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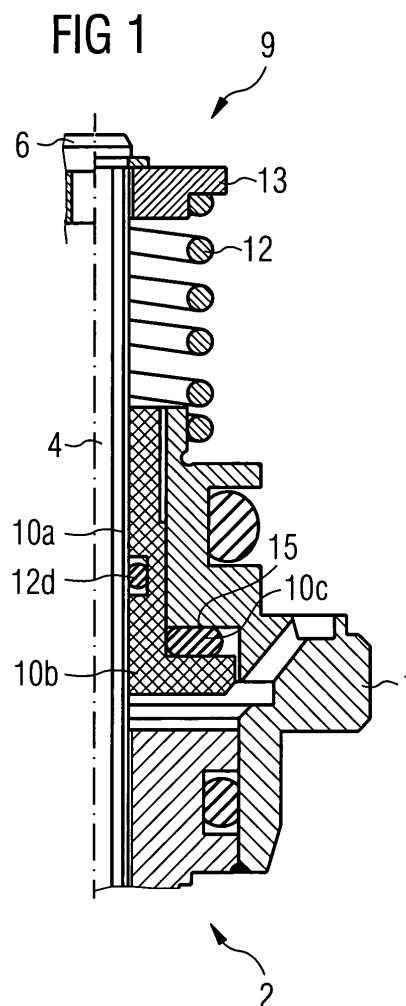
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(54) **Metering device with dynamic sealing**

(57) A metering device for dosing pressurized fluids, in particular an injection valve for a fuel injection system in an internal combustion engine, is disclosed in which the hermetic sealing between the fluid chamber (2) for the pressurized fluid to be dosed and the actuator chamber (9) is provided by an elastic element (10c). The elastic element (10c) is arranged in a compressed manner between a sealing seat (15) of the valve body (1) and a flange section (10b) of a metallic sleeve that additionally comprises a hollow cylinder section (10a) in hermetic rigid contact with the valve needle (4).



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## Description

**[0001]** The present invention relates to a metering device for dosing pressurized fluids, in particular an injection valve for a fuel injection system in an internal combustion engine, comprising a valve body with a fluid chamber for the pressurized fluid to be dosed, the fluid chamber terminating with a metering opening, an axially moveable valve needle passing through the fluid chamber, the valve needle having a first end that controls the opening and closing of the metering opening, and a second end that cooperates with an actuator assembly arranged in an actuator chamber and controlling the axial movement of the valve needle to be in a first end position in which the metering opening is closed and in a second end position in which the metering opening is open, and a sealing element hydraulically isolating the actuator chamber and the fluid chamber.

**[0002]** Such a metering device is disclosed for example in the European Patent application EP 1 046 809 A2.

**[0003]** In the manufacture of piezoelectric actuator-controlled valves for high-pressure direct injection for gasoline engines, it is essential to provide a hydraulic sealing capable of isolating the space through which the pressurized gasoline travels, i.e. a fluid chamber, from that where the actuator is arranged, i.e. an actuator chamber.

**[0004]** Fundamental requirements for this sealing element are

- the ability to operate at high pressures of the fluid, exceeding 200 bar, and at its related peaks of pressure and hydraulic ram induced by the opening and closing of the injector needle,
- the guarantee of effectiveness during the whole expected lifetime of the injector, including resistance to breakage, creep, fatigue loading, and the like,
- satisfactory service life of the component in its operating environment, including chemical tolerance to gasoline, resistance to terminal stresses, and the like,
- a minimum number of mechanical parts and a total reliability of the element, and
- minimal material, manufacturing and assembly times and costs.

**[0005]** In the metering devices described in EP 1 046 809 A2, one of which is exemplary shown in Fig. 2, the valve body 1 comprises an actuator chamber 9 and a fluid chamber 2 terminating with a metering opening 3, between which chambers the sealing element 10l - 10n is arranged. The axially moveable valve needle 4 passes through the fluid chamber 2. The valve needle 4 has a first end 5 that controls the opening and closing of the

metering opening 3, and a second end 6 that cooperates with the actuator assembly 7, 8 arranged in the actuator chamber 9 and controlling the axial movement of the valve needle 4. The actuator assembly comprises a piezo stack 7 and a bottom cap 8. The bottom cap 8 of the actuator assembly is in Hertzian contact with the second end 6 of the valve needle 4, since the second end 6 of the valve needle 4 is biased against the bottom cap 8 by a helical spring 12, which is axially compressed arranged between a spring seat 14 of the valve body 1 and an abutting washer 13 fastened to the valve needle 4.

**[0006]** The sealing element 10l - 10n is formed by a metal bellows 101, an element able to be axially deformed and to guarantee the required separation between the two described volumes, e.g. gasoline in the fluid chamber 2 and the piezo stack 7 as part of the actuator assembly outside, i.e. in the actuator chamber 9. The top collar of the metal bellows 101 is attached to a washer 10m that is attached on the valve needle 4 and the bottom collar of the metal bellows 101 is attached to a ring element 10n attached to the inner cylindrical surface 11 of the valve body 1. The metal bellows 101 offers a high mechanical elasticity in the direction of movement of the valve needle 4, a sufficient resistance to fuel pressures of up to 500 bar, and a high reliability with respect to leakage throughout the required temperature range of -40 °C to +150 °C. However, an injector with such a metal bellows with these dimensions has disadvantages of high component and manufacturing costs, as well as a complex assembly, requiring two hermetic welds to attach the metal bellows to the washer 10m and to the ring element 10n, as well as two hermetic welds to attach the washer 10m to the valve needle 4 and the ring element 10n to the inner cylindrical surface 11 of the valve body 1.

**[0007]** In view of the foregoing, it is the object underlying the present invention to provide a metering device of the above-mentioned type which is easier and more economic to manufacture, while still fulfilling the requirements specified above.

**[0008]** This object is achieved by a metering device with the features of appended claim 1.

**[0009]** Advantageous embodiments of the metering device according to the present invention are disclosed in the respective following dependent claims.

**[0010]** According to the invention, in a metering device with the features of the preamble of claim 1, the sealing element is formed by a sleeve that comprises a hollow cylinder section in hermetic rigid contact with the valve needle and a flange section hermetically connected to the hollow cylinder section, and a first elastic ring that is arranged axially compressed between a sealing seat of the valve body and the flange section to hermetically seal the actuator chamber and the fluid chamber in the first end position of the valve needle, in the second end position of the valve needle and in all positions of the valve needle between these end positions. Thus, a

different sealing from the metal bellows sealing according to prior art is employed, thereby providing additional liberty in the design of the device so that different requirements may be individually fulfilled.

**[0011]** In the metering device according to the present invention, preferably the hollow cylinder section of the sleeve is hermetically sealed to the valve needle by a second elastic ring. Thereby, a secure sealing is provided.

**[0012]** In the metering device according to the present invention, alternatively or additionally preferably the first and/or second elastic rings are made of a resilient material, such as rubber. Thus, the material itself provides the elastic properties to the sealing according to the present invention.

**[0013]** The first and/or second elastic rings preferably have a circular cross section in an uncompressed state. Elastic rings with circular cross sections are available in different sizes and shapes so that employing such elastic rings with circular cross sections is particularly cost effective.

**[0014]** The sleeve is preferably made of metal. Thereby, the required rigidity of the sealing is provided.

**[0015]** In the metering device according to the present invention, further alternatively or additionally preferably the sleeve is welded to the valve needle, preferably hermetically.

**[0016]** The invention, both its construction and its method of operation together with additional objects and advantages thereof, will be best understood from the following description of a specific exemplary embodiment thereof taken in conjunction with the accompanying drawings, wherein

Fig. 1 is a schematic axial cross section of a part of an injection valve according to the present invention; and

Fig. 2 is a schematic axial cross section of an injection valve according to the prior art.

**[0017]** In the following description of an exemplary embodiment according to the present invention the same reference signs as those shown in Fig. 2 denote the same or equal parts that have basically the same functionality. These parts might have a slightly different arrangement in respect to each other than that shown in Fig. 2, but nevertheless have the same functionality as is apparent to the skilled person. Therefore, a detailed description of those parts is omitted here and only the differences of the metering device according to the present invention are described in detail.

**[0018]** According to the present invention, as shown in Fig. 1, the hermetic sealing between the fluid chamber 2 and the actuator chamber 9 is performed by a metallic sleeve and an elastic element. The metallic sleeve comprises a hollow cylinder section 10a in hermetic rigid contact with the valve needle 4 and a flange section 10b

hermetically connected to the hollow cylinder section 10a. The elastic element is a first elastic ring 10c that is axially so compressed arranged between a sealing seat 15 of the valve body 1 and the flange section 10b that a sealing is provided in all positions of the valve needle 4. Such an embodiment easily resists against peaks of pressure until 20% of the nominal value of the fluid pressure of 200 bar. The hollow cylinder section 10a of the sleeve is hermetically sealed to the valve needle 4 by a second elastic ring 10d. Alternatively, the hollow cylinder section might be rigidly and hermetically welded to the valve needle 4.

**[0019]** A metering device for dosing pressurized fluids, in particular an injection valve for a fuel injection system in an internal combustion engine, is disclosed in which the hermetic sealing between the fluid chamber for the pressurized fluid to be dosed and the actuator chamber is provided by an elastic element. The elastic element is arranged in a compressed manner between a sealing seat of the valve body and a flange section of a metallic sleeve that additionally comprises a hollow cylinder section in hermetic rigid contact with the valve needle.

**[0020]** The features disclosed in the foregoing description, in the drawings, and in the claims may alone as well as in any possible combination be important for the realisation of the invention.

## Claims

1. A metering device for dosing pressurized fluids, in particular an injection valve for a fuel injection system in an internal combustion engine, comprising
  - a valve body (1, 14) comprising a fluid chamber (2) for the pressurized fluid to be dosed, the fluid chamber (2) terminating with a metering opening (3),
  - an axially moveable valve needle (4) passing through the fluid chamber (2), the valve needle (4) having a first end (5) that controls the opening and closing of the metering opening (3), and a second end (6) that cooperates with an actuator assembly (7, 8) arranged in an actuator chamber (9) and controlling the axial movement of the valve needle (4) to be in a first end position in which the metering opening (3) is closed and in a second end position in which the metering opening (3) is open, and
  - a sealing element (10a - 10d) hydraulically isolating the actuator chamber (9) and the fluid chamber (2),

## characterized in that

the sealing element (10a - 10d) is formed by

- a sleeve (10a, 10b) that comprises a hollow cylinder section (10a) in hermetic rigid contact with the valve needle (4) and a flange section (10b) hermetically connected to the hollow cylinder section (10a), and 5
- a first elastic ring (10c) that is arranged axially compressed between a sealing seat (15) of the valve body (1) and the flange section (10b) to hermetically seal the actuator chamber (9) and the fluid chamber (2) in the first end position of the valve needle (4), in the second end position of the valve needle (4) and in all positions of the valve needle (4) between these end positions. 10 15

2. The metering device according to claim 1, **characterized in that** the hollow cylinder section (10a) of the sleeve (10a, 10b) is hermetically sealed to the valve needle by a second elastic ring (10d). 20
3. The metering device according to claim 1 or 2, **characterized in that** the first and/or second elastic rings (10c, 10d) are made of a resilient material, such as rubber. 25
4. The metering device according to anyone of claims 1 to 3, **characterized in that** the first and/or second elastic rings (10c, 10d) have a circular cross section in an uncompressed state. 30
5. The metering device according to anyone of claims 1 to 4, **characterized in that** the sleeve (10a, 10b) is made of metal. 35
6. The metering device according to anyone of claims 1 to 5, **characterized in that** the sleeve (10a, 10b) is welded to the valve needle (4). 40

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FIG 1

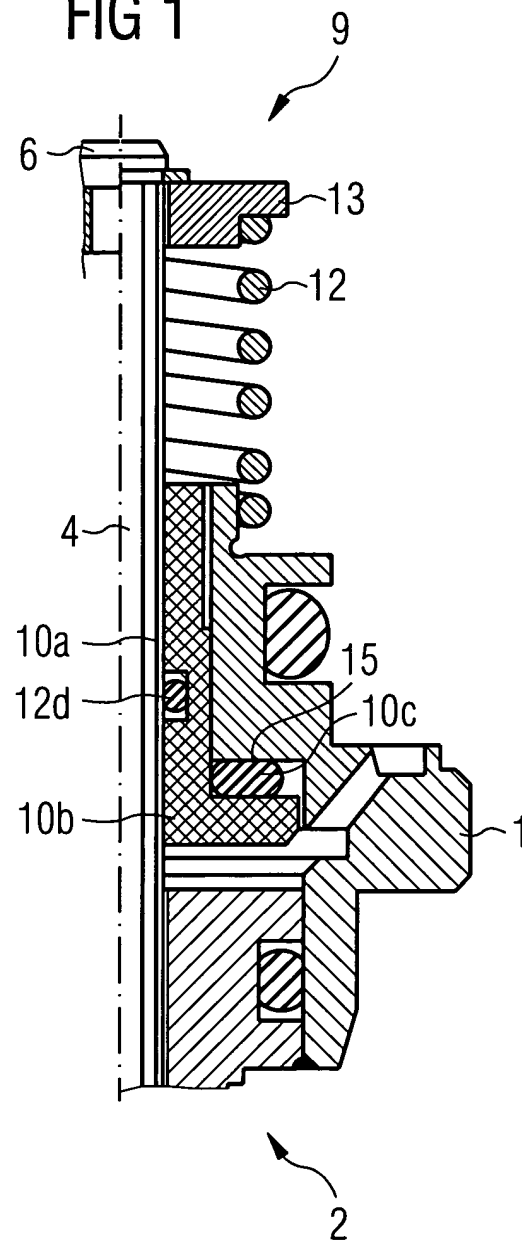
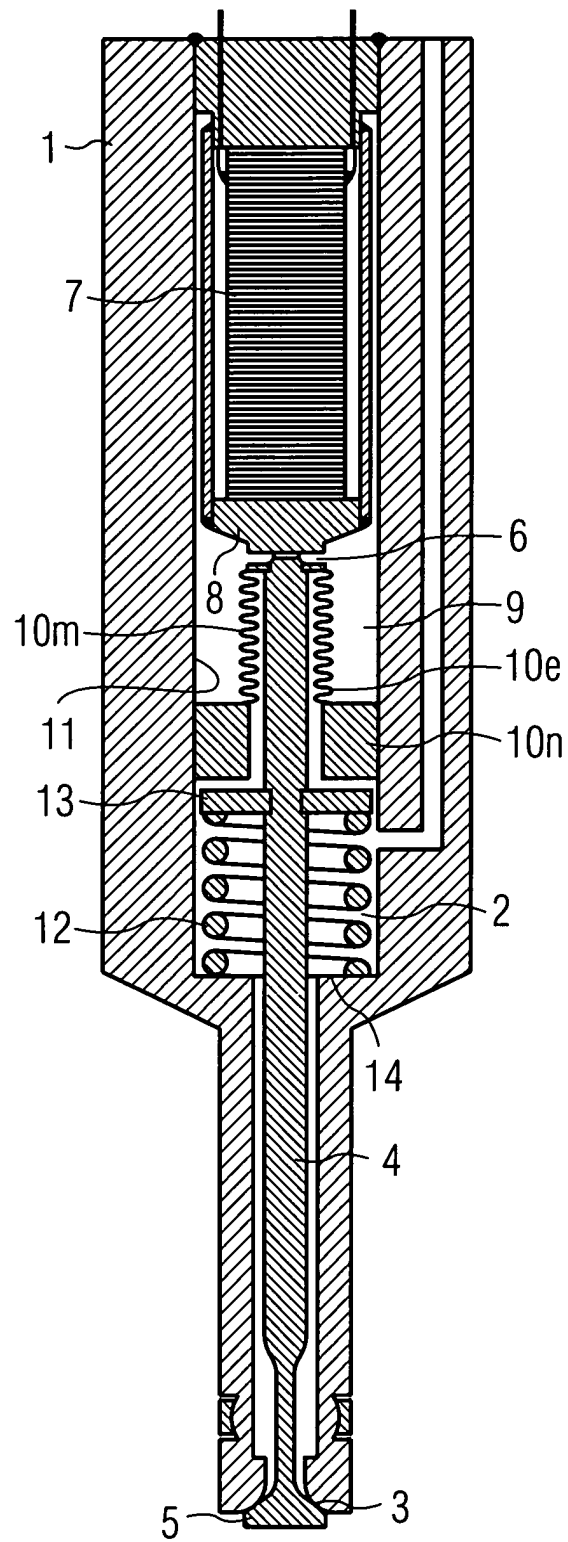


FIG 2





European Patent  
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# EUROPEAN SEARCH REPORT

Application Number  
EP 03 00 2402

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 3 703 184 A (MESSERSCHMIDT FRIEDRICH) 21 November 1972 (1972-11-21) * column 1, line 53 - column 2, line 31; figures 1,2 *	1,3-5	F02M61/16 F02M61/08 F02M61/12 F16J15/56 F02M51/06
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A	DE 199 56 830 A (SIEMENS AG) 21 June 2001 (2001-06-21) * column 5, line 41 - line 55 * * column 7, line 20 - line 39; figures 2,4,6 *	1,5,6	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>11 July 2003</b>	Examiner <b>Schmitter, T</b>
CATEGORY OF CITED DOCUMENTS		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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EP 03 00 2402

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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