



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.09.2007 Bulletin 2007/38

(51) Int Cl.:
F02M 51/06 (2006.01)

(21) Application number: **06255201.3**

(22) Date of filing: **09.10.2006**

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

(30) Priority: **14.03.2006 JP 2006068599**

(71) Applicant: **Nikki Co., Ltd.**
Kanagawa-ken 243-0801 (JP)

(72) Inventors:
• **Yamaguchi, Shinya**
Atsugi-shi, Kanagawa-ken, 243-0801 (JP)
• **Kawahara, Yumi**
Atsugi-shi, Kanagawa-ken, 243-0801 (JP)
• **Iwasaki, Masashi**
Atsugi-shi, Kanagawa-ken, 243-0801 (JP)

(74) Representative: **Merrifield, Sarah Elizabeth**
Boult Wade Tennant
Verulam Gardens
70 Gray's Inn Road
London WC1X 8BT (GB)

(54) **Fuel injection valve**

(57) In a normally closed type fuel injection valve, an accurate valve function can be achieved over a long period of time by making a durability sufficient while securing gas and liquid tightness of a valve function portion. A fuel injection valve (1) provided with a stopper core (3) forming a stationary core, a movable valve (10) having a valve member (15) in a leading end side of a rod portion (101) extending from an enlarged portion (102) forming a movable core, and a seat member (5), and the valve being closed by the urging force of a valve closing spring (16), wherein the rod portion (101) has a sliding hole (103) in a leading end side, the valve member (15) having a valve element (151) is inserted so as to be slidable in an axial direction and is urged by a coil spring (17) on a proximal end side, the urging force when the valve is closed is set weaker than the valve closing spring (16), the valve element (151) closely contacts the valve seat (52) in the state that the valve member (15) is moved backward within the sliding hole (103) by a predetermined amount so as to compress the coil spring (17) when the valve is closed, and the valve element (151) is separated from the valve seat (52) while engaging with the rod portion (101) side by a stopper (152) provided in the rear end side so as to move backward when the valve is opened.

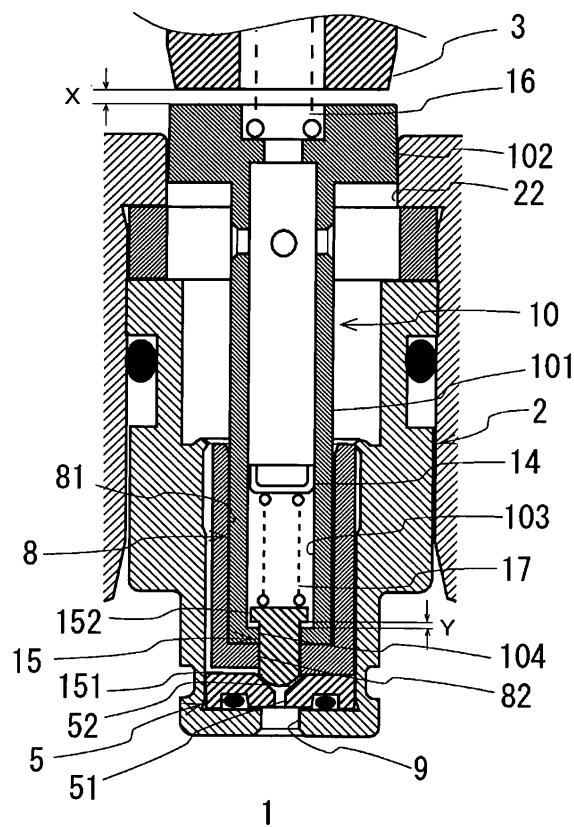


FIG.1

Description

Technical Field

[0001] The present invention relates to an electromagnetically driven type injection valve (injector) which is controlled so as to be opened and closed on the basis of an electric signal transmitted from a control apparatus and supplies a high-pressure liquid fuel or gas fuel to an engine.

Background Art

[0002] For example, there has been known an electromagnetically driven type fuel injection valve controlled so as to be opened and closed on the basis of an electric signal output from a control apparatus, for example, as described in Japanese Unexamined Utility Model Publication No. 55-180066. The electromagnetically driven type fuel injection valve generally employs a normally closed type electromagnetically driven type having a structure such that a stopper core 3 serving as a stationary core is excited by supplying an electric current to an electromagnetic coil (not shown) to attract a plunger 112 of a movable valve 11 serving as a movable core, to cause a needle 111 to move backward 111 and a valve element 110 provided in the leading end of the needle to be separated from a valve seat 52 of a seat member 5 so that the valve is opened, and the movable valve 11 is pushed back under the urging force of a valve closing spring 16 by stopping the supply of the electric current so that the valve is closed, for example, as shown in Fig. 3.

[0003] In the electromagnetically driven type fuel injection valve 100 of the normally closed type as mentioned above, it is desired that the movable valve 11 subtly responds to the electric signal, and that an accurate valve function is achieved over a long period of time. Accordingly, in the case of a liquid fuel as typified by a gasoline, a material having a comparatively high hardness and a high durability such as a metal or the like is employed for the valve element 110 and the seat member 5, taking into consideration a durability against a collision between the parts, and a high precision finish is applied to the valve functioning unit constituted by the valve element and the valve seat for securing gas and liquid tightness.

[0004] On the other hand, in the case of a fuel injection valve using a high-pressure gas fuel such as CNG, LPG or the like, it is generally harder to secure the gas and liquid tightness in the valve functioning unit than in the valve for the liquid fuel. Accordingly, it is often the case that the parts made of an elastic material having a low hardness such as a rubber, a resin or the like are used in the valve element 110 or the seat member 5 constituting the valve functioning unit, and it is intended to secure the gas and liquid tightness by utilizing the elastic deformation.

[0005] However, a "permanent set in fatigue" or a change due to abrasion occurs in the collision portion between the parts made of the elastic material, after the collisions between the parts on the basis of the valve opening and closing motion are repeated many times. The change or the deformation tends to more significantly appear than in the valve for the liquid fuel using the material having the high hardness, and a problem occurs that the durability becomes insufficient so as to make it hard to secure the accurate valve function over a long period of time.

Disclosure of the Invention

15 Technical Problem

[0006] An object of the present invention is to achieve an accurate valve function over a long period of time by solving the problem that the durability becomes insufficient and it is hard to achieve the accurate valve function over a long period of time which problem occurs in the conventional electromagnetically driven fuel injection valve of the normally closed type using the valve closing spring, for the high-pressure gas fuel such as the CNG, LPG or the like, as mentioned above, and making the durability thereof sufficient while securing the gas and liquid tightness of the valve functioning unit. Means for Solving the problem

[0007] In accordance with the present invention, there is provided an electromagnetically driven type fuel injection valve comprising: a stopper core forming a stationary core; a movable valve having a plunger portion forming a movable core on the proximal end side, a rod portion extending from the plunger portion in the leading end direction, and a valve member provided on the rod portion on the leading end side thereof; a seat member having a valve seat which a valve element of the valve member provided on the leading end side thereof closely contacts or is separated from; and the valve being closed by an urging force of a valve closing spring arranged on the proximal end side of the movable valve when an electric current is not applied. The electromagnetically driven type fuel injection valve is characterized in that the rod portion has a sliding hole at least in a portion on the leading end side, the valve member is inserted in the sliding hole so as to be slidable in an axial direction with a portion of the valve member on the leading end side thereof protruding from the leading end surface of the rod portion, a spring member arranged in the sliding hole urges the proximal end side of the valve member, and the urging force of the spring member when the valve is closed is set weaker than the valve closing spring, so that the valve member is moved backward by a predetermined amount within the sliding hole and the valve element closely contacts the valve seat with the spring member in compression when the valve is closed, and the valve member engages by a stopper provided on the valve member on the rear end side thereof with the sliding hole side and

is moved backward together with the rod portion and the valve element is separated from the valve seat when the valve is opened

[0008] In this way, the impact caused by the collision between the valve element and the valve seat can be easily absorbed, the durability becomes excellent and the excellent valve function can be achieved over a long period of time, by arranging such that the valve member is urged by the spring member in the state that the urging force is weaker than the valve closing spring and the valve member is slidable in the leading end side of the rod portion. Further, since the valve element closely contacts the valve seat in such a manner that the protruding amount of the valve member is adjusted by the spring member provided in the rod portion, it is not necessary to make the finish precision of the valve functioning unit constituted by the valve element and the valve seat high.

[0009] Further, in the case that at least one of the valve member and the valve seat is made of an elastic material, it is easy to secure a close-contact characteristic between the valve element and the valve seat, and it is possible to make the gas and liquid tightness of the valve functioning unit higher. Further, in this case, since the impact absorbing force is increased by the elasticity of the spring member having the weaker urging force than the valve closing spring, in the valve element of the valve member as mentioned above, the durability can be easily secured even if the elastic material is used in the collision portion.

Effect of the Invention

[0010] In accordance with the present invention slidably provided in such a manner as to energize the valve member by the spring member in the state in which the energizing force is weaker than the valve closing spring, in the leading end side of the movable valve, it is possible to make the durability sufficient while securing the gas and liquid tightness of the valve function portion, and it is possible to achieve the accurate valve function over a long period.

Brief Description of the Drawings

[0011]

Fig. 1 is a longitudinal cross sectional view showing a fuel injection valve in accordance with an embodiment of the present invention in the closed state;
Fig. 2 is a longitudinal cross sectional view showing the fuel injection valve in Fig. 1 in the opened state;
and
Fig. 3 is a longitudinal cross sectional view showing a prior art.

Best Mode for Carrying Out the Invention

[0012] The description will be given below of a best mode for carrying out the present invention with refer-

ence to the accompanying drawings. In this case, an elastic material in the present invention indicates a material having a comparatively low hardness such as a rubber, a resin or the like which is easily elastically deformed by applying a pressure at a normal temperature.

[0013] Fig. 1 shows a longitudinal cross sectional view of a fuel injection valve 1 in the present embodiment. A casing 2 accommodating a movable valve 10 so as to be slidable up and down within a sliding hole 22 is formed as an approximately cylindrical member and is provided with an injection hole 9 in the leading end side. A seat member 5 is arranged in the inner surface of the opening of the injection hole 9, the seat member 5 being structured such that a fuel hole 51 passes therethrough along the center thereof and a valve seat 52 is formed by cutting the upper surface at the periphery of the fuel hole in an approximately conical shape. A guide member 8 is arranged on the upper surface side of the seat member 5, the guide member 8 being formed in an approximately cylindrical shape with an open upper end, a guide hole 81 therein and an insertion hole 82 passing through the bottom wall.

[0014] Further, the movable valve 10 has at the proximal end side thereof an enlarged portion 22 serving as a plunger portion made of a magnetic material, which is enlarged in the centrifugal direction in a disc shape having the outer diameter approximately coinciding with the inner diameter of the sliding hole 22 on the proximal end side thereof, and a cylindrical rod portion 101 extends from the lower surface of the enlarged portion 22 and the outer diameter of the rod portion 101 on the leading end side thereof approximately coincides with the inner diameter of the guide hole 81 of the guide member 8, so the rod portion 101 is inserted in the guide hole 81. Further, a stopper core 3 is arranged on the proximal end side (the upper side in the figure) of the enlarged portion 102, and the stopper core 3 is constituted by a magnetic material, and serves as a stationary core excited by applying an electric current to a coil (not shown).

[0015] The rod portion 101 is a hollow member having an approximately columnar space therein an inner side, and has an insertion hole 104 passing through the bottom wall on the leading end side thereof. A lid member 14 is arranged in the hollow space on the leading end side from the center portion thereof in a close-contact state with the inner wall of the rod portion 101, the hollow space being sectioned by the lid member 14 into upper and lower spaces, in which the space on the leading end side (lower side in the figure) is formed as a sliding hole 103. A valve member 15 shaped in a cartridge case of a bullet is inserted at its proximal end portion thereof in the sliding hole 103 and is slidable therein in the axial direction (vertical direction in the figure), the leading end portion of the valve member 15 extending through the insertion hole 104.

[0016] The valve member 15 has on the proximal end thereof a stopper 152 enlarged in a flange shape, which is brought into contact with the bottom wall of the sliding

hole 103 so as to be locked, thereby preventing the valve member 15 from falling away from the sliding hole 103. Further, a coil spring 17 corresponding to a spring member is interposed between the top wall of the sliding hole 103 and the proximal end surface of the valve member 15 so as for urging the valve member 15 in the leading end direction (downward direction in the figure).

[0017] A valve element 151 on the leading end side of the valve member 15 is formed in an approximately conical shape or an approximately spherical shape, protrudes through the insertion hole 82 provided in the bottom wall of the guide member 8, and closely contacts the valve seat 52 formed by depressing the upper surface of the seat member 5 arranged on the leading end side thereof in an approximately conical shape, thereby closing the fuel hole 51. In this case, if at least one of the valve member 15 and the seat member 5 is made of an elastic material having a low hardness and being easily elastically deformable such as a rubber or the like, it is possible to further increase gas and liquid tightness of the valve functioning unit constituted by the valve element 151 and the valve seat 52.

[0018] Further, the spring pressure of the coil spring 17 urging the valve member 15 in the leading end direction is made weaker than that of the valve closing spring 16 urging the entire movable valve 10 when the valve is closed, and the urging force by which the leading end side of the valve member 15 is protruded from the leading end surface of the rod portion 101 is set weaker than the urging force of the valve closing spring 16 when the valve is closed. Accordingly, when the leading end surface of the rod portion 101 is brought into contact with the bottom wall of the guide member 8 and the rod portion 101 is stopped by being urged by the valve closing spring 16, the valve member 15 is moved backward at a predetermined amount within the sliding hole 103 and the coil spring 17 is compressed, with the valve element 151 in close contact with the valve seat 52. This point corresponds to the remarkable feature of the present invention.

[0019] Next, the description will be given of the operation of the present embodiment with reference to Figs. 1 and 2.

[0020] Fig. 1 is a longitudinal cross sectional view showing the fuel injection valve 1 in accordance with the present embodiment in the closed state. An electric current is not supplied to the coil (not shown), the stopper core 3 is under a non-excited state, the movable valve 10 is moved in the leading end direction by the urging force of the valve closing spring 16, and the valve element 151 of the valve member 15 protruding from the leading end side of the rod portion 101 closely contacts the valve seat 52 of the seat member 5, whereby the fuel hole 51 becomes in the closed state.

[0021] At this time, a gap X is formed between the rear end surface of the enlarged portion 102 of the movable valve 10 and the stopper core 3, and this is the amount of the valve stroke. Further, the valve member 15 is moved backward within the sliding hole 103 of the mov-

able valve 10, while compressing the coil spring 17 by the amount Y. In other words, the coil spring 17 is set such that the urging force thereof is weaker than that of the valve closing spring 16 at this time, and the dimensional relation between the members is set such that the valve member 15 protrudes in the state that the valve element 151 on the leading end side closely contacts the valve seat 52 and the rear end side of the valve member 15 is moved backward within the sliding hole 103 by the amount Y, when the leading end surface of the rod portion 101 is brought into contact with the bottom surface of the guide member 8.

[0022] Further, the stopper core 3 is excited by supplying the electric current to the coil (not shown) and the movable valve 10 is attracted by the amount X against the urging force of the valve closing spring 16, thereby the movable valve 10 contacts the stopper core 3 so as to form the state shown in Fig. 2. At this time, the rod portion 101 is also moved backward (lifted up) by the amount X, the amount X is larger than the amount Y of the backward movement of the valve member 15 within the sliding hole 103 as mentioned above, and the valve element 151 is separated from the valve seat 52 due to this difference of the amounts so as to open the valve.

[0023] In accordance with the structure mentioned above, since it is possible to reduce the impact generated between the valve element 151 and the valve seat 52 during the valve closing motion, and it is possible to make the pressing force when the valve is closed smaller than the conventional fuel injection valve to which the urging force of the valve closing spring 16 is directly applied, it is easy to secure the durability of the valve functioning unit. Further, since an allowable range corresponding to the amount Y exists when the valve is closed in the valve functioning unit, an accurate valve function can be easily achieved even if the finish precision is not high, and the present invention is advantageous in reducing the cost.

[0024] Particularly, in the case that the elastic material is employed for the valve seat or the valve element in the light of securing the gas and liquid tightness of the valve functioning unit, at a time of using the gas fuel such as CNG, LPG or the like for the used fuel, it is possible to easily reduce the impact and the pressure applied to the member made of the elastic material in accordance with the present invention. Accordingly, it is easy to secure the durability thereof and it is possible to achieve an accurate valve function over a long period of time.

Claims

1. An electromagnetically driven type fuel injection valve comprising:

a stopper core (3) forming a stationary core;
a movable valve (10) having a plunger portion (102) forming a movable core on the proximal end side, a rod portion (101) extending from the

plunger portion (102) in the leading end direction, and a valve member (15) provided on the rod portion (101) on the leading end side thereof; a seat member (5) having a valve seat (52) which a valve element (151) of the valve member (15) provided on the leading end side thereof closely contacts or is separated from; and the valve being closed by an urging force of a valve closing spring (16) arranged on the proximal end side of the movable valve (10) when an electric current is not applied;

characterized in that the rod portion (101) has a sliding hole (103) at least in a portion on the leading end side, the valve member (15) is inserted in the sliding hole (103) so as to be slidable in an axial direction with a portion of the valve member (15) on the leading end side thereof protruding from the leading end surface of the rod portion (101), a spring member (17) arranged in the sliding hole (103) urges the proximal end side of the valve member (15), and the urging force of the spring member (17) when the valve is closed is set weaker than the valve closing spring (16), so that the valve member (15) is moved backward by a predetermined amount within the sliding hole and the valve element (151) closely contacts the valve seat (52) with the spring member (16) in compression when the valve is closed, and the valve member (15) engages by a stopper provided on the valve member (15) on the rear end side thereof with the sliding hole side and is moved backward together with the rod portion (102) and the valve element (152) is separated from the valve seat when the valve is opened.

2. The fuel injection valve as claimed in claim 1, **characterized in that** at least one of the valve member (15) and the valve seat (52) is made of an elastic material.

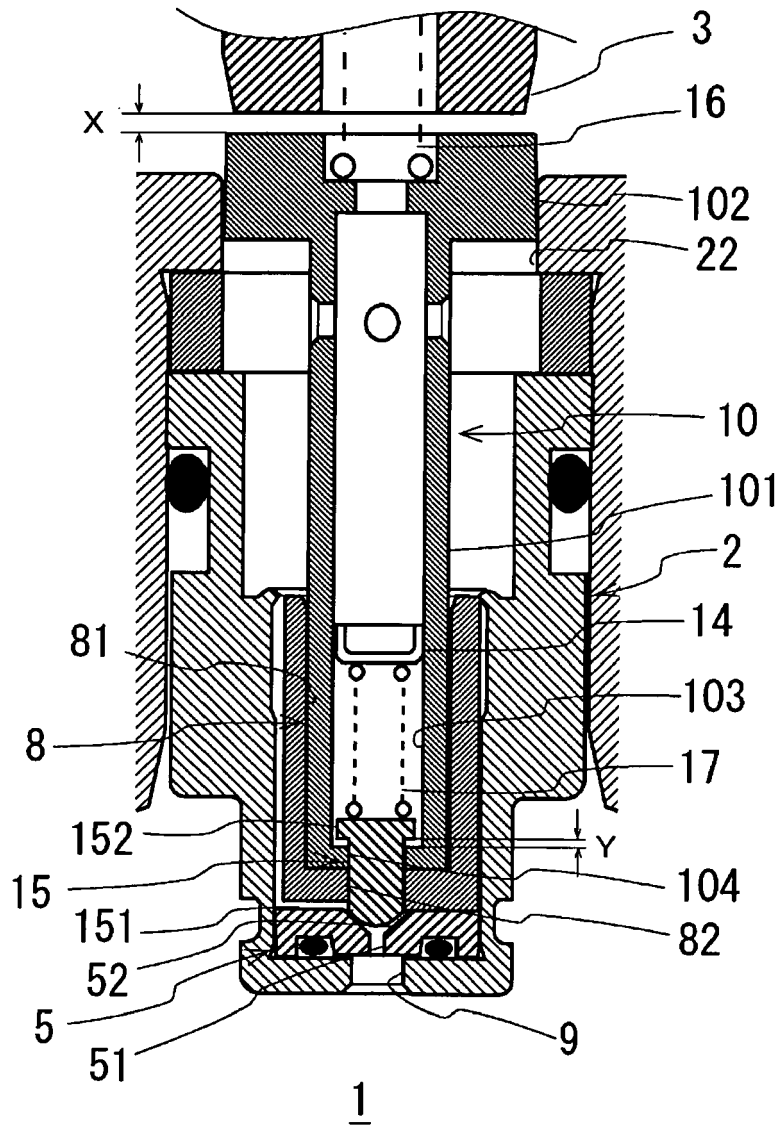


FIG.1

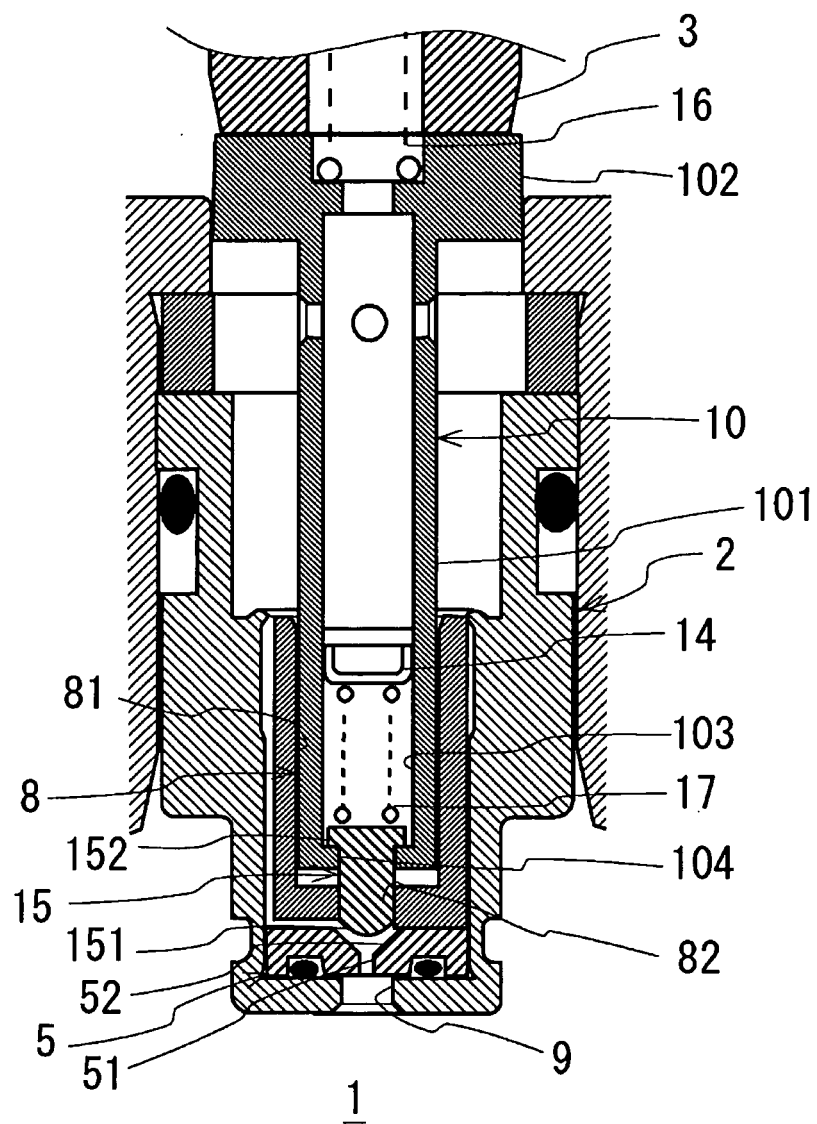


FIG.2

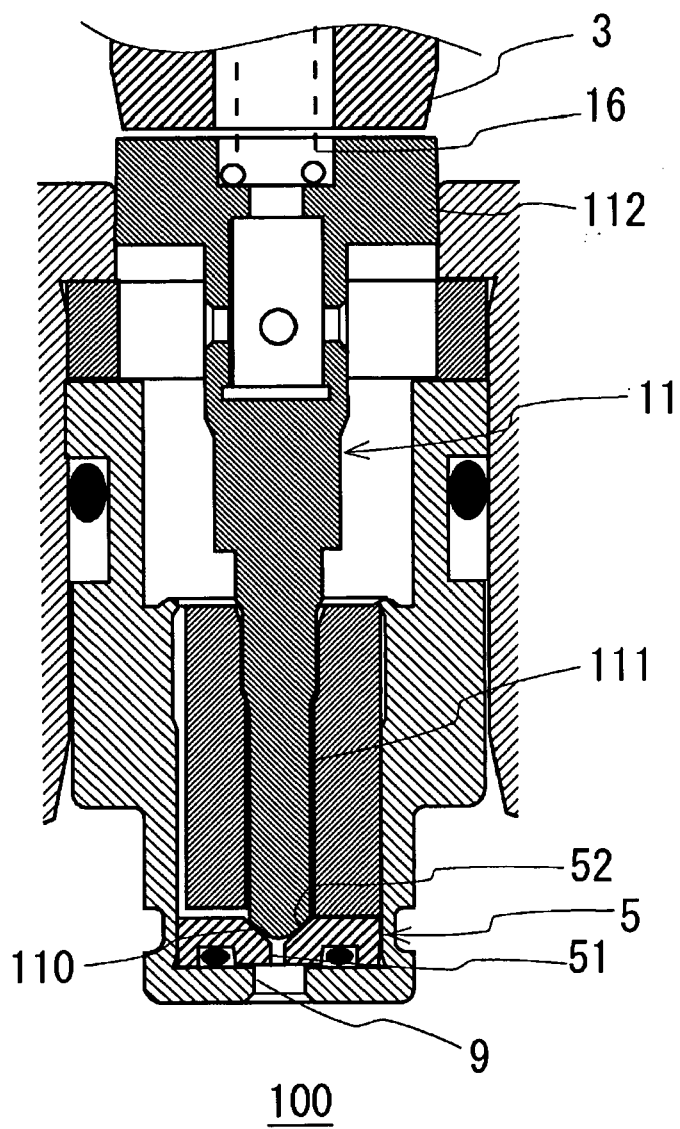


FIG.3



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 1 460 263 A (SIEMENS AG [DE]) 22 September 2004 (2004-09-22) * column 2, paragraph 11 - column 3, paragraph 15; figures 1,2 * * column 4, paragraph 20 *	1,2	INV. F02M51/06
A	DE 198 49 210 A1 (BOSCH GMBH ROBERT [DE]) 27 April 2000 (2000-04-27) * column 3, line 42 - column 4, line 42; figure 1 *	1,2	
A	WO 02/053906 A (BOSCH GMBH ROBERT [DE]; SEBASTIAN THOMAS [DE]) 11 July 2002 (2002-07-11) * abstract; figures 1,2 *	1,2	
A	EP 1 199 465 A2 (HITACHI LTD [JP]; HITACHI CAR ENG CO LTD [JP]) 24 April 2002 (2002-04-24) * column 8, paragraph 48 - column 9, paragraph 55; figures 2,3 *	1,2	
A	EP 1 482 165 A (SIEMENS AG [DE]) 1 December 2004 (2004-12-01) * column 2, paragraph 8; figures 1,2A-C *	1,2	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 8 December 2006	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			

 1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 06 25 5201

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

08-12-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1460263	A	22-09-2004	NONE
DE 19849210	A1	27-04-2000	CZ 20002388 A3 14-03-2001 WO 0025018 A1 04-05-2000 EP 1045974 A1 25-10-2000 JP 2002528672 T 03-09-2002 US 6367769 B1 09-04-2002
WO 02053906	A	11-07-2002	DE 10065528 A1 04-07-2002 EP 1350025 A1 08-10-2003 ES 2238488 T3 01-09-2005 JP 2004517255 T 10-06-2004 US 2003141476 A1 31-07-2003
EP 1199465	A2	24-04-2002	DE 60114971 D1 22-12-2005 DE 60114971 T2 10-08-2006 JP 3734702 B2 11-01-2006 JP 2002130071 A 09-05-2002 US 2002043575 A1 18-04-2002
EP 1482165	A	01-12-2004	NONE

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 55180066 U [0002]