial length if it gets energized in an expansion-duration of some microseconds. The needle body 26 prevents a fluid flow through an injection nozzle 27 in the injector body 22 in a closing position of the needle body 26. Outside of the closing position of the needle body 26, the needle body 26 enables the fluid flow through the injection nozzle 27. By changing its length the actor 28 may force the needle body 26 out of the closing position of the needle body 26. Outside of the closing position of the needle body 26 there is a gap between the injector body 22 and the needle body 26 at an axial end of the injector 20 facing away from the compensation device 30, the gap forming the injection nozzle 27. A needle body spring 34 forces the

needle body 26 via a needle plate 36 towards the actor 28. So, if the actor 28 is de-energized the actor 28 shortens its length and the needle spring 35 forces the needle body 26 in its closing position. It depends on a force balance between the force on the needle body 26 because of the actor 28 and the force on the needle body 26 because of the needle body spring 34 whether the needle body 26 is in its closing position or not.

[0032] If the temperature of the injector 20 changes, the actor 28 and the injector body 22 change their axial length with the temperature. If the injector body 22 expands more or less than the actor 28 because of the temperature, without the compensation device 30 this may lead to a different position of the actor 28 relative to the injector body 22 and to a different position of the actor 28 relative to the needle body 26. This may lead to a loss of a contact between the actor 28 and the needle body 26, for example, in such a way that the actor 28 is not able to force the needle body 26 out of its closing position. So, without the compensation device 30 the different change of length of the injector body 22 and the actor 28 may contribute to a worsening of the fluid injection into the internal combustion engine.

[0033] The compensation device 30 may be arranged between the injector body 22 and the actor 28 to compensate the different thermal expansions of the injector body 22 and the actor 28. The compensation device 30 may further compensate a different thermal expansion of the needle body 26 relative to the actor 28 and/or the injector body 22.

[0034] The compensation device 30 is fixed to the injector body 22 and coupled to the injector body 22 by a compensation device spring 32. In order to have a seat for the compensation device spring 32, the stamp 6 preferably comprises a first axial section and a second axial section separated by a step 41 (Figure 6). The first axial section of the stamp 6 comprises a smaller diameter than the second axial section. The step 41 preferably forms the seat for the compensation device spring 32. The second axial section is preferably used to center the compensation device spring 32.

[0035] The compensation device 30 may comprise a first volume 42 and a second volume 44. The first volume 42 may be hydraulically coupled to the second volume 44. Preferably the first volume 42 is hydraulically coupled to the second volume 44 by a throttle 46. A piston 48 may be arranged in a way that the second volume 44 is bordered at one side by the piston 48. At that side of the piston 48 facing away from the throttle 46 the compensation device comprises a second membrane 50 and a rod 52 which extends through the second membrane 50 and which is fixed to the piston 48. For filling fluid into the compensation device 30 the compensation device 30 comprises a fluid inlet 54. After filling the compensation device 30 with the fluid, the compensation device 30 may be sealed with a sealing body 56. In that way the compensation device 30 is a totally closed hydraulic system.

[0036] The compensation device spring 32 acts on the stamp 6. The stamp 6 transfers the pressure on the membrane 4 via the transferring element 8. The membrane 4 deforms inwardly and presses the fluid from the first volume 42 to the second volume 44. The pressure in the second volume 44 forces the piston 48 away from the first volume 42 and in the injector 20 against the actor 28. If the temperature rises, the injector body 22 expands slowly and more than the actor 28. So, the pressure from the piston 48 on the actor 28 and vice-versa decreases. This leads to a decreasing pressure in the second volume 44. The decreasing pressure in the second volume 8 leads to a flow of the fluid from the first volume 42 to the second volume 44 which is still under pressure because of the compensation device spring 32. A decreasing temperature of the injector 20 leads to an increasing pressure in the second volume 44 and to a fluid flow from the second volume 44 to the first volume 42. So, the piston 48, especially the rod 52 never loses the contact to the actor 28 because of the slow thermal expansion of the injector 20. So, the actor 28 does not lose its contact to the needle body 26. This contributes to a precise dosing of fluid by the injector 20.

[0037] If the actor 28 gets energized or de-energized, the pressure on the piston 48 increases or respectively decreases so fast that the fluid can not flow fast enough through the throttle 46. So, the whole compensation device 30 acts nearly like a stiff body and forms a back stop for the actor 28. So the pressure is transferred nearly completely from the actor 28 to the needle body 26.

[0038] The invention is not restricted to the explained embodiments. For example, in a further or alternative embodiment of the injector 20, the compensation device 30 may be arranged between the actor 28 and the needle body 26. The actor then acts on the needle body 26 via the compensation device 30. Further in an alternative embodiment of the compensation device 30, the throttle 46 may be arranged in the piston 48 and the piston 48 separates the first volume 42 from the second volume 44. Further in an alternative embodiment of the compensation device 30 there is a fluid path in combination with a valve or a check valve instead of the throttle 46. Further in an alternative embodiment of the compensation device 30 there is a sealing at the piston 48 in such a way that the second volume 44 is sealed by the piston 48 and the sealing instead of having the second membrane 50.

Claims

1. Pressure transferring device comprising

- a stamp (6),
- a sealed fluid chamber (2) which is bordered by a first membrane (4) at one side of the fluid chamber (2),
- a transferring element (8) which is fixed to the stamp (6) at one axial end of the stamp (6) cou-

pling the stamp (6) with the first membrane (4) of the fluid chamber (2), the transferring element (8) comprising a material which comprises a smaller Young's modulus of elasticity than the material of the first membrane (4).

2. Pressure transferring device in accordance with claim 1 with

- the transferring element (8) and the stamp (6) comprising an overlapping area (10),
- the transferring element (8) being coupled to the stamp (6) in a central area (12) of the overlapping area (10),
- the pressure transferring device comprising a gap (14) between the stamp (6) and the transferring element (8) outside of the central area (12).

3. Pressure transferring device in accordance with claim 2 with the transferring element (8) or the stamp (6) comprising a dowel pin (16) in the central area (12) and the stamp (6) or respectively the transferring element (8) comprising a corresponding mortise (18) for the dowel pin (16).

4. Pressure transferring device in accordance with claim 3 with the dowel pin (16) being fixed into the corresponding mortise (18) by a press fit.

5. Pressure transferring device in accordance with one of the preceding claims with

- the stamp (6) comprising a first axial section and a second axial section separated by a step (41),
- the first axial section having a bigger diameter than the second axial section and comprising the axial end of the stamp (6) facing to the transferring element (8).

6. Pressure transferring device in accordance with one of the preceding claims with the transferring element (8) comprising a synthetic material and the first membrane (4) comprising a metal.

7. Pressure transferring device in accordance with claim 6 with the transferring element (8) comprising Teflon and/or Nylon.

8. Pressure transferring device in accordance with one of the claims 6 or 7 with the first membrane (4) comprising steel and/or aluminum.

9. Compensation device (30) comprising the pressure transferring device in accordance with one of the preceding claims and further comprising

- a first volume (42) of the fluid chamber (2) and a second volume (44) of the fluid chamber (2), the first volume (42) being hydraulically coupled with the second volume (42) at least in a given state of the compensation device (30), 5
- a piston (48) which is arranged in the fluid chamber (2) movable in axial direction, the piston (48) bordering at least one of the volumes (42,44) in axial direction. 10

10. Injector (20) comprising the compensation device (30) in accordance with claim 9 and further comprising

- an injector body (22) with an injector body recess (24) in which the compensation device (30) is arranged, 15
- an actor (28) which is coupled to the piston (48) of the compensation device (30) at a first axial end of the actor (28), 20
- a needle body (26) which is coupled to the actor (28) at a second axial end of the actor (28) facing away from the piston (48) and which prevents a fluid flow through an injection nozzle (27) of the injector body (22) in a closing position of the needle body (26) and otherwise enabling the fluid flow. 25

11. Injector (20) comprising the compensation device (30) in accordance with claim 9 and further comprising 30

- an injector body (22) with an injector body recess (24) in which an actor (28) is arranged, 35
- a needle body (26) which is coupled to the actor (28) via the compensation device (30) and which prevents a fluid flow through an injection nozzle (27) of the injector body (22) in a closing position of the needle body (26) and otherwise enables the fluid flow. 40

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FIG 1

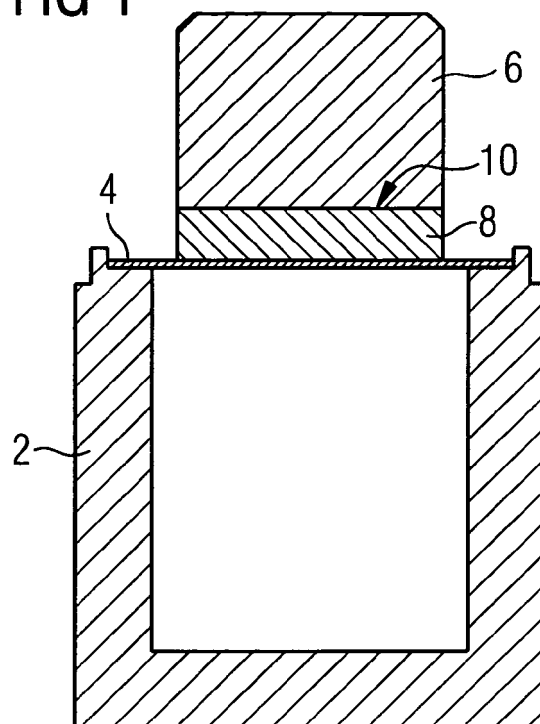


FIG 2

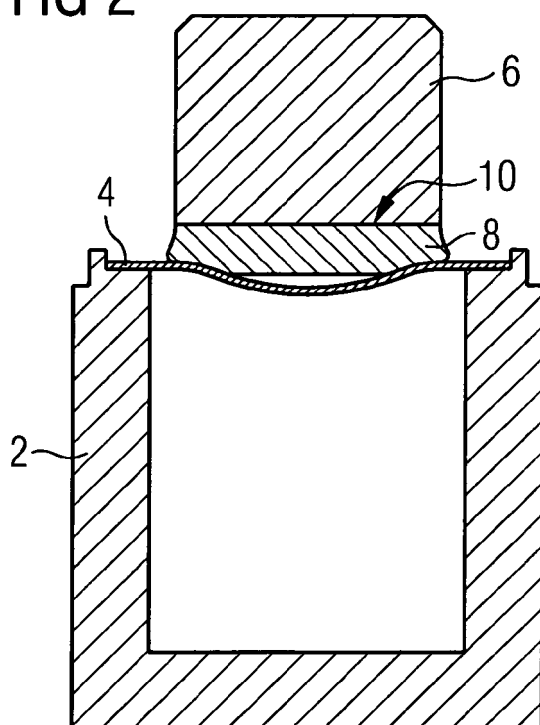


FIG 3

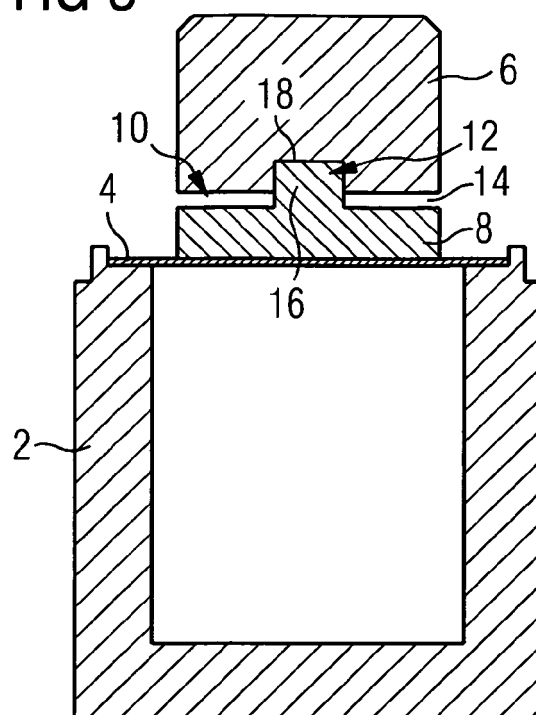


FIG 4

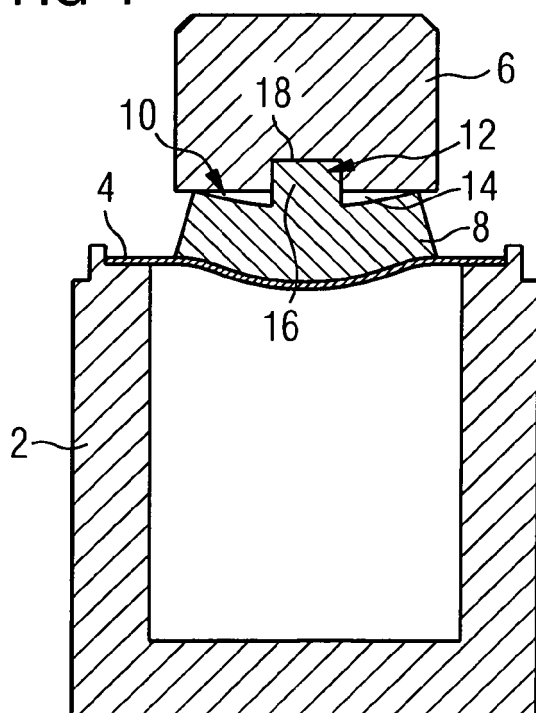


FIG 5

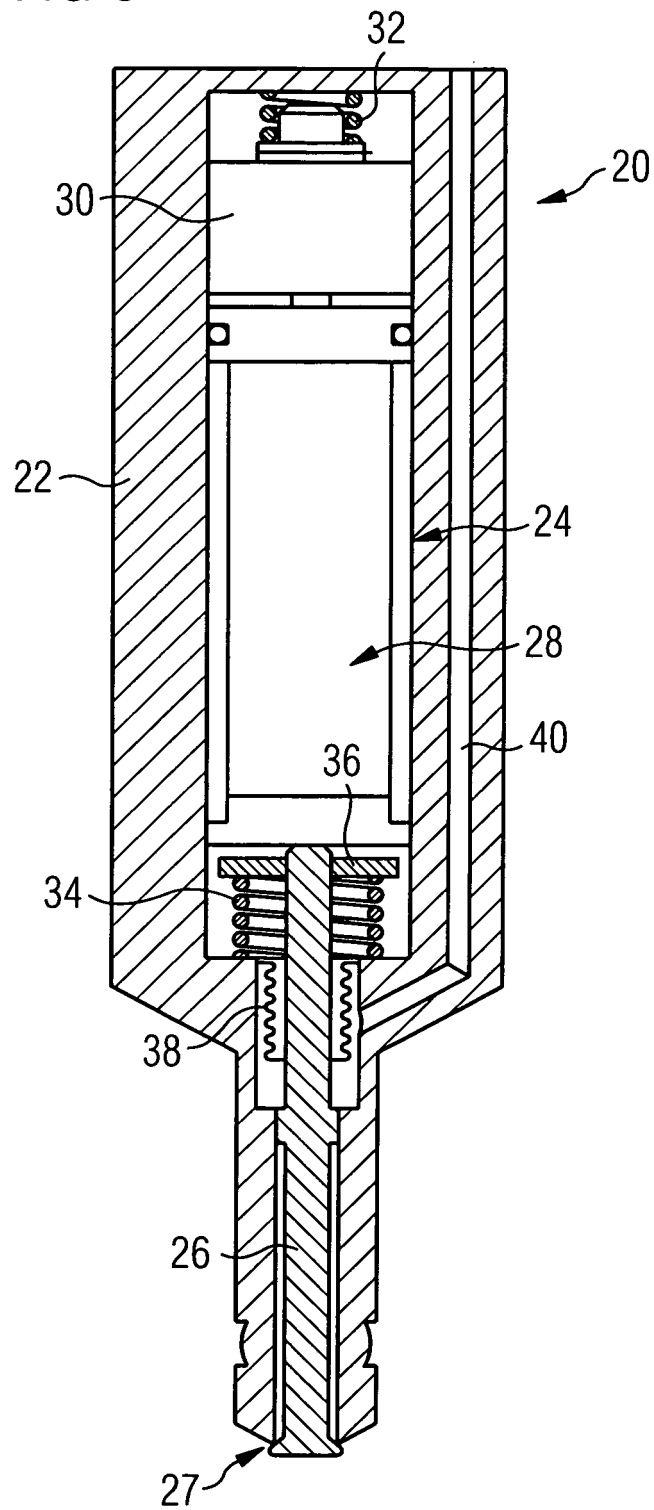
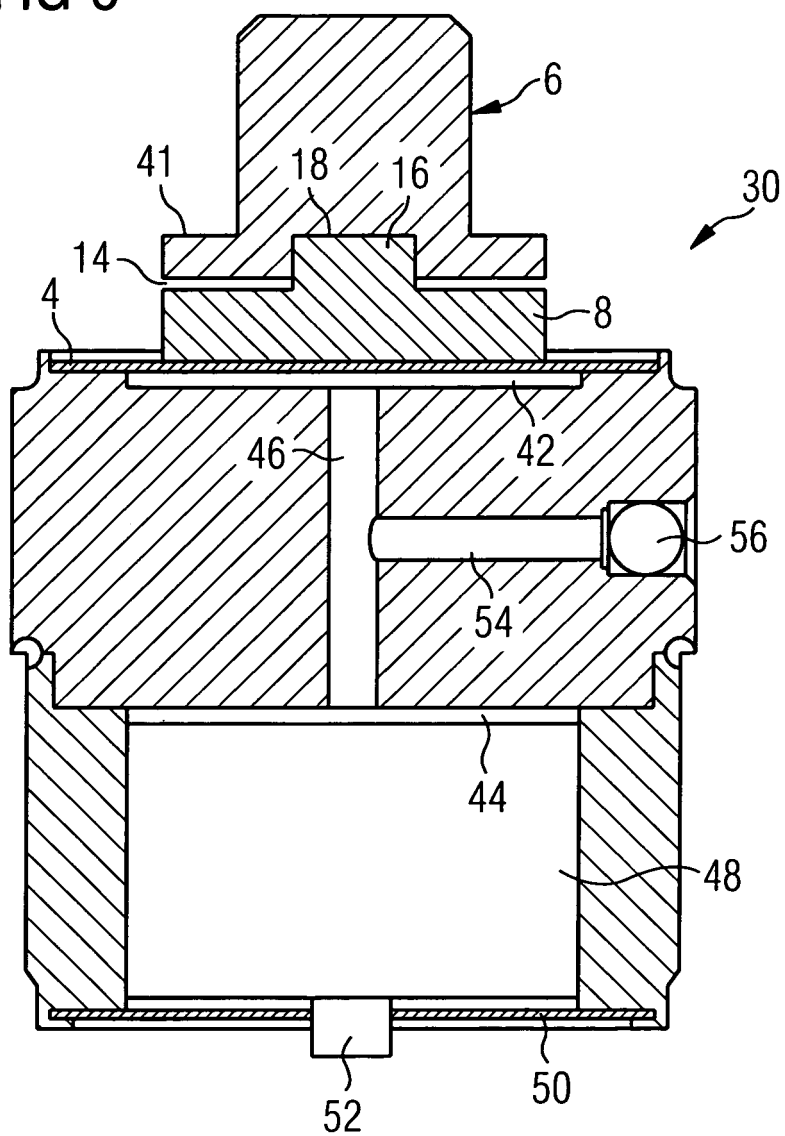


FIG 6





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EUROPEAN SEARCH REPORT

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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