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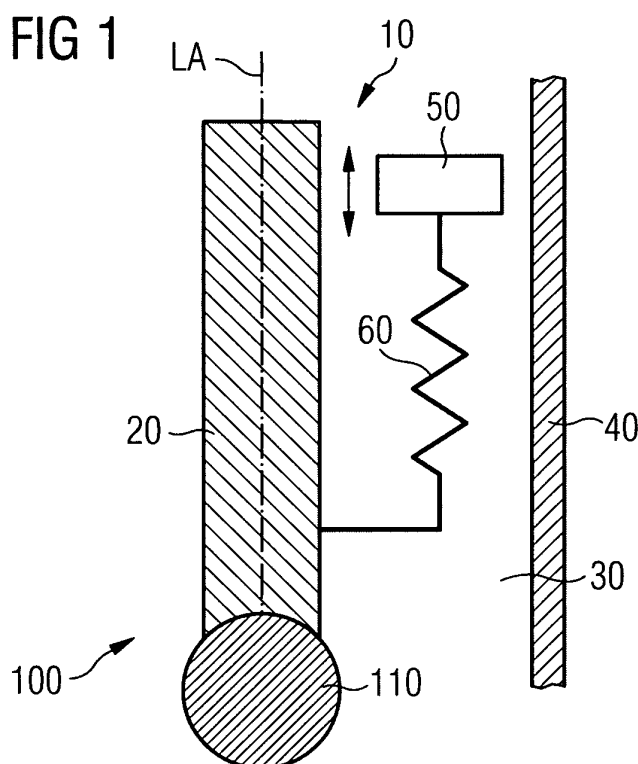
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(54) **Injection valve**

(57) Injection valve (100) for injecting fluid comprising a central longitudinal axis (LA) and an injection valve housing (40) with an injection valve cavity (30). The injection valve (100) comprises a valve needle (10) being axially moveable within the injection valve cavity (30) and comprising a valve needle body (20). The valve needle (10) comprises a sealing element (110) being fixedly coupled to the valve needle body (20) and preventing a fluid injection in a closing position and permitting the fluid in-

jection in further positions. The valve needle comprises at least one mass element (50) being axially moveable relative to the valve needle body (20) and to the injection valve housing (40). The valve needle (10) comprises at least one spring element (60) being coupled to the valve needle body (20) with a first end and being coupled to the at least one mass element (50) with a second end, whereas the at least one spring element (60) affects the at least one mass element (50) in axial directions.



Description

[0001] The invention relates to an injection valve for injecting fluid.

[0002] Injection valves are in widespread use, in particular for internal combustion engines where they may be arranged in order to dose the fluid into an intake manifold of the internal combustion engine or directly into the combustion chamber of a cylinder of the internal combustion engine.

[0003] Injection valves are manufactured in various forms in order to satisfy the various needs for the various combustion engines. Therefore, for example, their length, their diameter and also various elements of the injection valve being responsible for the way the fluid is dosed may vary in a wide range. In addition to that, injection valves may accommodate an actuator for actuating a valve needle of the injection valve, which may, for example, be an electromagnetic actuator.

[0004] In order to enhance the combustion process in view of the creation of unwanted emissions, the respective injection valve may be suited to dose fluids under very high pressures. The pressures may be in case of a gasoline engine, for example, in the range of up to 200 bar and in the case of diesel engines in the range of up to 2000 bar.

[0005] US 6,523,759 B1 discloses that during operation of the injection valve, a close action of the valve needle to prevent dosing of fluid into the intake manifold or into the combustion chamber is followed by an unwanted reopen and close phase of the valve needle, called needle bounce. During the unwanted reopen and close phase, unwanted fluid is dispensed from the injection valve, resulting in a degraded performance of the injection valve. Therefore, a flow restrictor is disposed in an armature of the valve needle to restrict fluid flow towards an upstream end of the armature, resulting in a reduced bouncing of the valve needle.

[0006] The object of the invention is to create an injection valve which facilitates a reliable and precise function.

[0007] These objects are achieved by the features of the independent claim. Advantageous embodiments of the invention are given in the sub-claims.

[0008] The invention is distinguished by an injection valve for injecting fluid comprising a central longitudinal axis and an injection valve housing with an injection valve cavity. The injection valve further comprises a valve needle being axially moveable within the injection valve cavity. The valve needle comprises a valve needle body and a sealing element being fixedly coupled to the valve needle body and preventing a fluid injection in a closing position and permitting the fluid injection in further positions. The valve needle further comprises at least one mass element being axially moveable relative to the valve needle body and to the injection valve housing. Furthermore, the valve needle comprises at least one spring element being coupled to the valve needle body with a first end and being coupled to the at least one mass element with

a second end. The at least one spring element affects the at least one mass element in axial directions. This contributes to minimizing a bouncing of the valve needle and by this contributes to ensuring a reliable and precise fluid injection. The valve needle body is for example coupled to an armature which is operable to be actuated by a solenoid in case of an electromagnetic actuated injection valve. In case of a piezoelectric injection valve, the valve needle body is preferably coupled to a piezoelectric actuator.

[0009] The injection valve cavity is designed to be filled with fluid. The at least one mass element is operable to axially move within the fluid, accumulated within the injection valve cavity. This has the advantage that the kinetic energy of the valve needle body due to axial movements, which results in unwanted reopen phases of the sealing element and unwanted fluid injections, is dissipated and dampened. Additionally, the spring element at least partially absorbs the kinetic energy of the valve needle body. This reduces the bouncing of the sealing element and by this reduces the unwanted fluid injections.

[0010] In an advantageous embodiment of the invention, the at least one mass element comprises a predetermined dimension. The predetermined dimension comprises a predetermined size of a radial contact surface which contacts the fluid accumulated within the injection valve cavity. The predetermined radial contact surface of the mass element provides a predetermined resistance to the fluid and/or the mass element and by this at least partially dissipates the kinetic energy of the moving valve needle body. This contributes to ensuring a reliable and precise function of the injection valve.

[0011] In a further advantageous embodiment of the invention, the at least one spring element is a helical spring. This contributes to ensuring a robust injection valve.

[0012] In a further advantageous embodiment of the invention, the valve needle comprises a first fixing element being fixedly coupled to the valve needle body. The first fixing element comprises an external thread with a pitch different to a pitch of the at least one spring element. The at least one spring element is screwed on the external thread of the first fixing element with its first end. I.e. the pitch of the spring at its first end differs from the pitch of the first fixing element. This contributes to ensuring a fixedly coupling of the at least one spring element to the first fixing element.

[0013] In a further advantageous embodiment of the invention, the at least one mass element comprises a central cavity. The central cavity envelops the valve needle body and comprises an internal thread with a pitch different to the pitch of the at least one spring element. The at least one spring element is screwed on the internal thread of the at least one mass element with its second end. I.e. the pitch of the spring at its second end differs from the pitch of the at least one mass element. This contributes to ensuring a fixedly coupling of the at least

one spring element to the at least one mass element.

[0014] In a further advantageous embodiment of the invention, the valve needle comprises a second fixing element with a central opening. The central opening envelops the valve needle body. The second fixing element is fixedly coupled to the valve needle body. The valve needle further comprises multiple mass elements being separated to each other. Each mass element is radially spaced to the second fixing element. Furthermore, the valve needle comprises multiple spring elements, each being plate-typed and each being adopted to fixedly couple a particular mass element to the second fixing element. The plate-typed spring elements contribute a radial contact surface to the radial contact surface of the multiple mass elements. This contributes to damping the axial movements of the valve needle body.

[0015] A spring rate of the particular spring element may be varied by varying the thickness of the particular plate and/or the radial distance between the second fixing element and the particular mass element.

[0016] Preferably the second fixing element, the multiple spring elements and the multiple mass elements are formed as a one piece component which is fixedly coupled to the valve needle body.

[0017] In a further advantageous embodiment of the invention the valve needle comprises at least one first retainer with a predetermined radial expansion being fixedly coupled to the valve needle body. The valve needle further comprises a second retainer with a predetermined radial expansion being fixedly coupled to the valve needle body. The first and second retainer are axially spaced to each other. Furthermore, the valve needle comprises the mass element being arranged between the first and second retainer. In addition, the valve needle comprises multiple spring elements. At least one of the multiple spring elements is arranged between a first end of the mass element and the first retainer. At least one of the multiple spring elements is arranged between a second end of the mass element and the second retainer. The at least first and second retainer may be a one piece component together with the valve needle body. The mass element is preferably hollow-cylindrically shaped with a central opening enveloping the valve needle body. The valve needle preferably comprises a radial clearance between the valve needle body and the mass element to facilitate an accumulation of fluid between the mass element and the valve needle body to reduce a friction between these components.

[0018] The valve needle may comprise more than one mass element, whereas it is also possible to axially space the multiple mass elements to each other and arrange additional spring elements between them. The spring element may be a helical spring.

[0019] In a further advantageous embodiment of the invention, the multiple spring elements are o-rings with each enveloping the valve needle body. The o-rings comprise elastic properties in particular in axial directions. The usage of o-rings facilitates a robust and simple in-

jection valve.

[0020] In a further advantageous embodiment of the invention the valve needle comprises a first retainer with a predetermined radial expansion being fixedly coupled to the valve needle body. The valve needle further comprises a second retainer with a predetermined radial expansion being fixedly coupled to the valve needle body. The first and second retainer are axially spaced to each other. In addition, the valve needle comprises the mass element being arranged between the first and second retainer. Furthermore, the valve needle comprises multiple spring elements each being bellows-typed and each enveloping the valve needle body. A first spring element of the multiple spring elements is arranged between the first end of the mass element and the first retainer. A second spring element of the multiple spring elements is arranged between the second end of the mass element and the second retainer. The at least first and second retainer may be a one piece component together with the valve needle body. The mass element is preferably hollow-cylindrically shaped with a central opening enveloping the valve needle body. The valve needle preferably comprises a radial clearance between the valve needle body and the mass element to facilitate an accumulation of fluid between the mass element and the valve needle body to reduce a friction between these components.

[0021] Each bellows-typed mass element comprises elastic properties, in particular in axial directions.

[0022] The valve needle may comprise more than one mass element, whereas it is also possible to axially space the mass elements to each other and arrange additional bellows-typed spring elements between them.

[0023] In a further advantageous embodiment of the invention, a first fluid volume is formed by the first retainer, the first spring element, the first end of the mass element and the valve needle body. A second fluid volume is formed by the second retainer, the second spring element, the second end of the mass element and the valve needle body. The at least one mass element envelops the valve needle body. At least one predetermined radial clearance between the valve needle body and the mass element is provided. The at least one radial clearance represents a fluid passage with a predetermined passage opening to hydraulically connect the first fluid volume with the second fluid volume. The first and second fluid volume are designed to be filled with fluid. The fluid passage with its predetermined opening contributes to damping the axial movements of the valve needle body. The damping effect due to the fluid passage may be varied by varying the diameter of the opening. This reduces the bouncing of the sealing element after impacting a valve needle seat.

[0024] In a further advantageous embodiment of the invention, the first and second spring element comprises steel. This facilitates a robust function of the injection valve.

[0025] Exemplary embodiments of the invention are explained in the following with the aid of schematic draw-

ings. These are as follows:

Figure 1 injection valve,

Figure 2 injection valve with first fixing element,

Figure 3 injection valve with second fixing element,

Figure 4 injection valve with o-rings,

Figure 5 injections valve with bellows-typed spring elements,

Figure 6 diagram.

[0026] Elements of the same design and function that appear in different illustrations are identified by the same reference character.

[0027] Figure 1, 2, 4 and 5 illustrate injection valves 100 in longitudinal section views, whereas only extractions of the particular longitudinal sections are depicted.

[0028] A basal function of the injection valves 100 is described with figure 1.

[0029] The injection valve 100 (figure 1) that is in particular suitable for dosing fluid into an internal combustion engine, comprises an injection valve housing 40 with a central longitudinal axis LA, an injection valve cavity 30 and a valve needle 10. The valve needle 10 comprises a valve needle body 20, a mass element 50, a sealing element 110 and a spring element 60.

[0030] The valve needle body 20 is operable to be actuated by an actuator of the injection valve 100, e.g. an electromagnetic actuator or a piezoelectric actuator. While being actuated, the valve needle body 20 moves axially within the injection valve cavity 30.

[0031] The valve needle body 20 is fixedly coupled to the sealing element 110, e.g. welded or made in one piece.

[0032] The sealing element 110 has a spherical shape. Alternatively, the sealing element 110 has a conical shape. In a closing position, the sealing element 110 sealingly rests on a valve needle seat of the injection valve 100, by this preventing a fluid flow through at least one injection nozzle of the injection valve 100. The injection nozzle may be, for example, an injection hole. However, it may also be of some other type suitable for dosing fluid. The sealing element 110 permits the fluid injection into the combustion chamber in further positions, i.e. when it does not rest on the valve needle seat. The further positions represent non-closing positions.

[0033] The mass element 50 is axially moveable relative to the valve needle body 20 and to the injection valve housing 40. The mass element 50 is disposed within the injection valve cavity 30 and comprises a predetermined dimension including a predetermined radial contact surface. The injection valve cavity 30 is operable to be filled with fluid.

[0034] The spring element 60 is a helical spring and

preferably made of stainless steel. A first end of the spring element 60 is fixedly coupled to the valve needle body 20 and a second end of the spring element 60 is fixedly coupled to the mass element 50. The spring element 60 affects the mass element 50 in axial directions.

[0035] If the sealing element 110 impacts the valve needle seat of the injection valve 100 in a closing phase, the kinetic energy of the valve needle body 20 is at least partially absorbed due to the inertia of the mass element 50, axial moving within the injection valve cavity 30. Additionally, the predetermined dimension of the mass element 50 comprises the predetermined radial contact surface contacting the fluid accumulated within the injection valve cavity 30. The predetermined radial contact surface of the mass element 50 provides a predetermined resistance to the mass element 50 if it axially moves within the injection valve cavity 30. By this, an additional dampening effect is effecting the axial movements of the valve needle body 20. By varying a size of the radial contact surface of the mass element 50, the dampening effect can be varied.

[0036] In another embodiment (figure 2) of the injection valve 100, the valve needle 10 comprises a first fixing element 70. The first fixing element 70 is fixedly coupled to the valve needle body 20, e.g. welded or a one piece component together with the valve needle body 20. The first fixing element 70 comprises an external thread 90 with a predetermined pitch. The pitch of the external thread 90 is different to a pitch of the spring element 60. The spring element 60 is screwed on the external thread 90 of the first fixing element 70 with its first end. This fixedly couples the spring element 60 to the valve needle body 20 in an easy and efficient manner. Alternatively, the spring element 60 is fixedly coupled to the valve needle body 20 via welding spots.

[0037] According to figure 2, the mass element 50 comprises a central cavity 80. The central cavity 80 envelops the valve needle body 20 and comprises an internal thread with a predetermined pitch being different to the pitch of the spring element 60. The spring element 60 is screwed on the internal thread of the mass element 50 and by this fixedly coupled to the mass element 50. Alternatively, the mass element 50 comprises an external thread where the spring element 60 is screwed on. Alternatively, the mass element 50 is fixedly coupled to the spring element 60 via welding spots.

[0038] As depicted in figure 2 the mass element 50 is arranged between the first fixing element 70 and the sealing element 110. Alternatively, the first fixing element 70 may be arranged between the mass element 50 and the sealing element 110.

[0039] In another embodiment (figure 3), the valve needle 10 comprises a second fixing element 75. The second fixing element 75 comprises a central opening 150 enveloping the valve needle body 20. The second fixing element 75 is fixedly coupled to the valve needle body 20, e.g. welded or a one piece component together with the valve needle body 20.

[0040] The valve needle 10 comprises multiple mass elements 50, e.g. three. The mass elements 50 are separated to each other and each is radially spaced to the second fixing element 75. Each mass element 50 is fixedly coupled to the second fixing element 75 via a particular spring element 60. The particular spring element 60 according to figure 3 is plate-typed and preferably comprises an additional radial contact surface to the fluid accumulated within the injection valve cavity 30. This additionally dampens the axial movements of the valve needle body 20. The spring rate of the particular spring element 60 can be varied by varying the thickness of the particular plate and/or by varying the radial distance between the second fixing element 75 and the particular mass element 50. The second fixing element 75, the multiple mass elements 50 and the multiple spring elements 60 are preferably a one piece component.

[0041] In another embodiment (figure 4), the valve needle 10 comprises a first and second retainer 120, 130, with each having a predetermined radial expansion and with each being fixedly coupled to the valve needle body 20. The first and second retainer 120, 130 are axially spaced to each other. The mass element 50 is preferably hollow-cylindrically shaped and envelops the valve needle body 20. The mass element 50 is axially arranged between the first and second retainer 120, 130.

[0042] The valve needle 10 may comprise more than one mass element 50.

[0043] The valve needle 10 comprises multiple o-rings, each comprising elastic properties and each representing a spring element 60. The o-rings preferably envelop the valve needle body 20. Three spring elements 60 are axially arranged between the first retainer 120 and a first end of the mass element 50. Another three spring elements 60 are axially arranged between the second retainer 130 and a second end of the mass element 50.

[0044] In another embodiment (figure 5), the valve needle 10 of the injection valve 100 comprises the first and second retainer 120, 130 according to figure 4. The mass element 50 corresponds to the mass element 50 described in figure 4. The valve needle 10 comprises multiple spring elements 60, each being bellows-typed. A first spring element 65 is axially arranged between the first retainer 120 and the first end of the mass element 50. A second spring element 66 is axially spaced between the second retainer 130 and the second end of the mass element 50. The multiple spring elements 60 comprise steel and provide elastic properties in axial directions.

[0045] In another embodiment (figure 5), the valve needle 10 comprises a first and second fluid volume 180, 190. The first fluid volume 180 is formed by the first retainer 120, the first bellows-typed spring element 65, the first end of the mass element 50 and the valve needle body 20. The second fluid volume 190 is formed by the second retainer 130, the second bellows-typed spring element 66, the second end of the mass element 50 and the valve needle body 20. The first and second fluid volume 180, 190 are designed to be filled with fluid.

[0046] The valve needle 10 may comprise more than one mass element 50.

[0047] A radial clearance between the mass element 50 and the valve needle body 20 is provided with a predetermined opening. The radial clearance represents a fluid passage 160 with a predetermined passage opening. The fluid passage 160 hydraulically connects the first fluid volume 180 with the second fluid volume 190.

[0048] If the mass element 50 axially moves due to an axial movement of the valve needle body 20, one of the fluid volumes 180, 109 is compressed and forces the fluid, accumulated within the particular fluid volume, to pass the fluid passage 160 towards the other fluid volume. A pressure of the accumulated fluid within the compressed fluid volume, due to the limited possibility of the fluid to flow into the other fluid volume, works against the compression of the compressed fluid volume and by this dampens the axial movement of the mass element 50 and the axial movement of the valve needle body 20. The dampening may be varied by varying the diameter of the passage opening of the fluid passage 160.

[0049] Figure 6 depicts a time diagram illustrating a bounce of particular sealing elements. A first characteristic 200 represents a lift L of the sealing element in an injection valve without reduced bouncing. A second characteristic 210 represents the lift L of the sealing element 110 in the injection valve 100 according to figure 1 to 5, i.e. with reduced bouncing. A first lift L1 represents a non-closing position of the particular sealing element. A second lift L2 represents the closing position of the particular sealing element. In a first point in time t1, the particular injection valve enters its closing phase. The particular sealing element impacts the valve needle seat in a second point in time t2 to stop the fluid injection.

[0050] As shown in figure 6, the injection valve without reduced bouncing of the sealing element has multiple unwanted reopen phases in which fluid is dispensed from the injection valve. The fluid injection finally stops at a fourth point in time t4 in which the kinetic energy of the valve needle is dissipated.

[0051] As depicted in figure 6, the injection valve 100 according to one of figure 1 to 5 has also multiple unwanted reopen phases, represented by the second characteristic 210. Compared to the first characteristic 200 the amount of reopen phases is significantly reduced. Furthermore, the particular amplitudes representing the particular lifts of the sealing element 110 of the second characteristic 210 are significantly reduced compared to the particular amplitudes of the first characteristic 200. The fluid injection finally stops at a third point in time t3, which is before the forth point in time t4.

Claims

1. Injection valve (100) for injecting fluid, comprising
 - a central longitudinal axis (LA),

- an injection valve housing (40) with an injection valve cavity (30),
 - a valve needle (10) being axially moveable within the injection valve cavity (30) and comprising:
 - a valve needle body (20),
 - a sealing element (110) being fixedly coupled to the valve needle body (20) and preventing a fluid injection in a closing position and permitting the fluid injection in further positions,
 - at least one mass element (50) being axially moveable relative to the valve needle body (20) and to the injection valve housing (40),
 - at least one spring element (60) being coupled to the valve needle body (20) with a first end and being coupled to the at least one mass element (50) with a second end, whereas the at least one spring element (60) affects the at least one mass element (50) in axial directions.
2. Injection valve (100) according to claim 1, with the at least one mass element (50) comprising a predetermined dimension.
3. Injection valve (100) according to claim 1 or 2, with the spring element (60) being a helical spring.
4. Injection valve (100) according to claim 3, with the valve needle (10) comprising a first fixing element (70) being fixedly coupled to the valve needle body (20) and comprising an external thread (90) with a pitch different to a pitch of the at least one spring element (60), whereas the at least one spring element (60) is screwed on the external thread (90) of the first fixing element (70) with its first end.
5. Injection valve (100) according to one of claims 3 or 4, with the at least one mass element (50) comprising a central cavity (80), the central cavity (80) envelops the valve needle body (20) and comprises an internal thread with a pitch different to the pitch of the at least one spring element (60), whereas the at least one spring element (60) is screwed on the internal thread of the at least one mass element (50) with its second end.
6. Injection valve (100) according to one of the preceding claims, with the valve needle (10) comprising
 - a second fixing element (75) with a central opening (150) enveloping the valve needle body (20), with the second fixing element (75) being fixedly coupled to the valve needle body (20),
 - multiple mass elements (50), being separated to each other and each being radially spaced to the second fixing element (75), and
 - multiple spring elements (60), each being plate-typed and each being adopted to fixedly couple a particular mass element (50) to the second fixing element (75).
7. Injection valve (100) according to one of the preceding claims, with the valve needle (10) comprising
 - at least one first retainer (120) with a predetermined radial expansion being fixedly coupled to the valve needle body (20),
 - a second retainer (130) with a predetermined radial expansion being fixedly coupled to the valve needle body (20), whereas the first and second retainer (120, 130) are axially spaced to each other,
 - the mass element (50) being arranged between the first and second retainer (120, 130),
 - multiple spring elements (60), whereas at least one of the multiple spring elements (60) is arranged between a first end of the mass element (50) and the first retainer (120) and at least one of the multiple spring elements (60) is arranged between a second end of the mass element (50) and the second retainer (130).
8. Injection valve (100) according to claim 7, with the multiple spring elements (60) being o-rings, with each enveloping the valve needle body (20).
9. Injection valve (100) according to one of the preceding claims, with the valve needle (10) comprising
 - a first retainer (120) with a predetermined radial expansion being fixedly coupled to the valve needle body (20),
 - a second retainer (130) with a predetermined radial expansion being fixedly coupled to the valve needle body (20), whereas the first and second retainer (120, 130) are axially spaced to each other,
 - the mass element (50) being arranged between the first and second retainer (120, 130),
 - multiple spring elements (60), each being bellows-typed and each enveloping the valve needle body (20), whereas a first spring element (65) of the multiple spring elements (60) is arranged between the first end of the mass element (50) and the first retainer (120) and a second spring element (66) of the multiple spring elements (60) is arranged between the second end of the mass element (50) and the second retainer (130).
10. Injection valve (100) according to claim 9, whereas

- a first fluid volume (180) is formed by the first retainer (120), the first spring element (65), the first end of the mass element (50) and the valve needle body (20),
 - a second fluid volume (190) is formed by the second retainer (130), the second spring element (66), the second end of the mass element (50) and the valve needle body (20),
 - the at least one mass element (50) envelops the valve needle body (20),
 - at least one predetermined radial clearance between the valve needle body (20) and the mass element(50) is provided, with the at least one radial clearance representing a fluid passage (160) with a predetermined passage opening to hydraulically connect the first fluid volume (180) with the second fluid volume (190).
11. Injection valve (100) according to claim 9 or 10, with the first and second spring element (65, 66) comprising steel.

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FIG 1

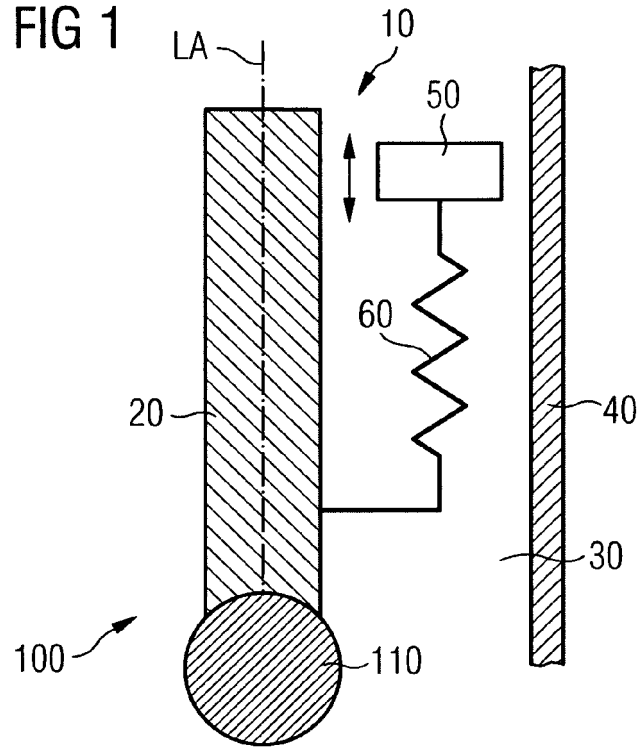


FIG 2

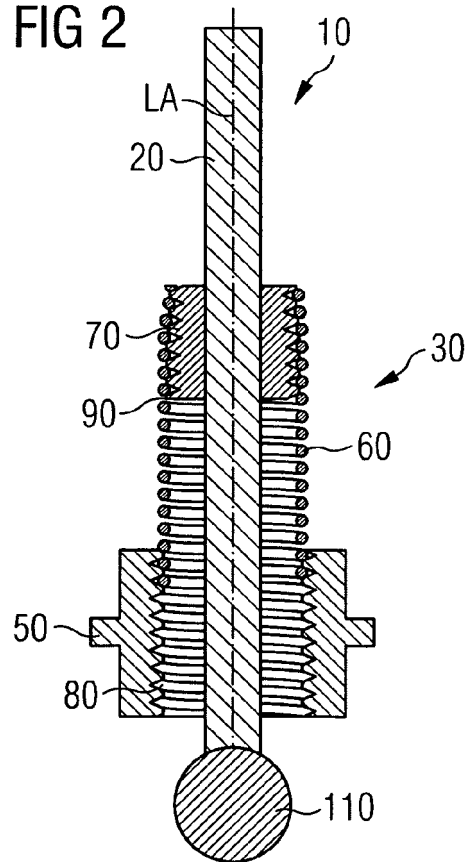


FIG 3

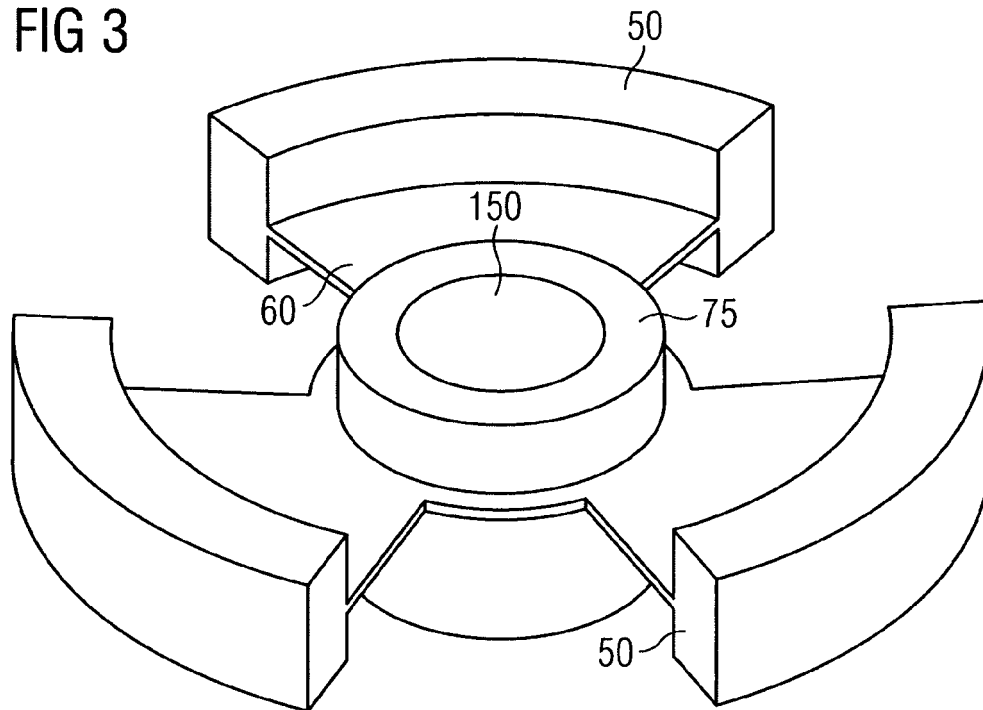


FIG 4

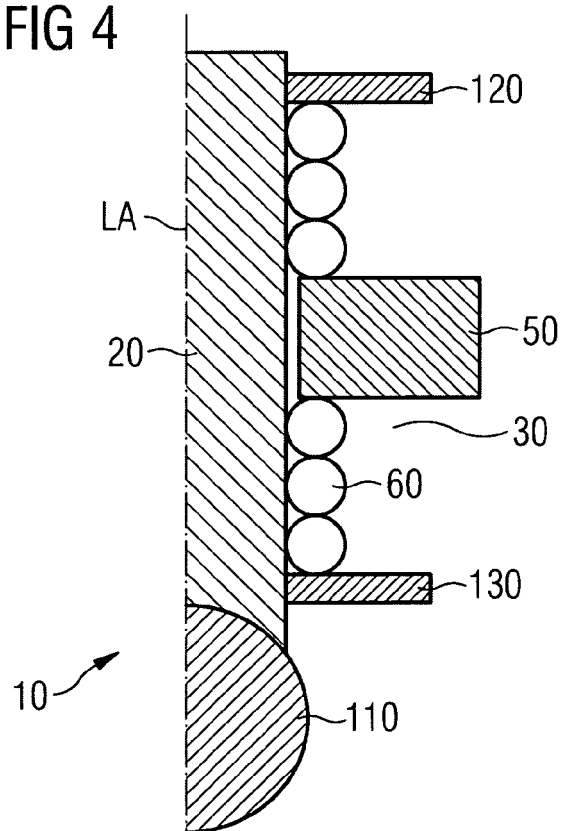


FIG 5

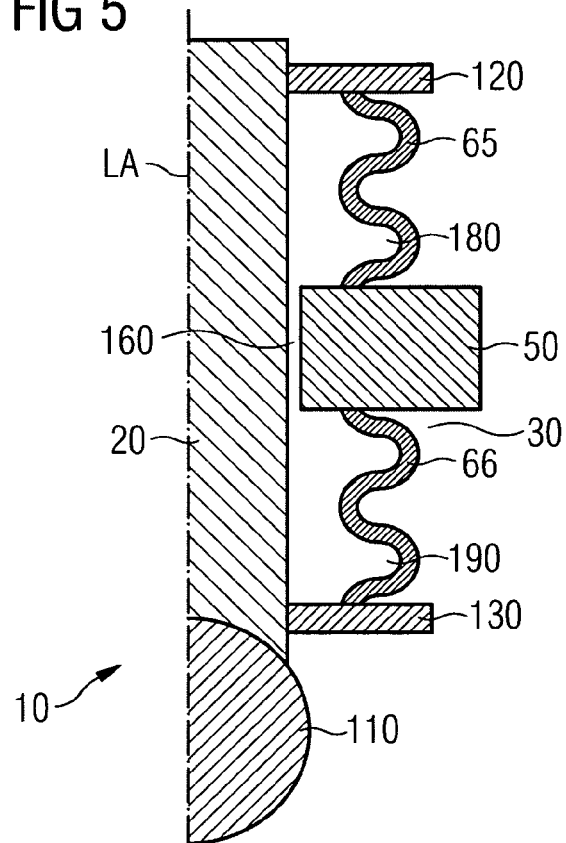
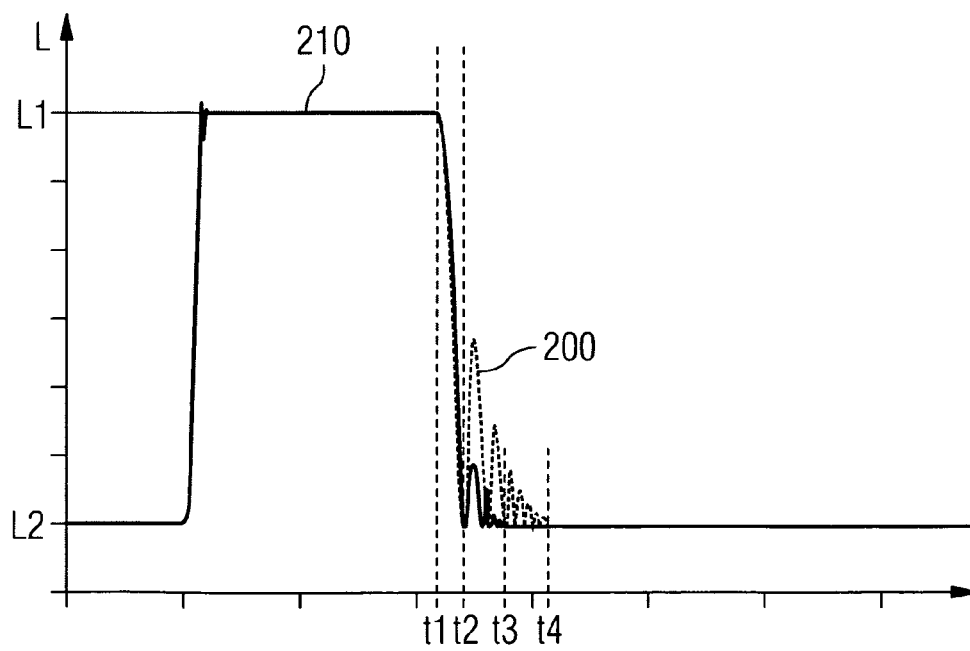


FIG 6





EUROPEAN SEARCH REPORT

Application Number
EP 09 00 4290

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 777 436 A (PEUGEOT CITROEN AUTOMOBILES SA [FR]) 25 April 2007 (2007-04-25) * page 3, paragraph 13; figures 1,2 *	1,2	INV. F02M61/20
X	WO 89/10478 A (SIEMENS BENDIX AUTOMOTIVE ELEC [US]) 2 November 1989 (1989-11-02) * abstract; figures 1,3 * * page 5, line 29 - page 6, line 17 *	1,3,7,8	
X	US 4 766 405 A (DALY PAUL D [US] ET AL) 23 August 1988 (1988-08-23) * column 2, lines 47-68; figures 1,7 * * column 4, lines 29-47 *	1,2,7	
A	US 5 139 224 A (BRIGHT JOHN S [US]) 18 August 1992 (1992-08-18) * abstract; figure 1 *	1	
A	WO 02/46604 A (BOSCH GMBH ROBERT [DE]; DANTES GUENTER [DE]; NOWAK DETLEF [DE]) 13 June 2002 (2002-06-13) * page 11, lines 32-39; figure 2C *	1	TECHNICAL FIELDS SEARCHED (IPC) F02M
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 16 September 2009	Examiner 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
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 00 4290

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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16-09-2009

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1777436	A	25-04-2007	FR 2892156 A1	20-04-2007
WO 8910478	A	02-11-1989	EP 0411041 A1	06-02-1991
			JP 2670874 B2	29-10-1997
			JP 3502227 T	23-05-1991
			US 4878650 A	07-11-1989
US 4766405	A	23-08-1988	AU 614080 B2	22-08-1991
			AU 1625988 A	04-11-1988
			BR 8807459 A	22-05-1990
			CA 1291175 C	22-10-1991
			CN 1030125 A	04-01-1989
			EP 0382721 A1	22-08-1990
			ES 2007199 A6	01-06-1989
			JP 7062503 B	05-07-1995
			JP 2501084 T	12-04-1990
			WO 8808199 A1	20-10-1988
US 5139224	A	18-08-1992	NONE	
WO 0246604	A	13-06-2002	DE 10060290 A1	06-06-2002
			EP 1339970 A2	03-09-2003
			JP 2004515691 T	27-05-2004
			US 2003132322 A1	17-07-2003

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6523759 B1 [0005]