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

(11) EP 1 391 608 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.02.2004 Bulletin 2004/09

(51) Int Cl.[7]: **F02M 51/06**, F02M 61/16

(21) Application number: **02018666.4**

(22) Date of filing: **20.08.2002**

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

(71) Applicant: **Siemens VDO Automotive S.p.A.
56040 Fauglia (Pisa) (IT)**

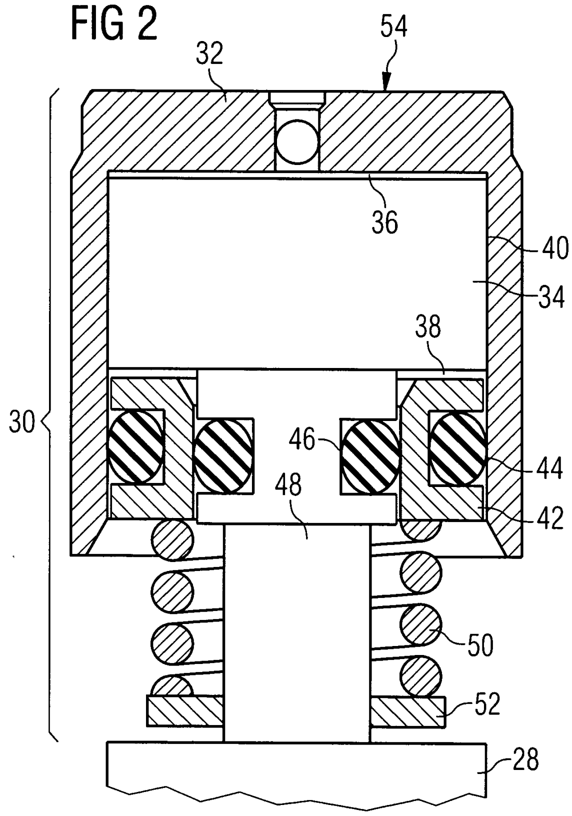
(72) Inventors:
- **Biagetti, Fabrizio
57128 Livorno (IT)**
- **Pulejo, Marco
56010 Pisa (IT)**
- **Siringo, Marco
19124 La Spezia (IT)**

(74) Representative: **Berg, Peter, Dipl.-Ing. et al
European Patent Attorney,
Siemens AG,
Postfach 22 16 34
80506 München (DE)**

(54) Metering device with thermal compensator unit

(57) The invention relates to a metering device comprising
a housing (12) having a metering opening (22), controllable by the movement of an axially moveable valve needle, an axially extendable piezoelectric actuator (28) cooperating with the valve needle to control its axial movement, and a thermal compensator unit (30) to compensate for different thermal expansion of the housing (12) and the piezoelectric actuator (28). According to the invention the thermal compensator unit (30) comprises a compensator housing (32) and a hydraulic piston (34), disposed axially slidable within the compensator housing (32), the compensator housing (32) and the piston (34) forming a first fluid chamber (36), a second fluid chamber (38) and a throttling passage (40) connecting the first (36) and second fluid chamber (38), and means for transmitting an axial extension of the piezoelectric actuator (28) to the compensator housing (32) or to the piston (34) to urge a hydraulic fluid from the first fluid chamber (36) to the second fluid chamber (38) in an activation phase of the piezoelectric actuator (28).

FIG 2



EP 1 391 608 A1

Description

[0001] The present invention relates to a metering device for dosing pressurized fluids, particularly an injection valve for a fuel injection system in an internal combustion engine. The metering device is of the type which comprises a housing having a metering opening, controllable by the movement of an axially moveable valve needle, the housing comprising a material having a first thermal coefficient of expansion, an axially extendable piezoelectric actuator cooperating with the valve needle to control its axial movement, the piezoelectric actuator comprising a material having a second thermal coefficient of expansion, and a thermal compensator unit cooperating with the piezoelectric actuator and the housing to compensate for different thermal expansion of the housing and the piezoelectric actuator to ensure elastic contact between an end stop of the housing, the piezoelectric actuator and the valve needle.

[0002] For such an injector valve, it is essential that the requirements of fuel flow rate and the geometry of the jet are met under all possible operating conditions of the injector.

[0003] Of particular importance is the influence of the temperature on the magnitude of the variations of the principal functional parameters of the injector. Within the required full range of the operating temperature from -40 °C to +150 °C, the flow rate and other parameters that characterize the operation of the injector must remain within predetermined limits of tolerance.

[0004] As a result of the thermal expansions experienced by the outer steel housing of the injector, the piezoelectric actuator, having a lower coefficient of thermal expansion than the outer housing, would not maintain Hertzian contact between its fixed end stop surface and the top end of the valve needle.

[0005] To deal with this problem, the injector valve is typically equipped with a hydraulic thermal compensation unit. As the operation temperature increases, the thermal compensation unit recovers the clearance that would otherwise be created between the valve needle and the piezoelectric actuator, thereby avoiding incorrect and potentially hazardous operation conditions. However, current designs have the disadvantages that an excessive number of pieces is required, that the manufacturing costs are high and that some of the parts, such as the bellows are critical.

[0006] In view of the foregoing, it is an object of the present invention to provide a metering device of the above mentioned type with an improved thermal compensation unit.

[0007] This object is achieved by a metering device with the features of appended claim 1. Advantageous embodiments of the invention are disclosed in the dependent claims.

[0008] According to the invention, the metering devices according to the preamble of claim 1 provides a thermal compensator unit comprising a compensator housing and a hydraulic piston, disposed axially slidable within the compensator housing, the compensator housing and the piston forming a first fluid chamber, a second fluid chamber and a throttling passage connecting the first and second fluid chamber, and means for transmitting an axial extension of the piezoelectric actuator to the compensator housing or to the piston to urge a hydraulic fluid from the first fluid chamber to the second fluid chamber in an activation phase of the piezoelectric actuator. The means for transmitting the axial extension of the piezoelectric actuator may, for example, be formed by a separate element disposed between the piezoelectric actuator and the compensator housing or the piston, or simply by a common contact surface of those elements.

[0009] Preferably, the thermal compensator unit further comprises restoring means to return the hydraulic piston to its initial position and to return the hydraulic fluid from the second fluid chamber (38) to the first fluid chamber (36) in a deactivation phase of the piezoelectric actuator (28).

[0010] In a preferred embodiment of the invention, a return passage for the hydraulic fluid between the second and first fluid chamber is provided inside the hydraulic piston for rapidly returning the hydraulic fluid in a deactivation phase of the piezoelectric actuator.

[0011] The return passage through the piston may, in an advantageous embodiment of the metering device, have an opening in the first fluid chamber, the opening being covered by a spot-welded metal strip which is pressed on the opening in the activation phase and which bends away form the opening in the deactivation phase due to the pressure exerted by the hydraulic fluid, to rapidly return the hydraulic fluid to the first fluid chamber.

[0012] In a further preferred embodiment of the invention, an upper surface of the compensator housing is connected to the end stop of the housing, and a lower surface of the hydraulic piston is connected to the piezoelectric actuator.

[0013] In this embodiment, the restoring means may advantageously comprise a helical spring acting on the hydraulic piston via an end stop plate connected to an end portion of the hydraulic piston, the helical spring being precompressed during the assembly process, the oil being pressurized and the piston applying a pre-load contact force to the piezoelectric actuator and the valve needle, at any operating condition. The helical spring is further compressed by an axial extension of the piezoelectric actuator.

[0014] Alternatively, the restoring means may comprise a Belleville washer, a compact type of spring in the shape of a washer pressed into a dished shape, arranged between the hydraulic piston and the upper surface of the compensator housing, the Belleville washer being compressed by an axial extension of the piezoelectric actuator.

[0015] In a further alternative, the hydraulic piston may have an upper part sliding within the compensator housing and a lower part sliding within a surrounding moveable ring member, and a bellows may be connected to the compensator housing and the moveable ring member. The first fluid chamber is then formed between the piston and the compensator housing and the second fluid chamber is formed between the piston and the bellows.

[0016] In any of the above mentioned alternatives the throttling passage may advantageously be formed by a small gap between the piston and the compensator housing.

[0017] In a further preferred embodiment of the invention, a lower surface of the compensator housing is connected to the piezoelectric actuator and a closing element is connected to the end stop of the housing.

[0018] A moveable ring member may advantageously be provided in a borehole of the piston, the ring member being connected to a helical spring acting on the ring member and on the closing element, the helical spring being compressed by an axial extension of the piezoelectric actuator.

[0019] For this design it is preferred that the first fluid chamber is formed between the piston and the compensator housing and that the second fluid chamber is formed between an inside surface of the borehole and the ring member.

[0020] It is further preferred that the throttling passage is formed by a straight passage through the lower portion of the piston, the passage being covered by a perforated strip.

[0021] The metering device according to the invention provides Hertzian contact between the fixed end stop surface of the outer injector housing and the top end of the valve needle under all operating conditions. The thermal compensator unit according to the invention further provides high stiffness to the compression produced during the activation of the piezoelectric actuator and allows at the same time a rapid recovery of the initial position during the deactivation phase of the piezoelectric actuator. Elastic contact between the components needle, actuator, and the end stop of the outer housing is thus maintained at all times.

[0022] The invention, both its construction an its method of operation together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, wherein

Figure 1 is a schematic axial cross section of an injector valve with a thermal compensator unit according to an embodiment of the invention;

Figure 2 is a schematic axial cross section of the thermal compensator unit of Fig. 1 in detail;

Figure 3 is a schematic axial cross section of a thermal compensator unit according to another embodiment of the invention;

Figure 4 is a schematic axial cross section of a thermal compensator unit according to a further embodiment of the invention;

Figure 5 is a schematic axial cross section of a thermal compensator unit according to still a further embodiment of the invention.

[0023] Figure 1 shows an injection valve 10 for direct-injection gasoline engines. The injection valve 10 has a double tube design in which the housing 12 comprises an outer tubular member 121 and an inner tubular member 123, forming an annular fluid supply passage 14 between them.

[0024] Gasoline under pressure is provided to an inlet fitting 16, from where it is flows through the annular supply passage 14 and enters into an axial outlet passage 20, projecting through the lower part of the housing 12. The outlet passage 20 terminates in a metering opening 22 surrounded by a valve seat which is opened or closed by the axial movement of a valve needle passing through the outlet passage 20.

[0025] Upon activation of a piezoelectric actuator 28, gasoline is injected into the engine cylinder. When an excitation voltage is applied to the piezoelectric actuator 28, its length in axial direction increases by a predetermined amount. The extension in length is transmitted to the valve needle which lifts from the valve seat and begins the injection of pressurized gasoline. When the excitation voltage is terminated, the length of the piezoelectric actuator 28 decreases to its normal value and the valve needle 24 is pushed back in its closing position.

[0026] Since the outer steel housing 12 has a higher thermal coefficient of expansion than the material of the piezoelectric actuator 28, changes in the operation temperature need to be compensated by a thermal compensator unit 30 to ensure safe operation of the injector.

[0027] Figure 2 shows a schematic axial cross section of the thermal compensator unit 30 of Fig. 1 in detail. The compensator housing 32 contains a hydraulic piston 34 which is able to slide axially inside it. The housing 32 rests via its upper surface 54 on the fixed end stop of the injector 10, while the lower end rod 48 of the piston 34 is in contact with the piezoelectric actuator 28. The piston 34 and the compensator housing form a first fluid chamber 36, a second fluid chamber 38 and a small annular throttling gap 40 connecting the two fluid chambers. In operation, the fluid chambers 36, 38 are filled with a hydraulic fluid, for example with silicone oil.

[0028] During the activation phase of the piezoelectric actuator 28, the piston 34 is pushed upward by the expansion of the piezoelectric actuator 28 and this forces the silicone oil contained inside the chamber 36 through the peripheral throttling gap 40 of the piston 34 sliding in the housing 32, thereby filling the lower oil chamber

38. As the ring element 42 moves downward, the lower oil chamber 38 expands during the activation phase. Two rubber seals 44 and 46 seal the silicone oil containing chambers against the surrounding.

[0029] In the subsequent deactivation phase of the actuator 28, the volume of oil contained in the second chamber 38 can move back toward the first chamber 36 either via the annular throttling gap 40 or via a channel formed in the head of the piston 34 that connects the chambers 36 and 38 to each other. As will be described in greater detail below, a metal strip may then be spot-welded to the upper face of the piston 34, offering hydraulic leak tightness during the activation phase of the actuator and a pathway for the silicone oil during the subsequent deactivation phase, owing to the way the metal strip bends.

[0030] The continual recovery of the initial position of the piston 34 after each injection is ensured by the return force of the helical spring 50 acting on the piston 34 via the end stop plate 52 welded to the base of the piston rod 48.

[0031] Figure 3 shows a schematic axial cross section of a thermal compensator unit 60 according to another embodiment of the invention. In this embodiment, same reference numbers relate to same or corresponding parts.

[0032] As with the first embodiment, the compensator housing 32 contains a piston 34 mounted axially slideable inside it. The housing 32 rests via its upper surface 54 on the fixed end stop of the injector, while the lower end of the piston 34 is in contact with the piezoelectric actuator 28. First 36 and second 38 fluid chambers and a small annular throttling gap 40 are formed between the piston 34 and the compensator housing 32, the two chambers 36 and 38 having the same radial cross section.

[0033] During the activation phase of the piezoelectric actuator 28, the piston 34 is pushed upward by the expansion of the piezoelectric actuator 28 and this forces the silicone oil contained inside the chambers 36 by the two seals 46 and 44 through the peripheral throttling gap 40, filling the lower oil chamber 38.

[0034] In the subsequent deactivation phase of the actuator 28, the volume of oil contained in the second chamber 38 can move back toward the first chamber 36 either via the annular throttling gap 40 or via a channel formed in the head of the piston 34 that connects the chambers 36 and 38 to each other. As in the first embodiment, a metal strip offering hydraulic leak tightness during the activation phase of the actuator and a pathway for the silicone oil during the subsequent deactivation phase may be spot-welded to the upper face of the piston 34.

[0035] In the Fig. 3 embodiment, the continual recovery of the initial position of the piston 34 after each injection is ensured by the return force of the Belleville washer 62.

[0036] A further embodiment of the invention is shown in the schematic cross section of Fig. 4. The compensator housing 32 of the thermal compensator unit 70 contains a piston 34, whose upper part is disposed axially slideable inside the housing 32. The lower part of the piston 34 slides inside a moveable ring member 82 against which it is sealed. The housing 32 rests via its upper surface 54 on the fixed end stop of the injector, while the lower end of the piston 34 is in contact with the piezoelectric actuator 28.

[0037] The first fluid chamber 36 is formed between the top surface of the piston 34 and the compensator housing 32. A bellows 72 is connected to the compensator housing 32 and to the moveable ring member 82. The second fluid chamber 38 is formed between the piston 34 and the bellows 72 and a small annular gap between the piston 34 and the housing 32 forms the throttling gap 40.

[0038] During the activation phase of the piezoelectric actuator 28, the piston 34 is pushed upward by the expansion of the piezoelectric actuator 28 and this forces the silicone oil contained inside the chamber 36 through the peripheral throttling gap 40, filling the lower oil chamber 38, which will expand as the ring member 82 moves downward. The continual movements of oil between the chambers 36 and 38 require the presence of the bellows 72 welded to the compensator housing 32 and to the moveable ring member 82.

[0039] In the subsequent deactivation phase of the actuator 28, the volume of oil contained in the second chamber 38 can move back toward the first chamber 36 either via the annular throttling gap 40 or via a channel 74 formed in the head of the piston 34. The opening 76 facing the first fluid chamber 36 is covered with a metal strip 80, while the opening 78 facing the second fluid chamber 38 remains uncovered. The strip 80 prevents leakage of oil during activation of the actuator 28 and is able to bend under the pressure of the returning oil to open a gap for the oil to move back from the second fluid chamber 38 to the first fluid chamber 36 during the deactivation phase of the actuator 28.

[0040] The continual recovery of the initial position of the piston 34 after each injection is ensured by the return force of the spring 50 acting on the piston 34 via the end stop represented by an expansion washer 52, inserted at the base of the piston 34.

[0041] A further design of a thermal compensator unit 90 according to the invention is shown in Fig. 5. There, the housing 32 contains a piston 34 able to slide axially inside it. A closing element 96 rests via its upper surface on the fixed end stop of the injector 10 while the lower end of the housing 32 is in contact with the piezoelectric actuator 28.

[0042] A moveable ring member 92 is provided in a borehole 100 of the piston 34, the ring member 92 being connected to a helical spring 94 acting on the ring member 92 and the closing element 96. In this embodiment, the first fluid chamber 36 is formed between the lower surface of the piston 34 and the compensator housing

32, and the second fluid chamber 38 is formed between the inside surface of the borehole 100 and the ring member 92. A throttling passage between the first and second fluid chamber 36 and 38 is formed by a straight passage 102, extending through the lower portion of the piston 34. The straight passage 102 is covered by a perforated strip 98 having a small hole to provide high hydraulic resistance to the flow of oil during the expansion of the actuator 28.

[0043] In contrast to the previously discussed embodiments, the piston 34 is pushed downward by the expansion of the piezoelectric actuator 28 during the activation phase of the piezoelectric actuator 28. This movement forces the silicone oil contained inside the chambers 36 through the hole formed in the strip 98, slowly filling the second fluid chamber 38.

[0044] In the subsequent deactivation phase of the actuator 28, the volume of oil contained in the second chamber 38 can move back toward the first chamber 36 due to the bending of the strip 98, which is welded to the piston at two points of its outer circumference only. The strip 98 provides good hydraulic resistance to the flow of oil during the expansion of the actuator and is able to bend, opening a gap for the oil to move back from the first fluid chamber 38 to the second fluid chamber 36 during the deactivation phase of the actuator 28.

[0045] In the embodiment of Fig. 5, the continual recovery of the initial position of the moveable ring member 92 and the piston 34 after each injection is ensured by the return force of the spring 94 acting on the ring member 92 and the closure element 96.

[0046] 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 realization of the invention.

Claims

1. A metering device for dosing pressurized fluids, particularly an injection valve for a fuel injection system in an internal combustion engine, comprising

- a housing (12) having a metering opening (22), controllable by the movement of an axially moveable valve needle, the housing (12) comprising a material having a first thermal coefficient of expansion,

- an axially extendable piezoelectric actuator (28) cooperating with the valve needle to control its axial movement, the piezoelectric actuator (28) comprising a material having a second thermal coefficient of expansion, and

- a thermal compensator unit (30; 60; 70; 90) cooperating with the piezoelectric actuator (28) and the housing (12) to compensate for different thermal expansion of the housing (12) and the piezoelectric actuator (28) to ensure elastic contact between an end stop of the housing (12), the piezoelectric actuator (28) and the valve needle,

characterized in that
the thermal compensator unit (30; 60; 70; 90) comprises

- a compensator housing (32) and a hydraulic piston (34), disposed axially slidable within the compensator housing (32), the compensator housing (32) and the piston (34) forming a first fluid chamber (36), a second fluid chamber (38) and a throttling passage (40; 102) connecting the first (36) and second fluid chamber (38), and

- means for transmitting an axial extension of the piezoelectric actuator (28) to the compensator housing (32) or to the piston (34) to urge a hydraulic fluid from the first fluid chamber (36) to the second fluid chamber (38) in an activation phase of the piezoelectric actuator (28).

2. The metering device according to claim 1, **characterized in that**
the thermal compensator unit (30; 60; 70; 90) further comprises restoring means (50; 62; 94) to return the hydraulic piston (34) to its initial position and to return the hydraulic fluid from the second fluid chamber (38) to the first fluid chamber (36) in a deactivation phase of the piezoelectric actuator (28).

3. The metering device according to any of the preceding claims, **characterized in that**
a return passage (74; 102) for the hydraulic fluid between the second (38) and first fluid chamber (36) is provided inside the hydraulic piston (34) for rapidly returning the hydraulic fluid in a deactivation phase of the piezoelectric actuator (28).

4. The metering device according to claim 3, **characterized in that**
the return passage (74; 102) through the piston (34) has an opening (76) in the first fluid chamber (36), the opening (76) being covered by a spot-welded metal strip (80; 98) which is pressed on the opening (76) in the activation phase and which bends away form the opening (76) in the deactivation phase due to the pressure exerted by the hydraulic fluid, to rapidly return the hydraulic fluid to the first fluid chamber (36).

5. The metering device according to any of the preceding claims, **characterized in that**

an upper surface of the compensator housing (32) is connected to the end stop of the housing (12), and that a lower surface of the hydraulic piston (34) is connected to the piezoelectric actuator (28).

6. The metering device according to any of claims 1 to 4, **characterized in that** an upper surface of the compensator housing (32) is connected to the bottom end of the piezoelectric actuator (28) and a lower surface of the hydraulic piston (34) is connected to the top of the valve needle.

7. The metering device according to claim 5 or 6, **characterized in that** the restoring means comprises a helical spring (50) acting on the hydraulic piston (34) via an end stop plate (52) connected to an end portion of the hydraulic piston (34), the helical spring (50) being precompressed during the assembly process, the hydraulic fluid being pressurized and the piston (34) applying a pre-load contact force to the piezoelectric actuator (28) and the valve needle, at any operating condition, the helical spring (50) further being compressed by an axial extension of the piezoelectric actuator (28).

8. The metering device according to claim 5 or 6, **characterized in that** the restoring means comprises a Belleville washer (62) arranged between the hydraulic piston (34) and the upper surface of the compensator housing (32), the Belleville washer (62) being compressed by an axial extension of the piezoelectric actuator (28).

9. The metering device according to claim 5 or 6, **characterized in that** the hydraulic piston (34) has an upper part sliding within the compensator housing (32) and a lower part sliding within a surrounding moveable ring member (82), and that a bellows (72) is connected to the compensator housing (32) and the moveable ring member (82), wherein the first fluid chamber (36) is formed between the piston (34) and the compensator housing (32) and the second fluid chamber (38) is formed between the piston (34) and the bellows (72).

10. The metering device according to any of claims 5 to 9, **characterized in that** the throttling passage (40) is formed by a small gap between the piston and (34) the compensator housing (32).

11. The metering device according to any of claims 1 to 4, **characterized in that** a lower surface of the compensator housing (32) is connected to the piezoelectric actuator (28) and that a closing element (96) is connected to the end stop of the housing (12).

12. The metering device according to any of claims 1 to 4, **characterized in that** an upper surface of the compensator housing (32) is connected to the bottom end of the piezoelectric actuator (28) and a lower surface of the hydraulic piston (34) is connected to the top of the valve needle.

13. The metering device according to claim 11 or 12, **characterized in that** a moveable ring member (92) is provided in a borehole (100) of the piston, the ring member (92) being connected to a helical spring (94) acting on the ring member (92) and the closing element (96), the helical spring (94) being compressed by an axial extension of the piezoelectric actuator (28).

14. The metering device according to any of claims 11 to 14, **characterized in that** the first fluid chamber (36) is formed between the piston (34) and the compensator housing (32), and the second fluid chamber (38) is formed between an inside surface of the borehole (100) and the ring member (92).

15. The metering device according to any of claims 11 to 14, **characterized in that** the throttling passage is formed by a straight passage (102) through the lower portion of the piston (34), the passage (102) being covered by a perforated strip (98), the strip (98) providing good hydraulic resistance to the flow of hydraulic fluid during the expansion of the actuator and being able to bend, opening a gap for the hydraulic fluid to move back from the first fluid chamber (38) to the second fluid chamber (36) during the deactivation phase of the actuator (28).

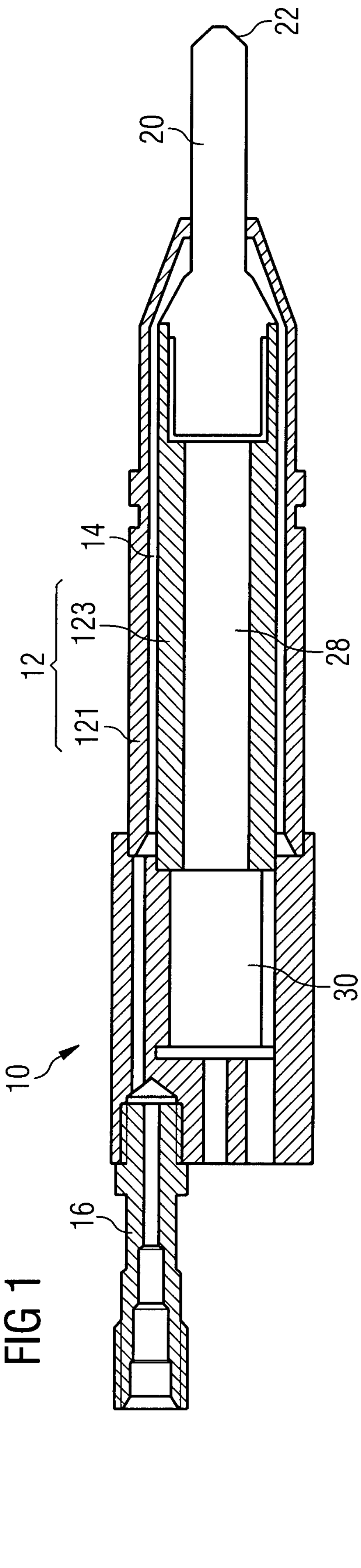


FIG 1

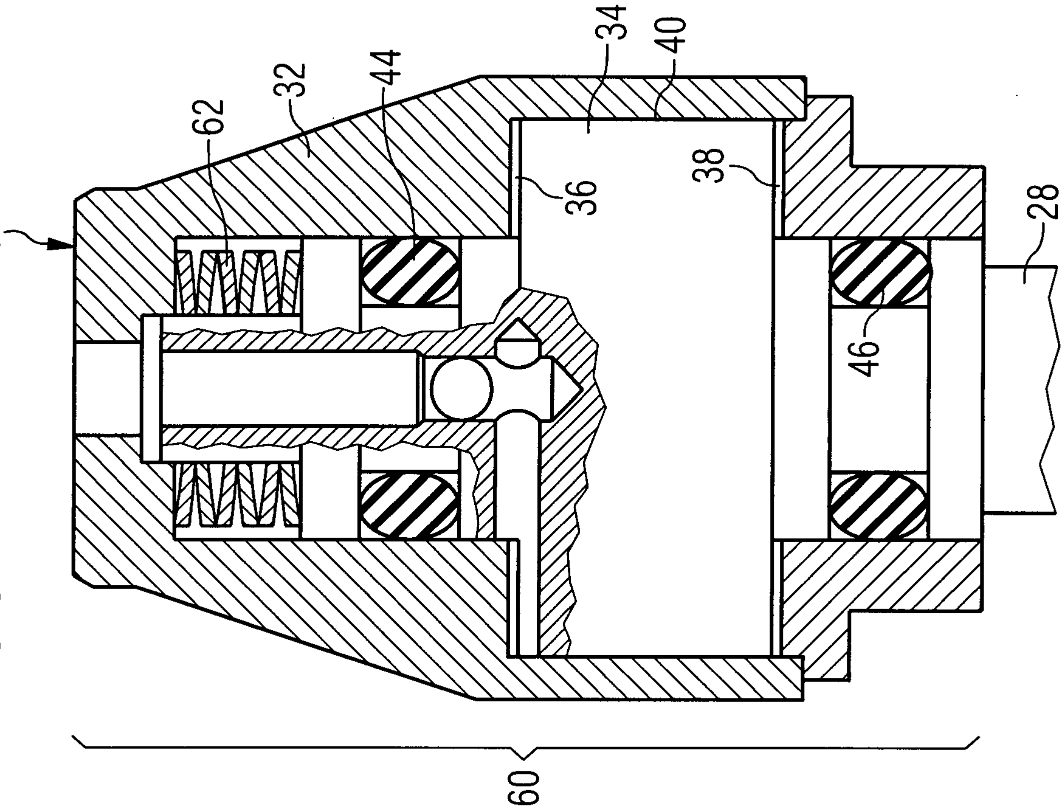

54
62
32
44
34
40
36
38
28
46
60

FIG 3

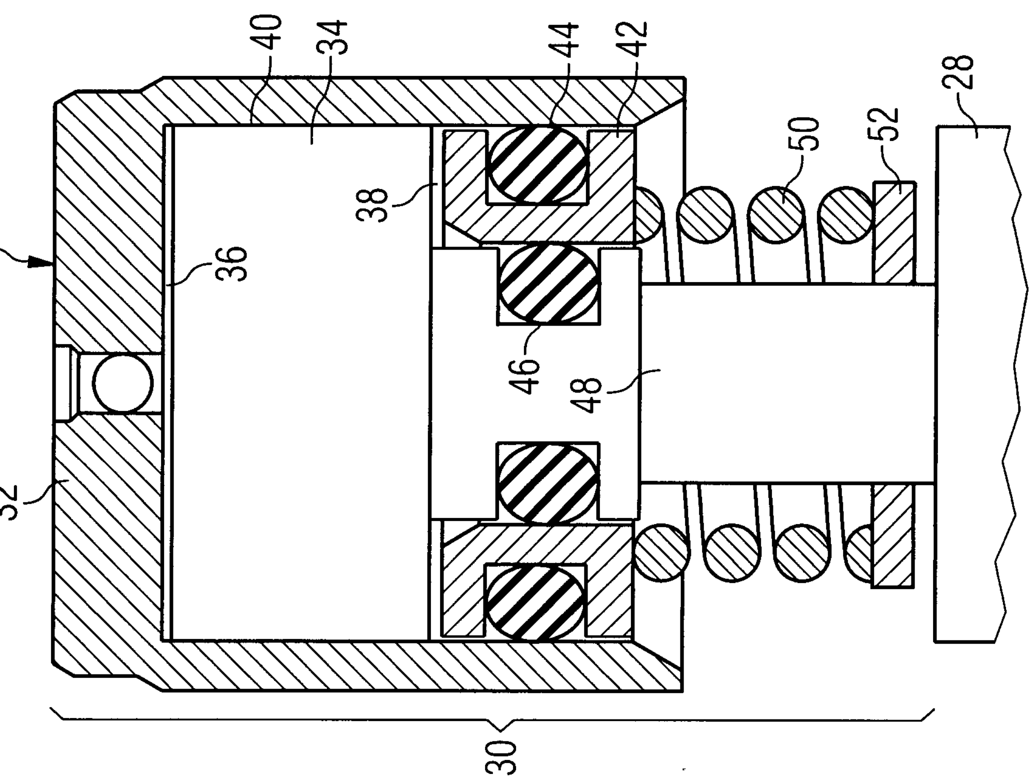

54
32
40
34
44
42
36
38
46
48
50
52
28
30

FIG 2

FIG 5

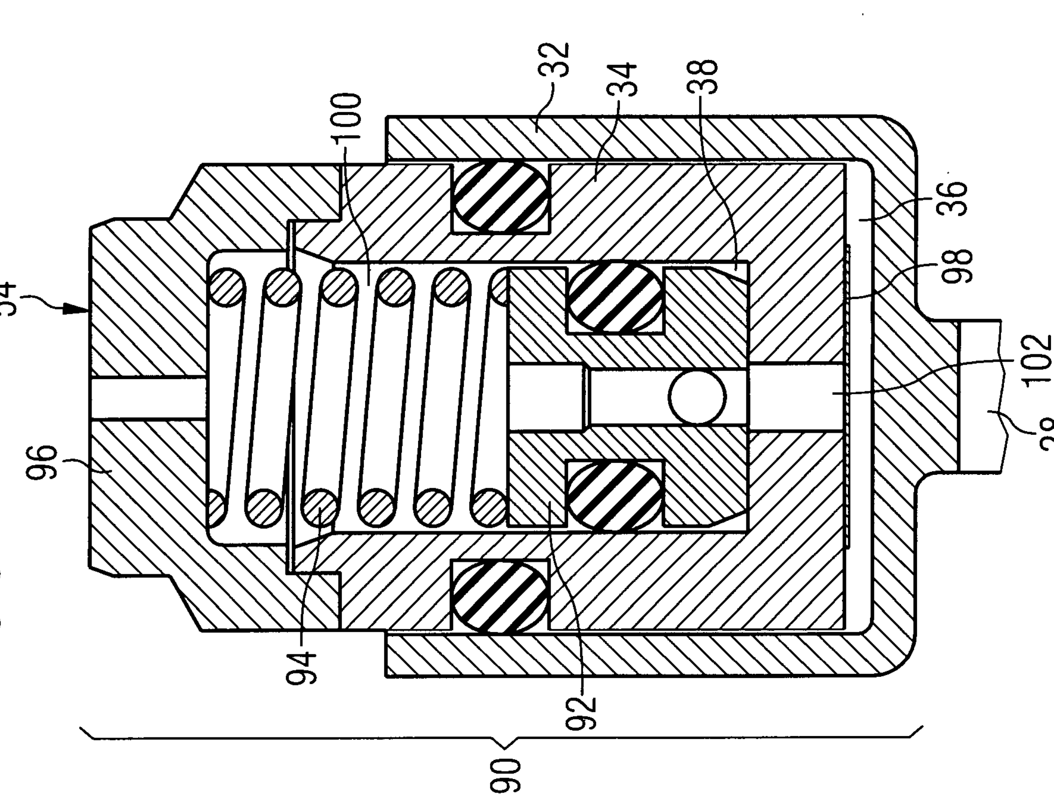
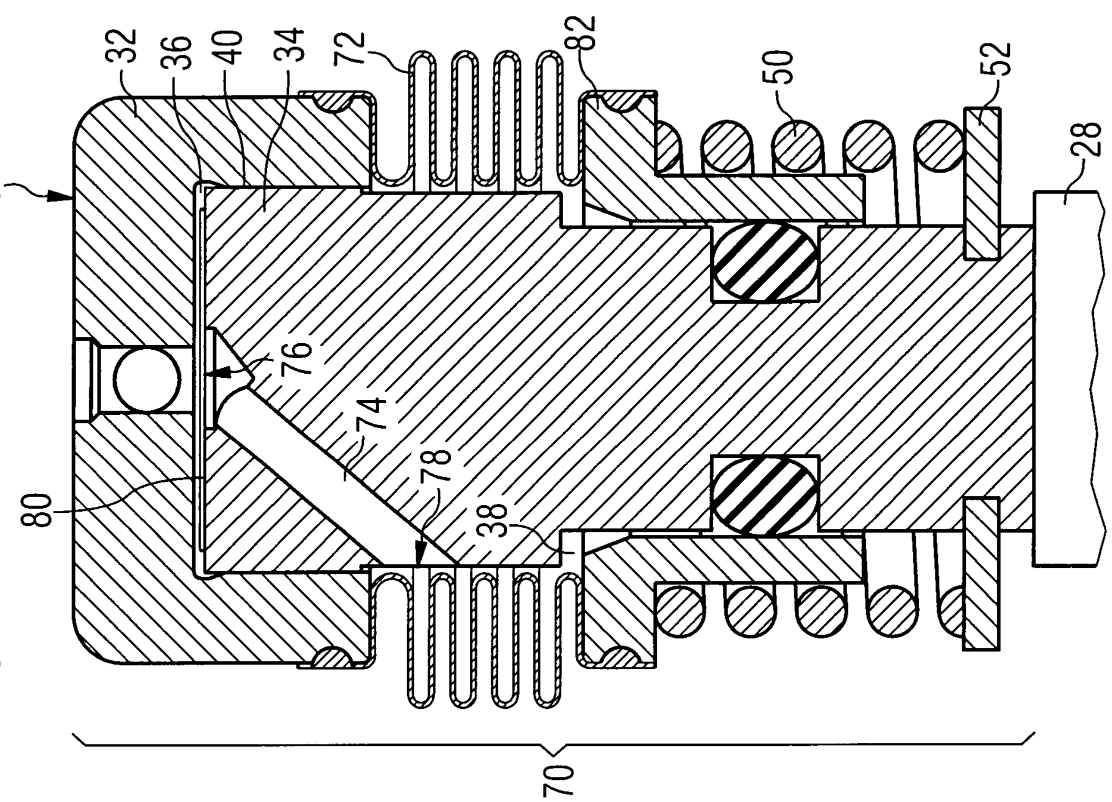

54
96
100
32
34
38
36
98
102
28
94
92
90

FIG 4


54
32
36
40
34
72
82
50
52
28
76
74
78
80
38
70

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 01 8666

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	WO 02 31344 A (SIEMENS AUTOMOTIVE CORP LP) 18 April 2002 (2002-04-18) * page 5, last paragraph - page 9, paragraph 1 * * page 13, paragraph 2; figures *	1-10	F02M51/06 F02M61/16
D,A	EP 1 046 809 A (SIEMENS AG) 25 October 2000 (2000-10-25) * column 5, line 18 - line 52; figure 1 *	1	
A	US 2001/035164 A1 (HEBBES MIKE ET AL) 1 November 2001 (2001-11-01)		
A	US 2002/047100 A1 (LORRAINE JACK) 25 April 2002 (2002-04-25)		

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 January 2003	Sideris, M

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

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 02 01 8666

This annex lists the patent family membersrelating 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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-01-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0231344 A	18-04-2002	WO 0231344 A1	18-04-2002
		WO 0231345 A1	18-04-2002
		WO 0231346 A1	18-04-2002
		WO 0231347 A1	18-04-2002
		WO 0231349 A1	18-04-2002
		US 2002134855 A1	26-09-2002
		US 2002134851 A1	26-09-2002
		US 2002047100 A1	25-04-2002
		US 2002139863 A1	03-10-2002
		US 2002139864 A1	03-10-2002
EP 1046809 A	25-10-2000	EP 1046809 A2	25-10-2000
		US 6311950 B1	06-11-2001
US 2001035164 A1	01-11-2001	US 6298829 B1	09-10-2001
		WO 02095213 A1	28-11-2002
		AU 7636500 A	30-04-2001
		BR 0014745 A	18-06-2002
		WO 0129400 A2	26-04-2001
		CN 1379846 T	13-11-2002
		EP 1220985 A2	10-07-2002
		US 2001032612 A1	25-10-2001
		US 2001035163 A1	01-11-2001
US 2002047100 A1	25-04-2002	WO 0231344 A1	18-04-2002
		WO 0231345 A1	18-04-2002
		WO 0231346 A1	18-04-2002
		WO 0231347 A1	18-04-2002
		WO 0231349 A1	18-04-2002
		US 2002134855 A1	26-09-2002
		US 2002134851 A1	26-09-2002
		US 2002139863 A1	03-10-2002
		US 2002139864 A1	03-10-2002

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82