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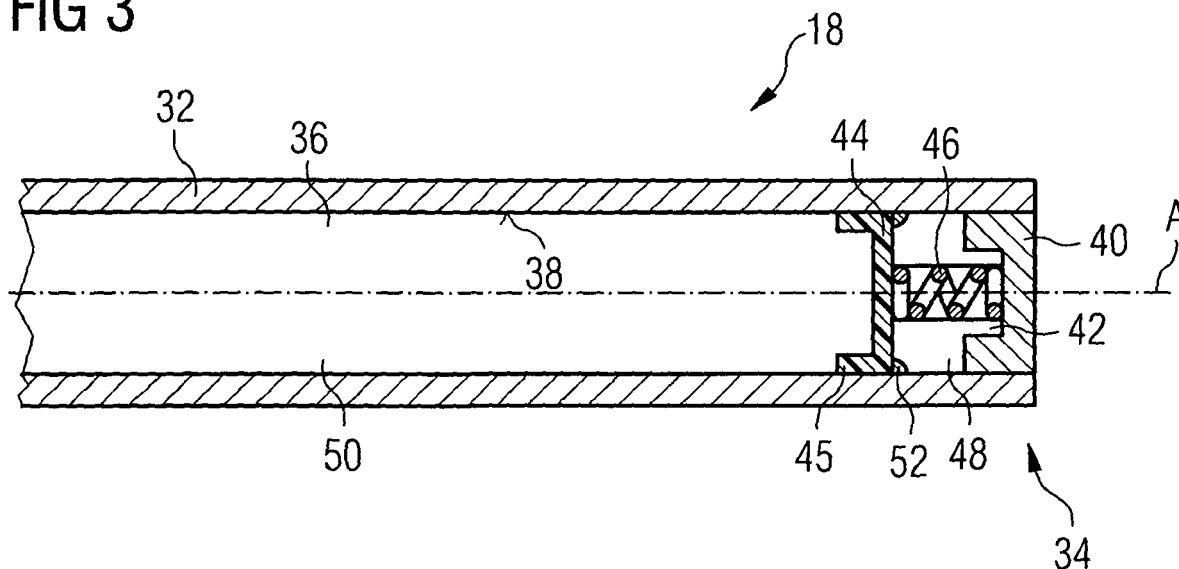
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(54) **Fuel rail of a combustion engine**

(57) Fuel rail (18) of a combustion engine (22) comprising a main tube (32) with a longitudinal central axis (A) and a cavity (36) forming an inner surface (38), the main tube (32) being designed to contain fuel, a membrane (44) being arranged in the cavity (36) and being fixedly coupled to the inner surface (38) of the main tube

(32) in a manner to sealingly separate a damping chamber (48) of the cavity (36) from a fuel chamber (50) of the cavity (36). The membrane (44) is designed to oscillate in axial direction. The membrane (44) and the damping chamber (48) are designed to compensate pressure variations of the fuel in the fuel chamber (50) of the main tube (32).

FIG 3



Description

[0001] The invention relates to a fuel rail of an internal combustion engine.

[0002] Internal combustion engines with fuel injector assemblies are in widespread use. The fuel injector assembly can be designed to supply fuel to the internal combustion engine.

[0003] In order to keep pressure fluctuations during the operation of the internal combustion engine at a very low level, internal combustion engines are supplied with a fuel accumulator to which fuel injectors are connected and which has a relatively large volume. Such a fuel accumulator is often referred to as a fuel rail. The fuel injector assembly includes the fuel rail and the fuel injector. Known fuel rails comprise a hollow body with recesses, wherein the fuel injectors are arranged.

[0004] The object of the invention is to create a fuel rail which is simply to be manufactured and that enables a precise dosing of fuel.

[0005] The objects are achieved by the features of the independent claim. Advantageous embodiments of the invention are given in the sub-claims.

[0006] The invention is distinguished by a fuel rail of a combustion engine comprising a main tube with a longitudinal central axis and a cavity forming an inner surface, the main tube being designed to contain fuel. Furthermore, the fuel rail comprises a membrane which is arranged in the cavity and is fixedly coupled to the inner surface of the main tube in a manner to sealingly separate a damping chamber of the cavity from a fuel chamber of the cavity. The membrane is designed to oscillate in axial direction. The membrane and the damping chamber are designed to compensate pressure variations of the fuel in the cavity of the main tube.

[0007] This has the advantage that pressure changes of the fuel in the cavity of the main tube can be balanced and unwanted oscillations of the mass flow rate in injectors coupled to the fuel rail can be avoided. The damping chamber can be filled with a compressible medium and can contribute to compensate pressure changes in the fuel chamber of the main tube.

[0008] In an advantageous embodiment of the invention a spring element is arranged in the damping chamber, is mechanically coupled to the main tube and is biasing the membrane. The spring element can support the membrane to maintain a defined position of the membrane.

[0009] In a further advantageous embodiment an end cap is fixedly coupled to an axial end of the main tube and is designed to sealingly close the damping chamber. This is a simple manner to obtain a sealingly closed damping chamber.

[0010] In a further advantageous embodiment the end cap comprises a recess facing the membrane and is designed to take up the spring element. This has the advantage that a secure mechanical coupling between the spring element and the end cap is possible.

[0011] In a further advantageous embodiment the membrane is of a material comprising stainless steel. This has the advantage that a chemical resistance of the membrane against aggressive substances is possible.

[0012] In a further advantageous embodiment the membrane is braced and/or welded to the main tube. This is a robust mean to make a rigid and sealing coupling of the membrane to the tube possible.

[0013] In a further advantageous embodiment the spring element is a coil spring. By this a low cost solution for the fuel rail is possible.

[0014] In a further advantageous embodiment the main tube has an inlet portion being arranged at a first axial end and the membrane and the damping chamber are arranged at a second axial end opposing the first axial end of the main tube. This makes it possible to balance pressure changes of the fuel in the cavity of the main tube in the case of a unilateral fuel supply to the fuel rail.

[0015] In a further advantageous embodiment the main tube has an inlet portion being arranged between a first axial end of the main tube and a second axial end opposing the first axial end of the main tube. A first membrane and a first damping chamber are arranged at the first axial end of the main tube. A second membrane and a second damping chamber are arranged at the second axial end of the main tube. This makes it possible to balance pressure changes of the fuel in the fuel chamber of the main tube in the case of a central fuel supply to the fuel rail.

[0016] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings. These are as follows:

Figure 1 an internal combustion engine with a fuel rail in a schematic view,

Figure 2 a first embodiment of the fuel rail in a perspective view.

Figure 3 a longitudinal section through a further embodiment of the fuel rail, and

Figure 4 a longitudinal section through a further embodiment of the fuel rail.

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

[0018] Figure 1 shows a fuel feed device 10 which is assigned to an internal combustion engine 22 of a vehicle. It includes a fuel tank 12 that is connected via a fuel line to a low-pressure pump 14. The output of the low-pressure pump 14 is connected to a fuel inlet 16 of a fuel rail 18. Fuel injectors 20 are connected to the fuel rail 18. The fuel is fed to the fuel injectors 20 via the fuel rail 18. The fuel injectors 20 have a sealed connection to the fuel rail 18.

[0019] Figure 2 shows a first embodiment of the fuel rail 18.

[0020] The fuel rail 18 comprises brackets 24 by which the fuel rail 18 can be fixed to the vehicle. Furthermore, the fuel rail 18 has fuel injector cups 26 which interact with the fuel injectors 20 to sealingly engage the fuel injectors 20 into the fuel injector cups 26. Preferably, the fuel injector cups 26 are made of stainless steel.

[0021] The fuel rail 18 comprises an inlet portion 30 which is arranged at a first axial end 34a of a main tube 32 of the fuel rail 18.

[0022] Figure 3 shows a detailed longitudinal section through the fuel rail 18 with an axial end 34. The main tube 32 of the fuel rail 18 has a cavity 36 which forms an inner surface 38 of the main tube 32. The cross section of the main tube 32 can be of any shape, in particular of a circular or square shape. The main tube 32 has a longitudinal central axis A and is designed to contain fuel.

[0023] The fuel rail 18 has an end cap 40 which is fixed and coupled to the axial end 34 of the main tube 32. Preferably, the end cap 40 is coupled to the main tube 32 by welding or brazing. This makes it possible to sealingly close the cavity 36 of the main tube 32 in a secure manner. The end cap 40 comprises a recess 42, the function of the recess 42 will be explained in the following.

[0024] The fuel rail 18 further comprises a membrane 44 which is arranged in the cavity 36 of the main tube 32 and is sealingly coupled to the inner surface 38 of the main tube 32. Preferably, the membrane 44 has a collar 45 which facilitates the fixed coupling of the membrane 44 to the inner surface 38 of the main tube 32. The membrane 44 separates a damping chamber 48 of the cavity 36 from a fuel chamber 50 of the cavity 36. The fuel chamber 50 of the cavity 36 contains fuel.

[0025] Preferably, the membrane 44 is made of a thin sheet of a material comprising a metal, preferably of a material comprising stainless steel. By this, the membrane 44 can be chemically resistant against aggressive substances such as fuel. Furthermore, the membrane 44 can be robust against mechanical forces. Preferably, the membrane 44 is braced or welded to the main tube 42, for example by a welding seam 52.

[0026] As the membrane 44 is built up of a thin sheet comprising a metal it is enabled to oscillate in the direction of the longitudinal central axis A. As the membrane 44 is coupled to the inner surface 38 of the main tube 42 for sealingly closing the fuel chamber 50 of the main tube 32, the damping chamber 48 between the membrane 44 and the end cap 40 can be filled with air or another appropriate compressible medium. By this, the damping chamber 48 can compensate pressure variations of the fuel in the fuel chamber 50 of the main tube 32.

[0027] The damping chamber 48 between the membrane 44 and the end cap 40 comprises a spring element 46 which is mechanically coupled to the membrane 44 and to the end cap 40. The recess 42 takes up the spring element 46 to enable a fixed coupling between the spring element 46 and the end cap 40. Preferably, the spring

46 is a coil spring, as this allows a low cost solution for the fuel rail 18. As the membrane 44 can oscillate in axial direction, the membrane 44 and the damping chamber 48 allow to compensate pressure variations of the fuel in the fuel chamber 50 of the main tube 32. The compressible medium between the membrane 44 and the end cap 40 can act as a damping medium for the pressure oscillations in the fuel chamber 50 of the main tube 32. The spring element 46 can support the membrane 44 and take up the axial movement of the membrane 44.

[0028] Figure 4 shows a further embodiment of the fuel rail 18 in a longitudinal section. This embodiment differs from the embodiment of Figure 2 in that the inlet portion 30 is arranged between the first axial end 34a of the main tube 32 and a second axial end 34b. The second axial end 34b is opposite to the first axial end 34a of the main tube 32. Preferably, the inlet portion 30 is arranged approximately halfway between the first axial end 34a of the main tube 32 and the second axial end 34b of the main tube 32. The first axial end 34a of the main tube 32 is closed by a first end cap 40a and a membrane 44a is coupled to the inner surface 38 of the main tube 32. Furthermore, a first spring element 46a is arranged between the first end cap 40a and the first membrane 44a. The construction of the end cap 40a, the first membrane 44a and the spring element 46a is in the description concerning figure 3. Furthermore, the second axial end 34b is closed by a second end cap 40b and a second membrane 44b is arranged in the cavity 36 of the main tube 32. Between the membrane 34b and the end cap 40b a second spring element 46b is arranged.

[0029] In the following the function of the fuel rail 18 will be described in detail:

[0030] The fuel enters the fuel rail 18 at the inlet portion 30 in a fuel flow direction F and leaves the fuel rail 18 through the fuel injectors 20. This can cause pressure changes in the fuel chamber 50 of the main tube 32 depending on the opening and the closing of the fuel injectors 20. Due to the pressure oscillation in the fuel chamber 50 of the main tube 32, the membrane 44, 44a, 44b can move towards the spring element 46, 46a, 46b, by this compressing the spring element 46, 46a, 46b. In a further step the spring element 46, 46a, 46b forces the membrane 44, 44a, 44b in an opposite direction to its initial position as shown in Figures 3 and 4. The dampening effect on the pressure oscillations in the fuel chamber 50 of the main tube 32 is obtained by the deflection of the membrane 44, 44a, 44b which is preferably built up as a very thin foil, and the counterforce of the spring element 46, 46a, 46b.

[0031] The assembling of the fuel rail 18 is carried out by first inserting the membrane 44, 44a, 44b into the cavity 36 of the main tube 32 and to prefix the membrane 44, 44a, 44b to the inner surface 38 of the cavity 36. The prefixing can be carried out by point welding. Furthermore, the membrane 44, 44a, 44b is braced or welded to the inner surface 38 of the main tube 32.

[0032] In a further step, the spring element 46, 46a,

46b and the end cap 40, 40a, 40b are inserted and braced or welded to the main tube 32. The recess 42 in the end cap 40, 40a, 40b can simplify the assembly of the spring element 46, 46a, 46b in the damping chamber 50 of the main tube 32.

[0033] Although this invention is described for fuel rails 18 made of metal it can be applied to fuel rails 18 made of plastics as well.

Claims

1. Fuel rail (18) of a combustion engine (22) comprising

- a main tube (32) with a longitudinal central axis (A) and a cavity (36) forming an inner surface (38), the main tube (32) being designed to contain fuel,
- a membrane (44) being arranged in the cavity (36) and being fixedly coupled to the inner surface (38) of the main tube (32) in a manner to sealingly separate a damping chamber (48) of the cavity (36) from a fuel chamber (50) of the cavity (36), and the membrane (44) being designed to oscillate in axial direction, wherein

the membrane (44) and the damping chamber (48) are designed to compensate pressure variations of the fuel in the fuel chamber (50) of the main tube (32).

2. Fuel rail (18) according to claim 1, with a spring element (46) being arranged in the damping chamber (48), being mechanically coupled to the main tube (32) and biasing the membrane (44).

3. Fuel rail (18) according to claim 1, with an end cap (40) being fixedly coupled to an axial end (34, 34a, 34b) of the main tube (32) and being designed to sealingly close the damping chamber (48).

4. Fuel rail (18) according to claim 1 or 2, with the end cap (40) comprising a recess (42) facing the membrane (44) and being designed to take in the spring element (46).

5. Fuel rail (18) according to one of the preceeding claims, with the membrane (44) being of a material comprising stainless steel.

6. Fuel rail (18) according to one of the preceeding claims, with the membrane (44) being brazed and/or welded to the main tube (32).

7. Fuel rail (18) according to one of the preceeding claims, the spring element (46) being a coil spring.

8. Fuel rail (18) according to one of the preceeding claims, with the main tube (32) having an inlet portion

(30) being arranged at a first axial end (34a) and the membrane (44) and the damping chamber (48) being arranged at a second axial end (34b) opposing the first axial end (34a) of the main tube (32).

9. Fuel rail (18) according to one of the claims 1 to 7, with the main tube (32) having an inlet portion (30) being arranged between a first axial end (34a) of the main tube (32) and a second axial end (34b) opposing the first axial end (34a) of the main tube (32), and a first membrane (44a) and a first damping chamber (48a) being arranged at the first axial end (34a) of the main tube (32), and a second membrane (44b) and a second damping chamber (48b) being arranged at the second axial end (34b) of the main tube (32).

FIG 1

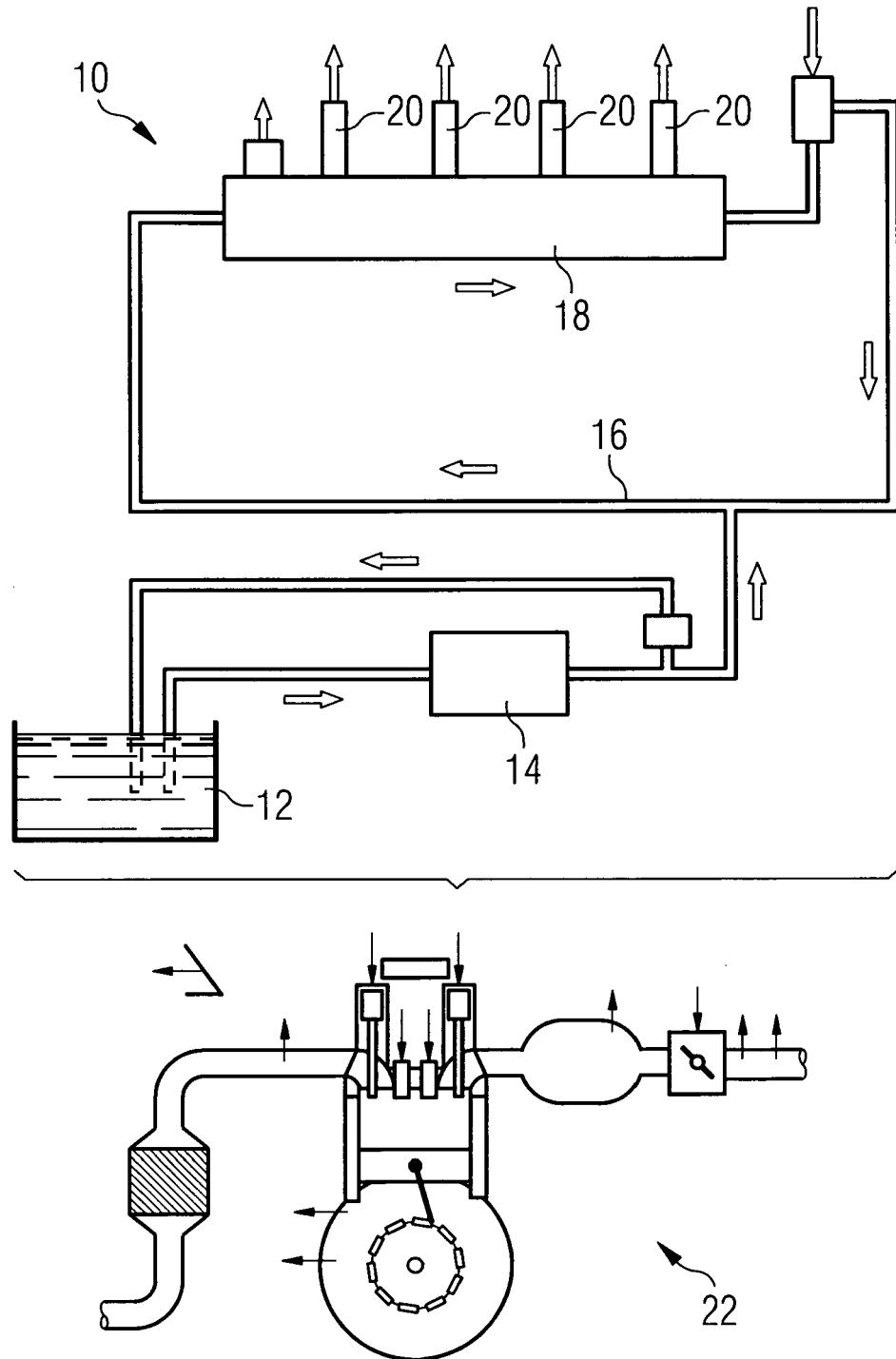


FIG 2

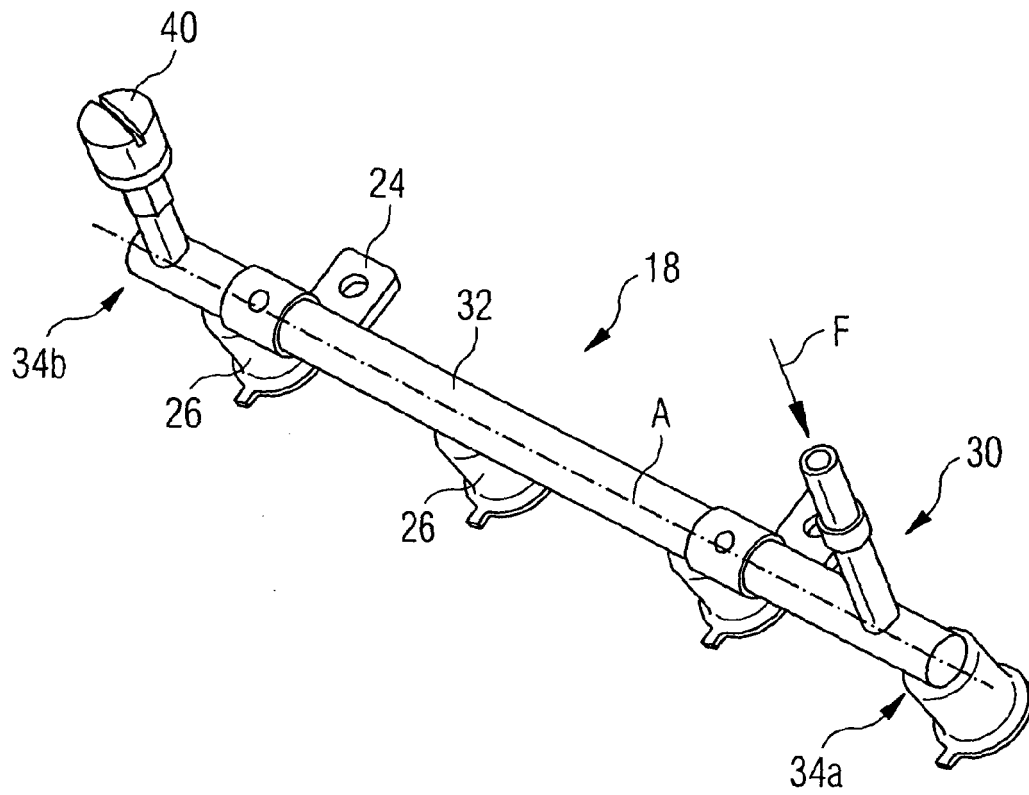


FIG 3

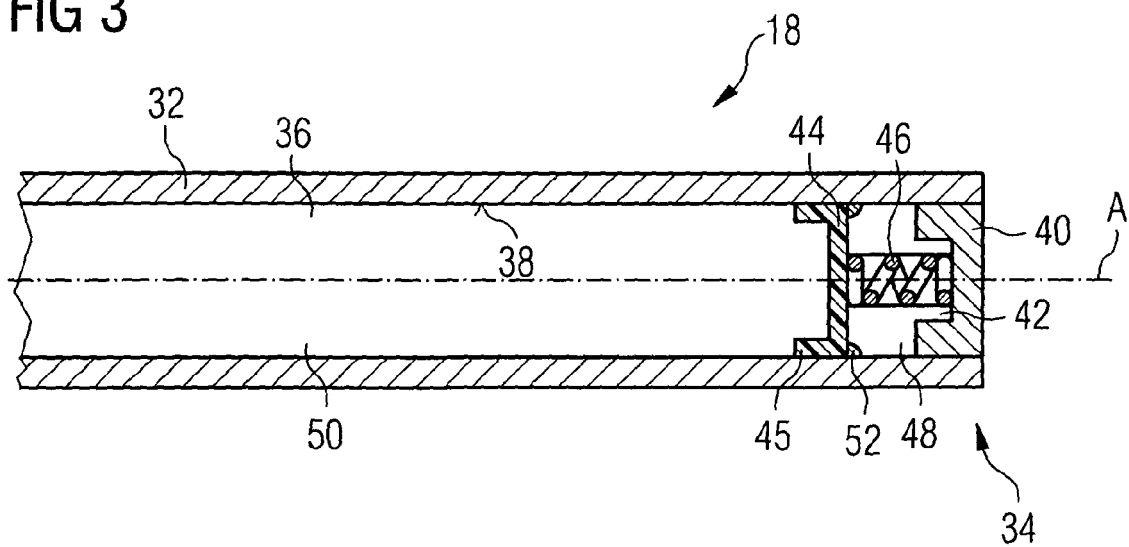
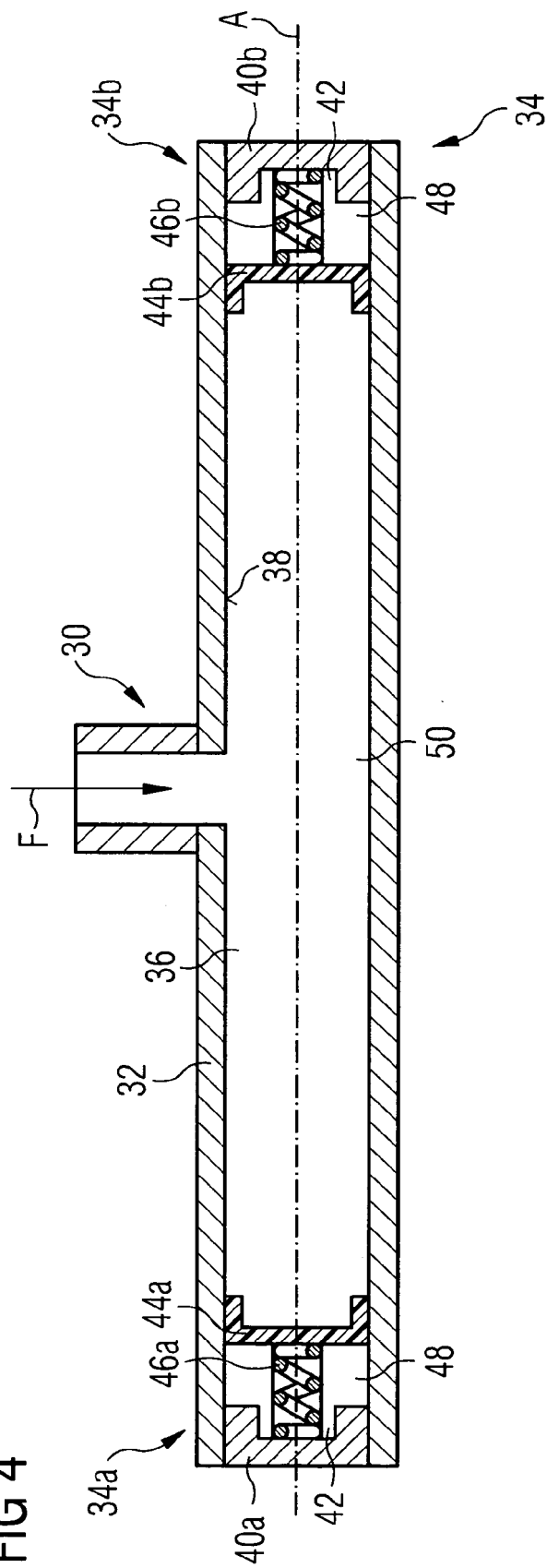


FIG 4





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 08 00 0958

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Place of search		Date of completion of the search	Examiner
Munich		27 June 2008	Etschmann, Georg
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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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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