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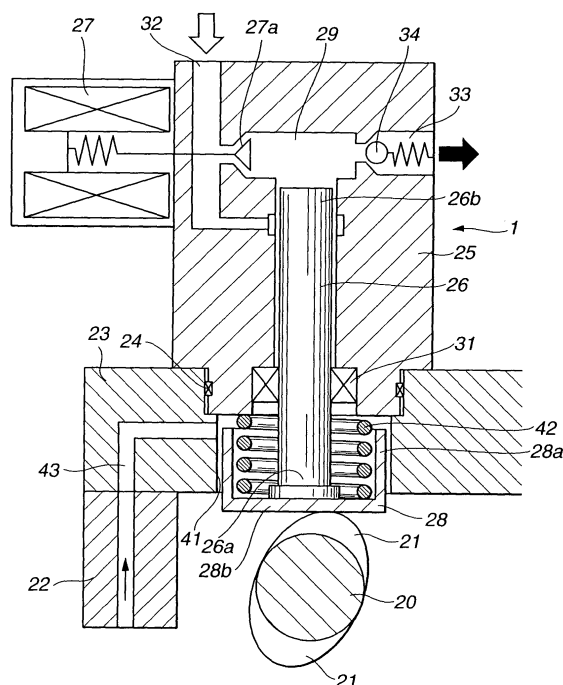
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### (54) Lubricant supply unit of high pressure fuel pump

(57) A lubricant supply unit of a fuel pump (1) includes: 1) a pump plunger (26) moving up and down for pressurizing a fuel, the pump plunger (26) having a lower end (26a); 2) a cam (20, 21) making a rotation; 3) a lifter (28) disposed in such a manner as to oppose the lower end (26a) of the pump plunger (26), the lifter (28) having a bottom wall portion (28b) on which the cam (20, 21) abuts, the lifter (28) making a slidable movement up and down by the rotation of the cam (20, 21); and 4) a lifter guide (23) mating with the lifter (28) in such a manner as to allow the lifter (28) to make the slidable movement up and down in the lifter guide (23), the lifter guide (23) being formed with a lubricant supply hole (51) for supplying a lubricant to a sliding face of the lifter guide (23) and a sliding face of the lifter (28), the lubricant supply hole (51) opening in an inner wall face of the lifter guide (23). The lubricant supply hole (51) is disposed at such a height that the lifter (28) at a bottom dead center allows a first part of the lubricant supply hole (51) to open at an upper end of the lifter (28) and a second part of the lubricant supply hole (51) to be covered with an outer periphery of the lifter (28).

**FIG. 1**



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## Description

### BACKGROUND OF THE INVENTION

#### 1. FIELD OF THE INVENTION

**[0001]** The present invention relates to a high pressure fuel pump including a pump plunger driven by means of a rotating cam.

**[0002]** Especially, the present invention relates to a lubricant supply unit for lubricating a lifter which moves up and down (round trip) with an abutment on the cam.

#### 2. DESCRIPTION OF THE RELATED ART

**[0003]** A high pressure fuel pump of an internal combustion engine of high pressure injection type includes a pump plunger which is moved up and down, by means of a cam of a cam shaft, via a cylindrical bottomed lifter. The above high pressure fuel pump is supposed to have a lubricant supply unit for lubricating the lifter sliding in a lifter guide.

**[0004]** Japanese Patent Unexamined Publication No. Heisei 8 (1996)-49632 (= JP8049632) discloses a lubricant supply unit.

**[0005]** The lubricant supply unit according to Japanese Patent Unexamined Publication No. Heisei 8 (1996)-49632 (= JP8049632) has a lifter guide having an inner wall face formed with a lubricant supply hole for supplying a lubricant to a sliding face of the lifter guide and a sliding face of a lifter. The thus formed lubricant supply hole are opened and closed in accordance with up-and-down movement of the lifter acting as a valve of the lubricant supply hole.

#### BRIEF SUMMARY OF THE INVENTION

**[0006]** The lubricant supply unit according to Japanese Patent Unexamined Publication No. Heisei 8 (1996)-49632 (= JP8049632) having the above construction may allow the lifter at its top dead center and/or its bottom dead center to completely open the lubricant supply hole, thus greatly fluctuating lubricant pressure of an entire hydraulic pressure system of the internal combustion engine during operation of the high pressure fuel pump, and thereby fluctuating an amount of the lubricant to be supplied to other sliding areas. The entire hydraulic pressure system having the thus fluctuating lubricant may cause seizure and wear to the sliding areas in a period of reduced amount of lubricant. Preventing the fluctuation in the lubricant (namely, potential seizure and wear) is, however, supposed to use a flow rate controller such as an orifice, resulting in increase in cost.

**[0007]** In addition, operating the high pressure fuel pump may cause a bearing pressure distribution to a side face of the lifter, which distribution can be determined relative to rotational direction of a cam.

**[0008]** The lubricant supply unit according to Japanese Patent Unexamined Publication No. Heisei 8 (1996)-49632 (= JP8049632), however, does not take into account the bearing pressure.

**[0009]** Forming the lubricant supply hole in a position having the high bearing pressure means a reduction in a pressure-applicable area by an area covered by the lubricant supply hole, thus further increasing the bearing pressure in the position. In addition, forming the lubricant supply hole in the position having the high bearing pressure may increase the bearing pressure relative to the supplied lubricant pressure, thus causing shortage of the lubricant to the side face of the lifter. As a result, the lifter and the lifter guide are likely to cause seizure and wear.

**[0010]** It is therefore an object of the present invention to provide a lubricant supply unit of a high pressure fuel pump.

**[0011]** According to a first aspect of the present invention, there is provided a lubricant supply unit of a fuel pump (1).

The lubricant supply unit comprises:

- 1) a pump plunger (26) moving up and down for pressurizing a fuel, the pump plunger (26) having a lower end (26a);
- 2) a cam (20, 21) making a rotation;
- 3) a lifter (28) disposed in such a manner as to oppose the lower end (26a) of the pump plunger (26), the lifter (28) having a bottom wall portion (28b) on which the cam (20, 21) abuts, the lifter (28) making a slidable movement up and down by the rotation of the cam (20, 21); and
- 4) a lifter guide (23) mating with the lifter (28) in such a manner as to allow the lifter (28) to make the slidable movement up and down in the lifter guide (23), the lifter guide (23) being formed with a lubricant supply hole (51) for supplying a lubricant to a sliding face of the lifter guide (23) and a sliding face of the lifter (28), the lubricant supply hole (51) opening in an inner wall face of the lifter guide (23).

**[0012]** The lubricant supply hole (51) is disposed at such a height that the lifter (28) at a bottom dead center allows a first part of the lubricant supply hole (51) to open at an upper end of the lifter (28) and a second part of the lubricant supply hole (51) to be covered with an outer periphery of the lifter (28).

**[0013]** According to a second aspect of the present invention, there is provided a lubricant supply unit of a fuel pump (1).

The lubricant supply unit comprises:

- 1) a pump plunger (26) moving up and down for pressurizing a fuel, the pump plunger (26) having a lower end (26a);
- 2) a cam (20, 21) making a rotation;
- 3) a lifter (28) disposed in such a manner as to op-

pose the lower end (26a) of the pump plunger (26), the lifter (28) having a bottom wall portion (28b) on which the cam (20, 21) abuts, the lifter (28) making a slidable movement up and down by the rotation of the cam (20, 21); and

4) a lifter guide (23) mating with the lifter (28) in such a manner as to allow the lifter (28) to make the slidable movement up and down in the lifter guide (23), the lifter guide (23) being formed with a lubricant supply hole (56) for supplying a lubricant to a sliding face of the lifter guide (23) and a sliding face of the lifter (28), the lubricant supply hole (56) opening in an inner wall face of the lifter guide (23).

**[0014]** The lubricant supply hole (56) is disposed at such a height that the lifter (28) at a top dead center allows a first part of the lubricant supply hole (56) to open at a lower end of the lifter (28) and a second part of the lubricant supply hole (56) to be covered with an outer periphery of the lifter (28).

**[0015]** The other objects and features of the present invention will become understood from the following description with reference to the accompanying drawings. BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

**[0016]** Fig. 1 shows an overall construction of a high pressure fuel pump 1 under the present invention.

**[0017]** Fig. 2 shows an entire fuel system of an internal combustion engine using high pressure fuel pump 1.

**[0018]** Fig. 3 shows a cross section of an essential part of high pressure fuel pump 1, according to a first embodiment of the present invention.

**[0019]** Fig. 4 shows a cross section taken along lines IV-IV in Fig. 3.

**[0020]** Fig. 5 shows a behavior of a lifter 28 as well as relation of a pump load F1, a reactive force F2 and a pressing load F3, when high pressure fuel pump 1 is under operation.

**[0021]** Fig. 6 shows a cross section showing a bearing pressure distribution between lifter 28 and a guide hole 41.

**[0022]** Fig. 7 shows a cross section (similar to the cross section in Fig. 4), according to a second embodiment of the present invention.

**[0023]** Fig. 8 shows a cross section of the essential part of high pressure fuel pump 1, according to a third embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE EMBODIMENT

**[0024]** In the following, various embodiments of the present invention will be described in detail with reference to the accompanying drawings.

**[0025]** For ease of understanding, the following description will contain various directional terms, such as, left, right, upper, lower, forward, rearward and the like. However, such terms are to be understood with respect to only a drawing or drawings on which the correspond-

ing part of element is illustrated.

**[0026]** Fig. 1 shows an overall construction of a high pressure fuel pump 1 under the present invention.

**[0027]** Fig. 2 shows an entire fuel system of an internal combustion engine using high pressure fuel pump 1. Herein, fuel is directly injected into a cylinder of the internal combustion engine.

**[0028]** More specifically, Fig. 2 shows a fuel tank 2, a low pressure feed pump 3, an electric motor 4, a fuel filter 5 and a low pressure regulator 6. Low pressure feed pump 3 is disposed in fuel tank 2. Electric motor 4 drives low pressure feed pump 3. Low pressure regulator 6 regulates the fuel supplied from low pressure feed pump 3 at a predetermined pressure (0.3 MPa to 0.5 MPa). Subsequently, the thus regulated fuel is conveyed into high pressure fuel pump 1.

**[0029]** High pressure fuel pump 1 is mechanically driven by means of a cam shaft 20 interlocked with a crank shaft of the internal combustion engine (to be described afterward). The pressure so pressurized (at its peak of 10 MPa to 20 MPa) by means of high pressure fuel pump 1 is then conveyed, by way of a high pressure fuel pass 8, to a fuel injection valve 9 of each cylinder of the internal combustion engine. Subsequently, the thus conveyed fuel is injected into each cylinder, in accordance with an injection signal from an engine control module 11.

**[0030]** The fuel pressure in high pressure fuel pass 8 is sensed with a fuel pressure sensor 10. The thus sensed fuel pressure is a base for variably controlling fuel supply (amount) of high pressure fuel pump 1, to obtain a predetermined fuel pressure.

**[0031]** Moreover in Fig. 2, there are provided a relief pass 12 and a relief valve 13 extending toward fuel tank 2, while there is provided a return pass 14 for returning to fuel tank 2 low pressure fuel leaked from high pressure fuel pump 1.

**[0032]** In general, cam shaft 20 also acts as a part of a dynamic valve system of the internal combustion engine. In other words, cam shaft 20 has a part provided properly with a pair of cam lobes 21 for driving high pressure fuel pump 1.

**[0033]** As is seen in Fig. 1, high pressure fuel pump 1 is disposed above a cylinder head 22 so that high pressure fuel pump 1 can be disposed above cam shaft 20.

**[0034]** High pressure fuel pump 1 includes a lifter guide 23, a pump housing 25, a pump plunger 26 and an electromagnetic control valve 27. Lifter guide 23 also acts as a member for mounting high pressure fuel pump 1. Pump housing 25 is fixed to lifter guide 23 by way of a lubricant seal 24. Pump plunger 26 is substantially cylindrical, and is disposed in substantially the center of pump housing 25 in such a manner as to move up and down. The above described variable control of the fuel supply (amount) of high pressure fuel pump 1 is carried out by means of electromagnetic control valve 27.

**[0035]** Pump plunger 26 has a lower end 26a protruding down from pump housing 25, and cam shaft 20

presses lower end 26a by way of a lifter 28. Moreover, pump plunger 26 has an upper end 26b for pressurizing the fuel in a pressurizing chamber 29.

**[0036]** A seal member 31 seals an area defined between pump plunger 26 and pump housing 25. Pump housing 25 has a low pressure fuel inlet 32 connecting to low fuel pressure fuel pass 7 (see Fig. 1), and a high pressure fuel outlet 33 connecting to high pressure fuel pass 8 (see Fig. 1).

**[0037]** Low pressure fuel pass 32 connects to pressurizing chamber 29 by way of a valve body 27a of electromagnetic control valve 27, while high pressure fuel outlet 33 connects to pressurizing chamber 29 by way of a check valve 34.

**[0038]** Electromagnetic control valve 27 controls timing of opening and closing valve body 27a, thereby variably controlling the fuel which is supplied from pressurizing chamber 29 to high pressure fuel outlet 33 in accordance with strokes of pump plunger 26.

**[0039]** Lifter 28 is shaped substantially into a bottomed cylinder having a cylindrical side wall portion 28a and a bottom wall portion 28b disposed beneath side wall portion 28a. Lifter 28 mates with a cylindrical guide hole 41 of lifter guide 23 in such a manner as to slide up and down and make a rotation. Lifter 28 is substantially concentric with pump plunger 26.

**[0040]** Moreover, lower end 26a of pump plunger 26 abuts on an inner face (upper face in Fig. 1) of bottom wall portion 28b of lifter 28. Furthermore, a return spring 42 disposed inside lifter 28 can continuously bias lifter 28 toward cam shaft 20, thereby allowing a bottom face (lower face in Fig. 1) of bottom wall portion 28b to abut on cam lobe 21.

**[0041]** In sum, operation of cam lobe 21 in accordance with rotation of cam shaft 20 can move lifter 28 up and down. Integrally with lifter 28, pump plunger 26 can make movement up and down (round trip). When viewed in a direction indicated by an arrow Z in Fig. 2, cam shaft 20 has its center line substantially orthogonal to a center line of lifter 28 such that cam lobe 21 with its maximum lift can press substantially the center of lifter 28.

**[0042]** A lubricant of the internal combustion engine lubricates an area defined between lifter 28 and lifter guide 23. Herein, the lubricant is supplied through a lubricant pass 43 formed in cylinder head 22 and lifter guide 23.

**[0043]** Fig. 3 and Fig. 4 show details of lifter 28 and a lubrication mechanism of lifter 28, according to a first embodiment of the present invention.

**[0044]** Fig. 5 shows a behavior of lifter 28, while Fig. 6 shows bearing pressure (face pressure) caused by the behavior of lifter 28.

**[0045]** As is seen in Fig. 5, there is defined an initial abutment point C of cam lobe 21 on the bottom face (lower face in Fig. 5) of bottom wall portion 28b of lifter 28. Rotation of cam shaft 20 in a direction  $\omega$  allows initial abutment point C to be deflected rightward in Fig. 5 from

the center of lifter 28.

**[0046]** Pressurizing the fuel with pump plunger 26 causes a pump load F1 to act along the center line of pump plunger 26, as is seen in Fig. 5, and thereby pump load F1 causes a reactive force F2 to initial abutment point C. Pump load F1 and reactive force F2 offset from each other may turn lifter 28 counterclockwise, as is seen in Fig. 5. In direction  $\omega$  of cam shaft 20, there may be caused a pressing load F3 for pressing (biasing) lifter 28 horizontally.

**[0047]** As a result, lifter 28 is strongly pressed radially to an inner periphery of guide hole 41 of lifter guide, in two portions, namely, a first portion A and a second portion B. First portion A abuts on an upper portion of lifter 28, while second portion B abuts on a lower portion of lifter 28. With pressing load F3 applied to first portion A, first portion A may have greater bearing pressure than second portion B. In other words, first portion A may have the greatest circumferential bearing pressure.

**[0048]** Fig. 6 shows a circumferential bearing pressure distribution of lifter 28. The scale of the bearing pressure can be depicted by radial expansion. Herein, the bearing pressure can be seen in only two portions, namely, the first portion A and second portion B which are disposed along a rotational plane of cam lobe 21, leaving substantially no (zero) bearing pressure in other area (including in a direction orthogonal to the rotational plane of cam lobe 21). Herein, Fig. 6 also shows a maximum bearing pressure portion A'.

**[0049]** Lifter 28 and the lubrication mechanism of lifter 28 in Fig. 3 and Fig. 4 according to the first embodiment of the present invention mainly take into account the lubrication at first portion A in Fig. 5 and Fig. 6.

**[0050]** As is seen in Fig. 4, a pair of upper lubricant supply holes 51 are formed substantially symmetrical in such a manner as to open on respective sides of first portion A which is a high bearing pressure area. A first radial line R1 of guide hole 41 (otherwise, of lifter guide 23) is disposed between the pair of upper lubricant supply holes 51. Upper lubricant supply hole 51 is an outlet of lubricant pass 43.

**[0051]** More specifically, first portion A has a third portion D having the bearing pressure of substantially 0 and included in an end opening of upper lubricant supply hole 51 shaped substantially into a circle. Moreover, upper lubricant supply hole 51 extends in a direction along a second radial line R2 of guide hole 41 (otherwise, of lifter guide 23).

**[0052]** The pair of upper lubricant supply holes 51 are the same in level in an axial direction of guide hole 41. Especially, as is seen in Fig. 3, lifter 28 at a bottom dead center causes the end opening of upper lubricant supply hole 51 to be disposed in such a height as to be partly open.

**[0053]** More specifically, side wall portion 28a of lifter 28 has an upper end formed with a chamfer 52 shaped substantially into a taper. Lifter 28 at the bottom dead center allows a boundary line 53 (defined between a ver-

tical face of side wall portion 28a and chamfer 52) to intersect with the end opening of upper lubricant supply hole 51. In other words, boundary line 53 is in such a position as to pass through (for example) substantially a center of the end opening of upper lubricant supply hole 51, with lifter 28 at the bottom dead center. Herein, as is seen in Fig. 3, bottom wall portion 28b of lifter 28 is formed with a plurality of through communication holes 54.

**[0054]** With the construction of lifter 28 and the lubrication mechanism of lifter 28, according to the first embodiment described above, a lubricant pressurized by means of a lubricant pump (not shown) of the internal combustion engine may be continuously discharged from upper lubricant supply hole 51, and thereby supplied to a clearance 55 defined between lifter 28 and guide hole 41's wall.

**[0055]** As is seen in Fig. 4, the pair of upper lubricant supply holes 51 supply the lubricant to the respective sides of first portion A (high bearing pressure area), thereby securely lubricating an area in the vicinity of first portion A. In addition, upper lubricant supply holes 51 not opening to first portion A (high bearing pressure area) can prevent further increase in bearing pressure of first portion A (high bearing pressure area).

**[0056]** Lifter 28 at the bottom dead center may partly open an upper part of upper lubricant supply hole 51, as is seen in Fig. 3. With this, a first portion of the lubricant may flow into clearance 55, as indicated with a single downward arrow in Fig. 3. On the other hand, as indicated with three sequential arrows in Fig. 3, a second portion of the lubricant may pass, by way of chamfer 52, over side wall portion 28a of lifter 28 to flow into lifter 28, thus lubricating a contact defined between lower end 26a of pump plunger 26 and bottom wall portion 28b of lifter 28. Also lubricated with the second portion of the lubricant includes return spring 42.

**[0057]** Thereafter, the second portion of the lubricant in lifter 28 may drop down by way of communication hole 54, thus lubricating a contact defined between cam shaft 20 and lifter 28.

**[0058]** Herein, even at the bottom dead center it is only part of upper lubricant supply hole 51 that is opened with lifter 28, thus preventing great decrease in the lubricant pressure in lubricant pass 43. In other words, decrease in the lubricant pressure in lubricant pass 43 is relatively small. Thereby, lubrication of other sliding areas is unlikely to be influenced. In sum, the construction of lifter 28 and the lubrication mechanism of lifter 28 according to the first embodiment can control fluctuation in lubricant pressure in the entire lubrication system and secure lubrication of members including those disposed inside lifter 28.

**[0059]** In addition, according to the first embodiment, upper lubricant supply hole 51 can be opened and closed by way of chamfer 52, thus eliminating the need for excessive reduction in axial length of side wall portion 28a. This can allow lifter 28 to open and close upper

lubricant supply hole 51 with stabilized movement (round trip) of lifter 28.

**[0060]** Fig. 7 shows details of lifter 28 with the pair of the upper lubricant supply holes 51 directing otherwise than those in Fig. 4, according to a second embodiment of the present invention.

**[0061]** According to the second embodiment, the pair of upper lubricant supply holes 51 are inclined inward with each other. In other words, each of the pair of upper lubricant supply holes 51 is inclined inward relative to second radial line R2 of guide hole 41 (otherwise, of lifter guide 23) in such a manner as to direct toward first portion A which is the high bearing pressure area. Herein, second radial line R2 passes through substantially the center of the end opening of upper lubricant supply hole 51. Like upper lubricant supply hole 51 in Fig. 4 according to the first embodiment, upper lubricant supply hole 51 in Fig. 7 according to the second embodiment is opened in the position including third portion D having the bearing pressure of substantially 0.

**[0062]** The thus inclined upper lubricant supply hole 51 in Fig. 7 can guide, toward first portion A (high bearing pressure area), the lubricant supplied to clearance 55 (see Fig. 3), thus further improving lubrication of first portion A.

**[0063]** Fig. 8 shows details of lifter 28, according to a third embodiment of the present invention.

**[0064]** In addition to upper lubricant supply hole 51 at first portion A in Fig. 3 and Fig. 4 according to the first embodiment or upper lubricant supply hole 51 at first portion A in Fig. 7 according to the second embodiment, there is provided a lower lubricant supply hole 56 in Fig. 8 according to the third embodiment.

**[0065]** Like the pair of upper lubricant supply holes 51 relative to first portion A according to the first embodiment and the second embodiment, a pair of lower lubricant supply holes 56 according to the third embodiment are disposed on respective sides of second portion B in a form of a symmetry. First radial line R1 of guide hole 41 (otherwise, of lifter guide 23) is disposed between the pair of lower lubricant supply holes 56. Second portion B has a portion (corresponding to its counterpart, namely, third portion D in Fig. 4 and Fig. 7) having bearing pressure of substantially 0 and included in an end opening of lower lubricant supply hole 56.

**[0066]** Lifter 28 at a top dead center in the axial direction of guide hole 41 allows an end opening of lower lubricant supply hole 56 to partly open due to a lower end of lifter 28.

**[0067]** The construction of lifter 28 and the lubrication mechanism of lifter 28 according to the third embodiment allow the pair of lower lubricant supply holes 56 to securely lubricate second portion B (high bearing pressure area second to first portion A), thus securely preventing local wear or seizure.

**[0068]** Lifter 28 at the top dead center can partly open lower lubricant supply hole 56, thus blowing the lubricant to cam lobe 21 and thereby further lubricating the area

between cam lobe 21 and lifter 28. Herein, even at the top dead center it is only part of lower lubricant supply hole 56 that is opened with lifter 28, thus preventing great decrease in the lubricant pressure in a lubricant pass (counterpart of lubricant pass 43 in Fig. 1).

**[0069]** Although the present invention has been described above by reference to certain embodiments, the present invention is not limited to the embodiments described above. Modifications and variations of the embodiments described above will occur to those skilled in the art, in light of the above teachings.

**[0070]** This application is based on a prior Japanese Patent Application No. P2002-064669 (filed on March 11, 2002 in Japan). The entire contents of the Japanese Patent Application No. P2002-064669 from which priority is claimed is incorporated herein by reference, in order to take some protection against mis-translation or omitted portions.

**[0071]** The scope of the present invention is defined with reference to the following claims.

## Claims

1. A lubricant supply unit of a fuel pump (1), comprising:
  - 1) a pump plunger (26) moving up and down for pressurizing a fuel, the pump plunger (26) having a lower end (26a);
  - 2) a cam (20,21) making a rotation;
  - 3) a lifter (28) disposed in such a manner as to oppose the lower end (26a) of the pump plunger (26), the lifter (28) having a bottom wall portion (28b) on which the cam (20, 21) abuts, the lifter (28) making a slidable movement up and down by the rotation of the cam (20, 21); and
  - 4) a lifter guide (23) mating with the lifter (28) in such a manner as to allow the lifter (28) to make the slidable movement up and down in the lifter guide (23), the lifter guide (23) being formed with a lubricant supply hole (51) for supplying a lubricant to a sliding face of the lifter (28), the lubricant supply hole (51) opening in an inner wall face of the lifter guide (23),  
the lubricant supply hole (51) being disposed at such a height that the lifter (28) at a bottom dead center allows a first part of the lubricant supply hole (51) to open at an upper end of the lifter (28) and a second part of the lubricant supply hole (51) to be covered with an outer periphery of the lifter (28).
2. The lubricant supply unit of the fuel pump (1) as claimed in claim 1, wherein  
the upper end of the lifter (28) is formed with a chamfer (52), and

the first part of the lubricant supply hole (51) at the bottom dead center is open via the chamfer (52).

3. The lubricant supply unit of the fuel pump (1) as claimed in claim 1, wherein  
the lubricant supply unit of the fuel pump (1) further comprises another lubricant supply hole (56) disposed lower than the lubricant supply hole (51),  
the another lubricant supply hole (56) in a circumferential direction of the lifter guide (23) is disposed on a side having an initial abutment point (C) for allowing a cam lobe (21) of the cam (20, 21) to abut initially on the bottom wall portion (28b) of the lifter (28) in a direction of the rotation of the cam (20, 21), and  
the side of the another lubricant supply hole (56) is opposite to a side of the lubricant supply hole (51), in the circumferential direction of the lifter guide (23).
4. A lubricant supply unit of a fuel pump (1), comprising:
  - 1) a pump plunger (26) moving up and down for pressurizing a fuel, the pump plunger (26) having a lower end (26a);
  - 2) a cam (20, 21) making a rotation;
  - 3) a lifter (28) disposed in such a manner as to oppose the lower end (26a) of the pump plunger (26), the lifter (28) having a bottom wall portion (28b) on which the cam (20, 21) abuts, the lifter (28) making a slidable movement up and down by the rotation of the cam (20, 21); and
  - 4) a lifter guide (23) mating with the lifter (28) in such a manner as to allow the lifter (28) to make the slidable movement up and down in the lifter guide (23), the lifter guide (23) being formed with a lubricant supply hole (56) for supplying a lubricant to a sliding face of the lifter (28), the lubricant supply hole (56) opening in an inner wall face of the lifter guide (23),  
the lubricant supply hole (56) being disposed at such a height that the lifter (28) at a top dead center allows a first part of the lubricant supply hole (56) to open at a lower end of the lifter (28) and a second part of the lubricant supply hole (56) to be covered with an outer periphery of the lifter (28).
5. The lubricant supply unit of the fuel pump (1) as claimed in claim 4, wherein  
the lubricant supply unit of the fuel pump (1) further comprises another lubricant supply hole (51) disposed upper than the lubricant supply hole (56), the lubricant supply hole (56) in a circumferential direction of the lifter guide (23) is disposed on a side

having an initial abutment point (C) for allowing a cam lobe (21) of the cam (20, 21) to abut initially on the bottom wall portion (28b) of the lifter (28) in a direction of the rotation of the cam (20, 21), and

the side of the lubricant supply hole (56) is opposite to a side of the another lubricant supply hole (51), in the circumferential direction of the lifter guide (23). 5

6. The lubricant supply unit of the fuel pump (1) as claimed in any one of claim 1 to claim 5, wherein the lubricant supply hole (51, 56) is open in a portion (D) that is free from a high bearing pressure area (A, B) in a circumferential direction of the lifter guide (23), the high bearing pressure area (A, B) being an intersection of the cam (20, 21)'s rotational plane and the lifter guide (23)'s inner wall face, and the portion (D) for the open lubricant supply hole (51, 56) is disposed in a vicinity of the high bearing pressure area (A, B) having a bearing pressure higher than a bearing pressure of another area of the lifter guide (23). 10 15 20

7. The lubricant supply unit of the fuel pump (1) as claimed in claim 6, wherein the lubricant supply hole (51, 56) comprises a pair of the lubricant supply holes (51, 56) which are disposed at a common height in such a manner as to form substantially a symmetry with each other putting therebetween a first radial line (R1) of the lifter guide (23). 25 30

8. The lubricant supply unit of the fuel pump (1) as claimed in claim 7, wherein the pair of the lubricant supply holes (51, 56) are disposed respectively on a first side and a second side of the high bearing pressure area (A, B) which is the intersection of the cam (20, 21)'s rotational plane and the lifter guide (23)'s inner wall face, a second radial line (R2) of the lifter guide (23) passes through substantially a center of the opened lubricant supply hole (51, 56), the center being defined at an end of the lubricant supply hole (51, 56), and the pair of the lubricant supply holes (51, 56) are inclined inward with each other relative to the respective second radial lines (R2) of the lifter guide (23) in such a manner as to direct toward the high bearing pressure area (A, B). 35 40 45 50

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**FIG. 1**

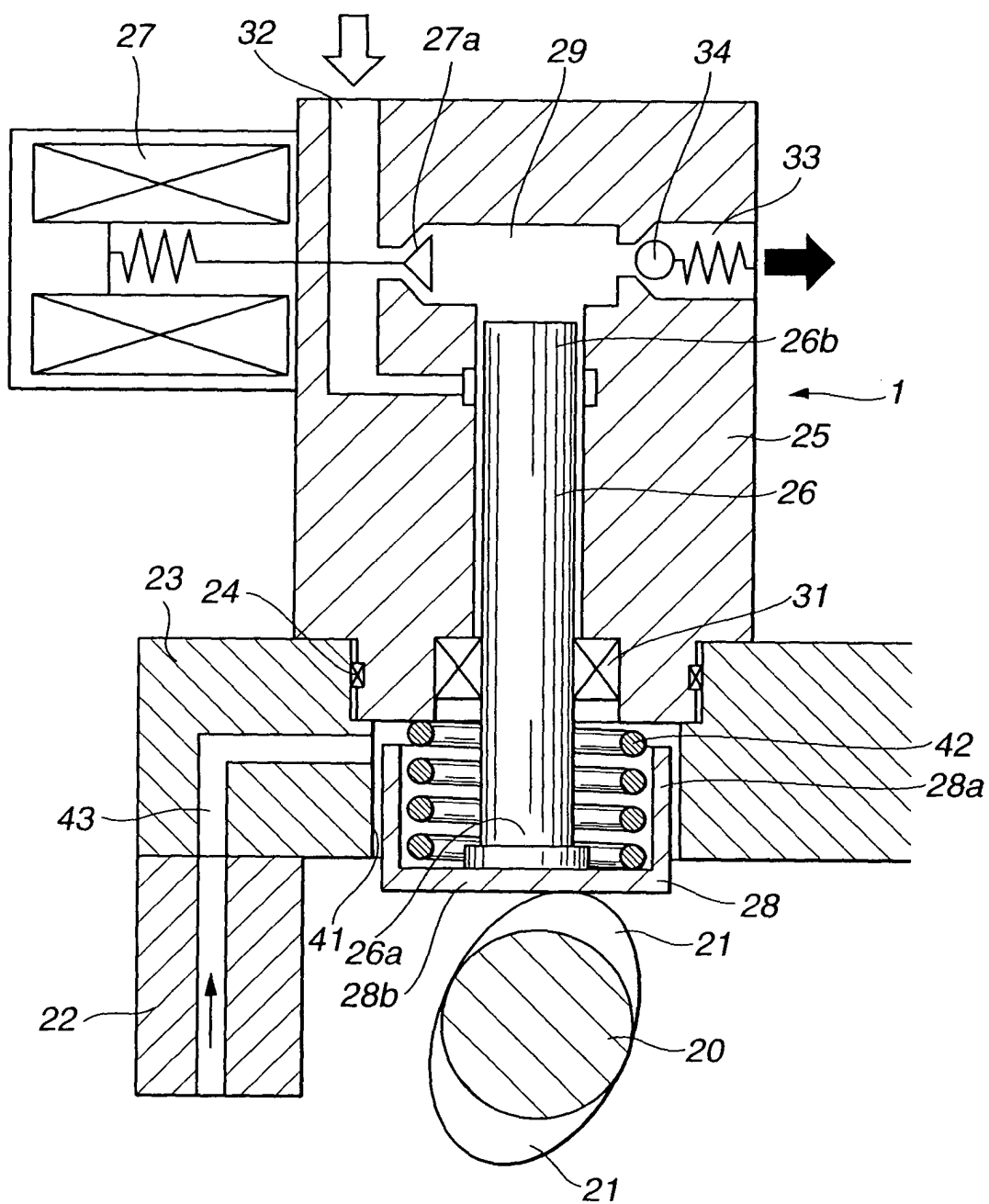
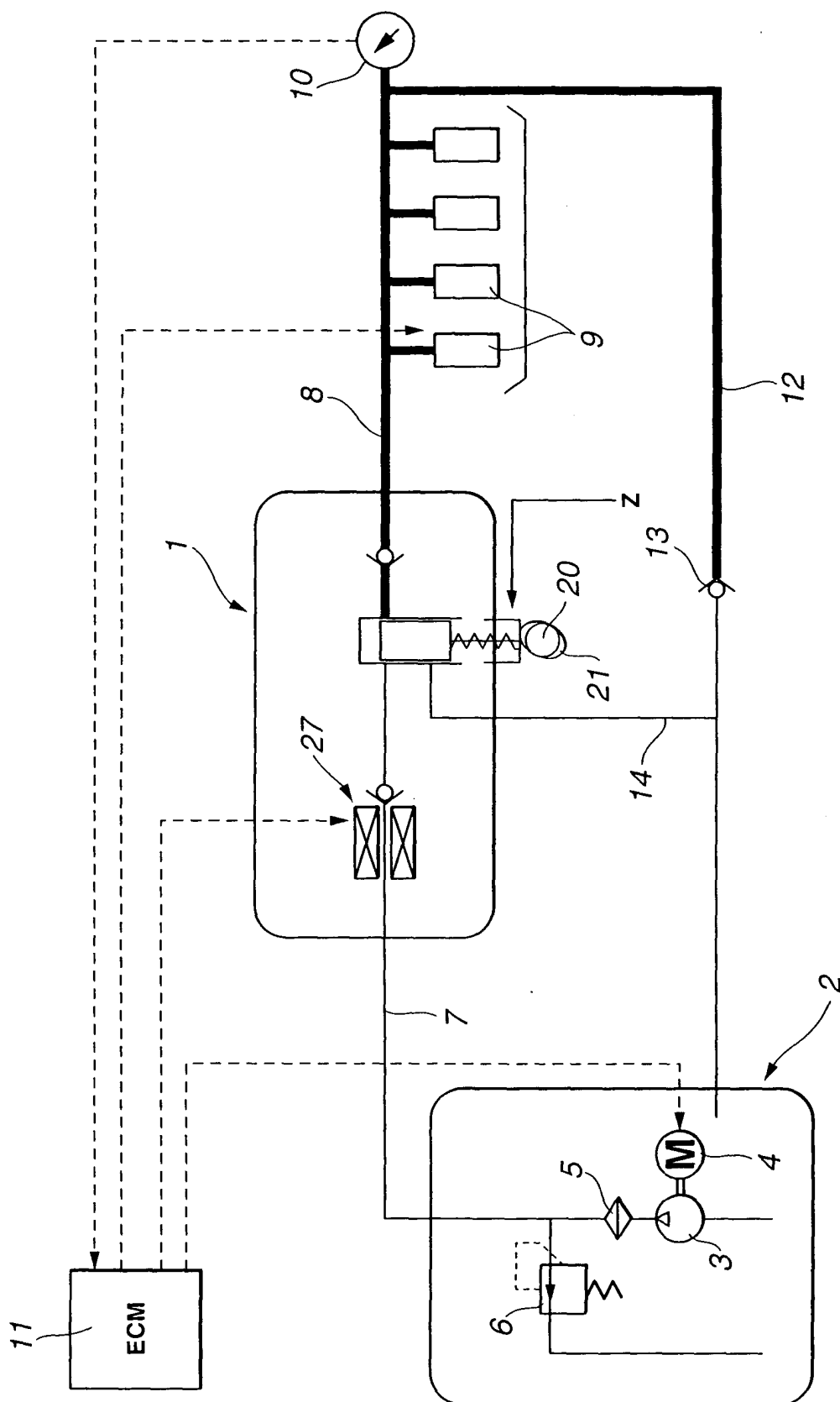
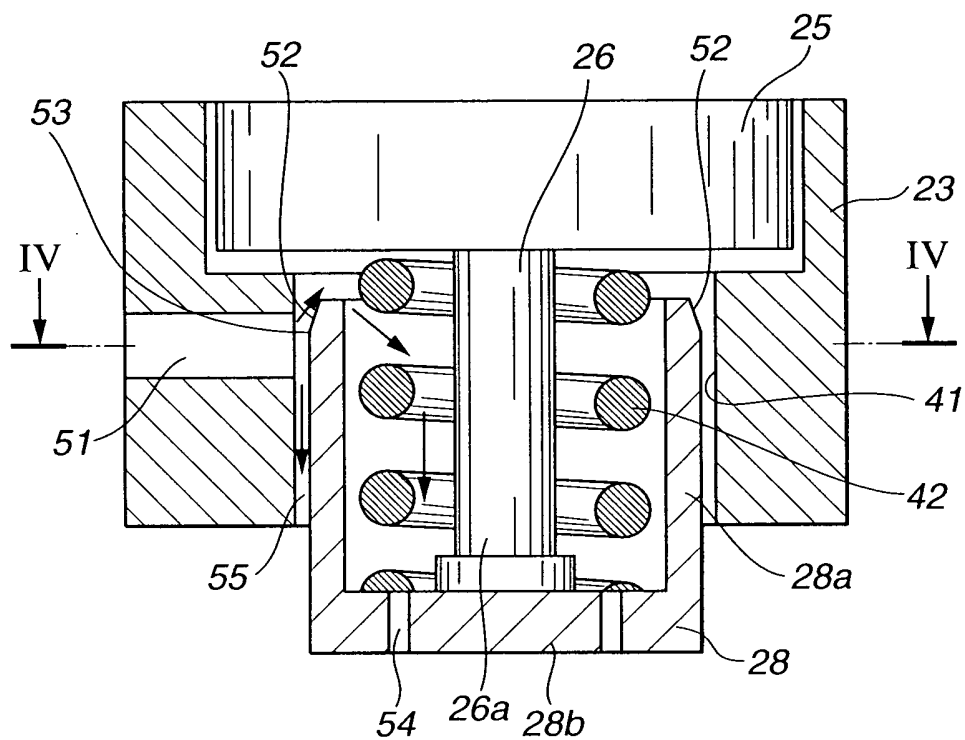




FIG. 2



**FIG. 3**



**FIG. 4**

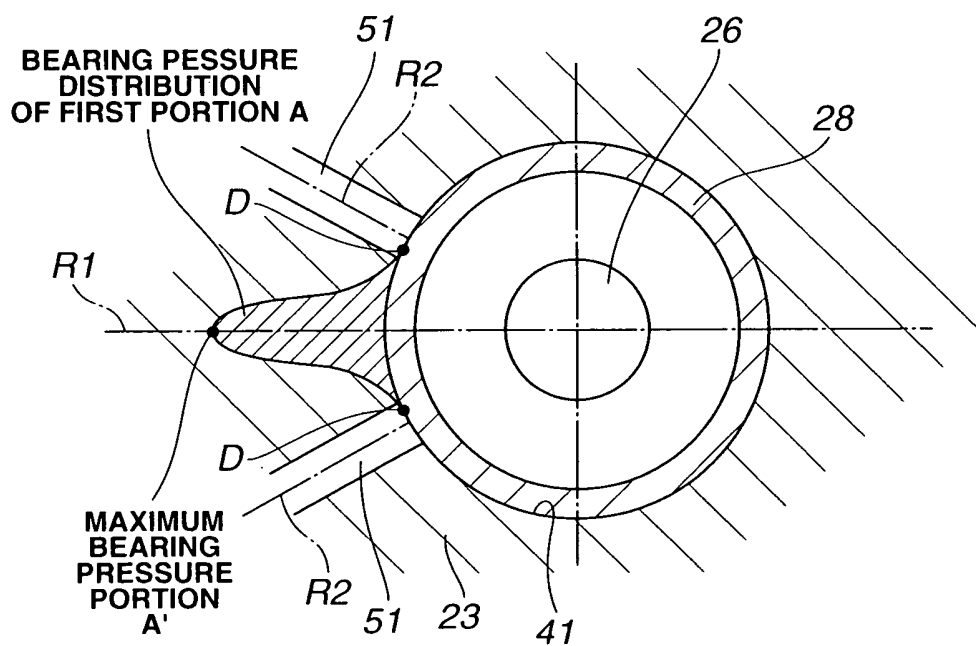
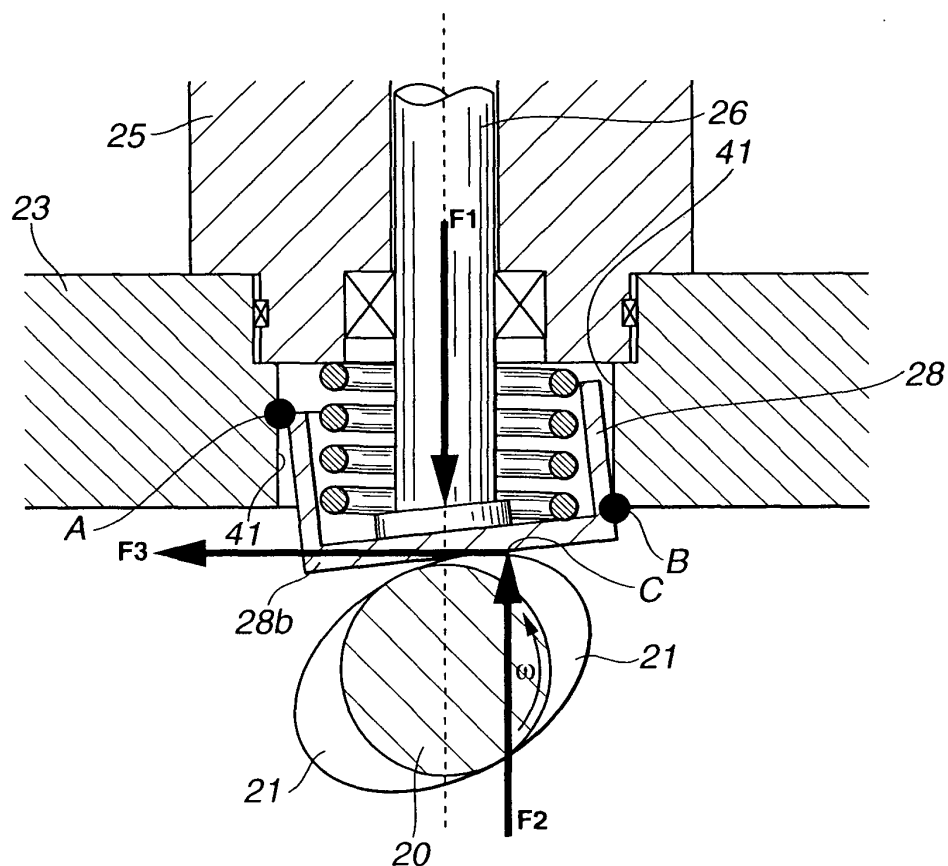
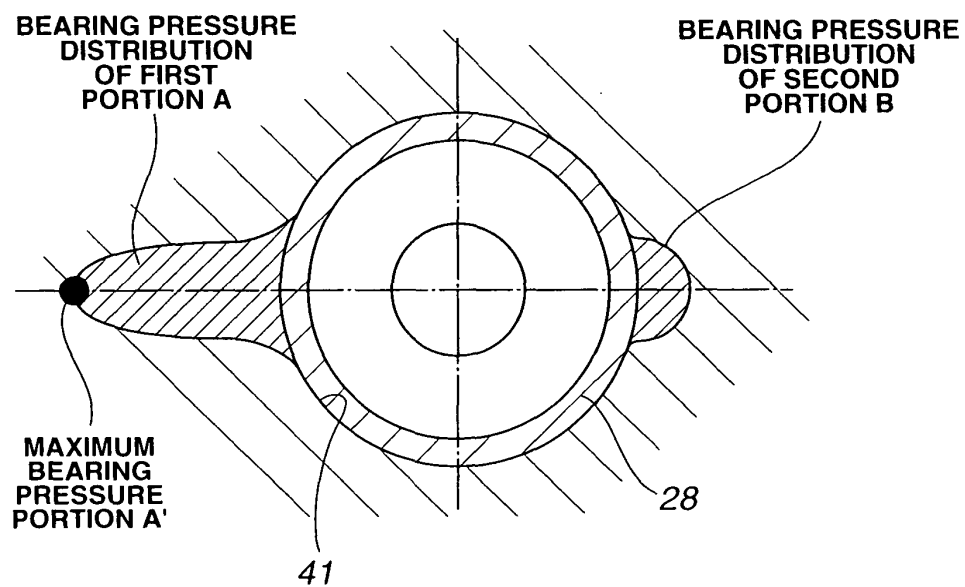


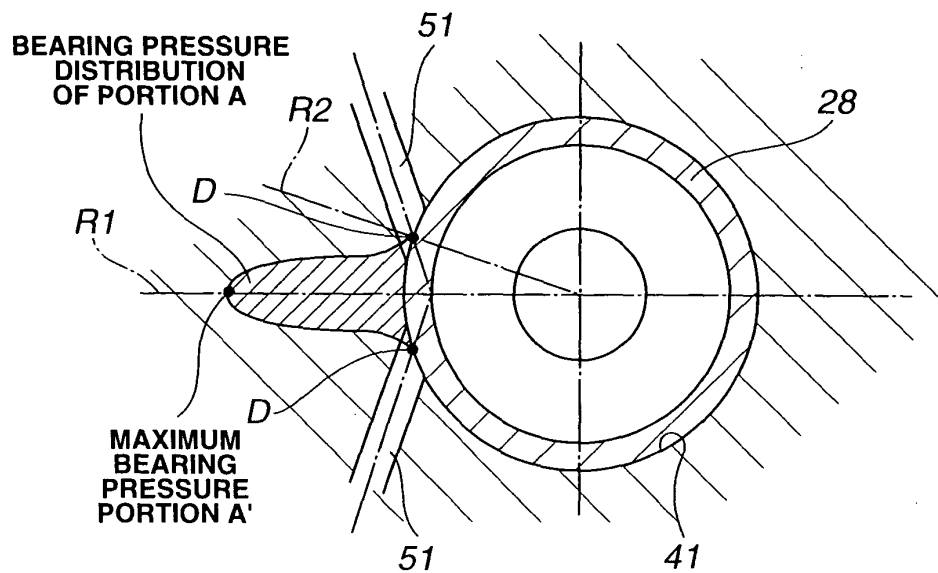
FIG. 5



**FIG. 6**



**FIG. 7**



**FIG. 8**

