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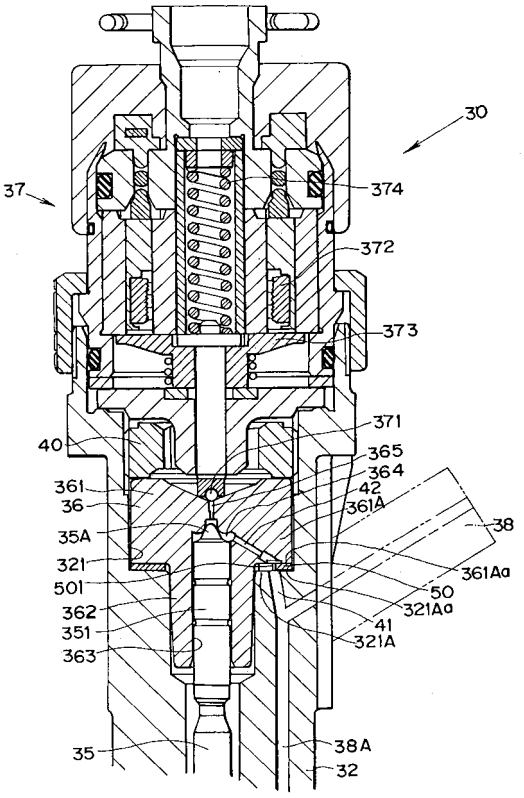
(54) FUEL INJECTION VALVE

(57) In a fuel injector (30) in which a valve body (36) which allows a valve piston (35) to be slidably inserted therein is arranged in the inside of an injector housing (32), one end of the valve piston (35) is arranged to face a control pressure chamber (364) formed in the inside of the valve body (36), and a high-pressure fuel is supplied to the inside of the control pressure chamber (364) from the injector housing (32), in the inside of the injector housing (32), on an annular stepped portion (321A) which is configured to be aligned with an injector axis, a large-diameter portion (361) of the valve body (36) which forms the control pressure chamber (364) therein and corresponds to the annular stepped portion (321A) is seated by way of a seal plate (50) in which an orifice (501) parallel to the injector axis is formed, and high pressure fuel supplied from the injector housing (32) side is supplied to the inside of the control pressure chamber (364) through an oil passage formed in the inside of the large-diameter portion (361) by way of the orifice (501).

FIG.2



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Description

Technical Field

[0001] The present invention relates to a fuel injector.

Background Art

[0002] Fig. 4 is a view for explaining the constitution of a conventional fuel injector. The fuel injector 1 is used for injecting and supplying a high-pressure fuel which is stored in the inside of a common rail 12 into the inside of a cylinder of a diesel internal combustion engine not shown in the drawing. Fuel F in the inside of a fuel tank 10 is pressurized by a fuel pump 11, and the pressurized fuel is stored in the inside of the common rail 12 as the high-pressure fuel. The fuel injector 1 includes an injector housing 2, a nozzle body 3, a nozzle needle 4, a valve piston 5, a valve body 6, a back-pressure control part 7 and a connecting rod 8. The nozzle body 3 is mounted on a distal end portion of the injector housing 2 using a nozzle nut 9, while the connecting rod 8 is mounted on an upper portion of the injector housing 2.

[0003] A fuel passage 13 is formed in the fuel injector valve 1 in a state that the fuel passage 13 extends to the nozzle body 3 through the injector housing 2 from the connecting rod 8, and a fuel reservoir 14 is formed in a state that the fuel reservoir 14 faces a pressure-receiving portion 4A of the nozzle needle 4 in an opposed manner. Further, in the injector housing 2, a fuel return passage 15 is formed in a state that the fuel return passage 15 is branched from the fuel passage 13 in the vicinity of the connecting rod 8 and is communicated with a low fuel pressure portion through the back-pressure control part 7.

[0004] The nozzle body 3 is configured such that an injection hole 16 is closed by seating a distal end portion of the nozzle needle 4 on a seat portion 17 which is communicated with the injection hole 16, and the injection hole 16 is opened by lifting the nozzle needle 4 from the seat portion 17. Due to such a constitution, it is possible to start or stop the fuel injection.

[0005] To an upper portion of the nozzle needle 4, a nozzle spring 18 for biasing the nozzle needle 4 in the direction that the nozzle needle 4 is seated on the seat portion 17 is provided, and the valve piston 5 is slidably inserted into a sliding hole 2A formed in the injector housing 2 and a sliding hole 6A formed in the valve body 6.

[0006] Fig. 5 is an enlarged cross-sectional view of respective essential parts of the valve body 6 and the back pressure control part 7. A pressure-controlling chamber 19 is formed in the valve body 6, and a distal end portion of the valve piston 5 is allowed to face the pressure-controlling chamber 19 from below.

[0007] The pressure-controlling chamber 19 is communicated with an introduction-side orifice 20 which is formed in the valve body 6. The introduction-side orifice 20 is configured to be communicated with the fuel passage 13 by way of a pressure introduction chamber 21 which is formed between the valve body 6 and the injector housing 2 so as to allow the supply of an introduced pressure from the common rail 12 to the pressure-controlling chamber 19.

[0008] To a lower end portion of the pressure introduction chamber 21, a seal member 22 made of a resin material, a rubber material, copper or other soft material is provided. The seal member 22 interrupts the communication between the pressure introduction chamber 21 which constitutes a high-fuel-pressure side and a gap 28 which is formed between the injector housing 2 and the valve body 6 and constitutes a low-fuel-pressure side.

[0009] The pressure-controlling chamber 19 is also communicated with an open/close orifice 23, and the open/close orifice 23 can be opened or closed by a valve ball 24 of the back-pressure control part 7. Here, a pressure-receiving area of a top portion 5A of the valve piston 5 in the pressure-controlling chamber 19 is set larger than a pressure-receiving area of the pressure-receiving portion 4A of the nozzle needle 4(see, Fig. 4).

[0010] As shown in Fig. 4, the back-pressure control part 7 includes a magnet 25, an armature 27, the valve ball 24 which is integrally formed with the armature 27, and the pressure-controlling chamber 19. By supplying a drive signal to the magnet 25, the magnet 25 attracts the armature 27 against a biasing force of the valve spring 26 so as to lift the valve ball 24 from the open/close orifice 23 thus releasing a pressure inside the pressure-controlling chamber 19 to the fuel return passage 15 side.

[0011] Accordingly, by controlling the pressure in the inside of the pressure-controlling chamber 19 with the above-mentioned operation of the valve ball 24 thus eventually controlling a back pressure of the nozzle needle 4 by way of the valve piston 5, it is possible to control the seating of the nozzle needle 4 onto the seat portion 17 and the lifting of the nozzle needle 4 from the seat portion 17.

[0012] In the fuel injector 1, the high-pressure fuel from the common rail 12 acts on the pressure receiving portion 4A of the nozzle needle 4 arranged in the inside of the fuel reservoir 14 by way of the fuel passage 13 from the connecting rod 8 and, at the same time, also acts on the top portion 5A of the valve piston 5 arranged in the inside of the pressure-controlling chamber 19 by way of the pressure introduction chamber 21 and the introduction-side orifice 20.

[0013] Accordingly, when the pressure-controlling chamber 19 is interrupted from the low-fuel-pressure side by the valve ball 24, the nozzle needle 4 receives the back pressure of the pressure-controlling chamber 19 by way of the valve piston 5 and is seated on the seat portion 17 of the nozzle body 3 together with the biasing force of the nozzle spring 18 thus closing the injection hole 16.

[0014] By attracting the armature 27 with the supply of the drive signal to the magnet 25 at predetermined timing thus releasing the open/close orifice 23 from the valve ball 24, the high pressure in the inside of the pressure-

controlling chamber 19 passes through the fuel return passage 15 byway of the open/close orifice 23 and returns to the fuel tank 10 and hence, the high pressure which acts on the top portion 5A of the valve piston 5 in the pressure-controlling chamber 19 is released and hence, the nozzle needle 4 is lifted from the seat portion 17 by the high pressure which acts on the pressure-receiving portion 4A against the biasing force of the nozzle spring 18 whereby the injection hole 16 is opened thus enabling the injection of the fuel.

[0015] When the valve ball 24 closes the open/close orifice 23 due to the deenergization of the magnet 25, a pressure in the inside of the pressure-controlling chamber 19 seats the nozzle needle 4 at a seat position (on the seat portion 17) by way of the valve piston 5 and hence, the injection hole 16 is closed thus finishing the injection of the fuel.

[0016] The pressure introduction chamber 21 is positioned at an inlet portion leading to the pressure controlling chamber 19 which controls an injection amount and an injection pressure of the fuel from the injection hole 16 and hence, a fuel pressure inside the pressure introduction chamber 21 is substantially equal to the injection pressure whereby a high pressure which is substantially equal to the injection pressure acts on the seal member 22.

[0017] As shown in Fig. 5, between the valve piston 5 and the valve body 6, it is necessary to provide a clearance which allows the axial slide movement of the valve piston 5 which is integrally moved with the nozzle needle 4 therein. By adopting the structure in which the valve body 6 is press-inserted into the inside of the injector housing 2, there exists a possibility that the valve body 6 is deformed slightly inwardly thus impeding the sliding of the valve piston 5. Accordingly, the gap 28 is provided also between the injector housing 2 and the valve body 6 as a slight clearance.

[0018] Since the seal structure of the high-pressure fuel passage of the conventional fuel injector has the above-mentioned constitution, the seal member is pressed toward the gap (low-pressure portion) between the injector housing and the valve body due to the high pressure in the inside of the pressure introduction chamber and is deformed and hence, there exists a possibility that a sealing performance is lowered. To avoid such a drawback, JP-A-2003-28021 discloses an injector having the constitution which can prevent a seal member from being pushed out to a low-pressure side by providing a metal backup ring to the low-pressure side (a gap side) of the seal member. However, due to such a constitution, a fastening stress of a fastening nut 40 is applied to a valve-body large-diameter portion 361 and hence, a seat surface which is constituted of an open/close orifice 365 and a valve ball 371 tends to be deformed so as to be displaced in the injector magnet direction by receiving a fastening stress. When such deformation is generated, the seat surface is moved thus giving rise to a drawback that an injector lift amount is changed so that an error occurs in an injection amount.

[0019] Further, in the conventional structure, in view of the constitution of the oil passages 13, 21 and 20, particularly the introduction-side orifice 20 is designed to extend toward a control chamber 19 perpendicular to the injector axis direction and hence, a large-diameter portion of a valve body is set at a position which avoids the introduction-side orifice 20. Accordingly, a thickness of the valve body in the injector axis direction is restricted thus giving rise to a drawback that a large-diameter portion of the valve body is liable to be easily deformed when a fastening stress is applied to the large-diameter portion.

[0020] It is an object of the present invention to provide a fuel injector which can overcome the above-mentioned drawbacks of the prior art.

Disclosure of the Invention

[0021] The technical feature of the present invention for overcoming the above-mentioned tasks lies in that, in a fuel injector in which a valve body which allows a valve piston to be slidably inserted therein is arranged in the inside of an injector housing, one end of the valve piston is arranged to face a control pressure chamber formed in the inside of the valve body, and a high-pressure fuel is supplied to the inside of the control pressure chamber from the injector housing, in the inside of the injector housing, on an annular stepped portion which is configured to be aligned with an injector axis, a large-diameter portion of the valve body which forms the control pressure chamber therein and corresponds to the annular stepped portion is seated by way of a seal plate in which an orifice parallel to the injector axis is formed, and high pressure fuel supplied from the injector housing side is supplied to the inside of the control pressure chamber through an oil passage formed in the inside of the large-diameter portion by way of the orifice.

[0022] By adopting the constitution in which the orifice plate which functions as the seal plate as well as the high-pressure-fuel introducing orifice is sandwiched by the valve body and the injector housing, it is possible to increase a thickness in the injector axial direction of the valve-body large-diameter portion and hence, the deformation of the valve-body large-diameter portion attributed to a fastening stress generated by a fastening nut can be suppressed whereby the irregularities of an injector injection amount can be lowered.

Brief Explanation of Drawings

[0023]

Fig. 1 is a view showing one embodiment of a fuel injector according to the present invention;
Fig. 2 is an enlarged view of an essential part shown in Fig. 1;
Fig. 3 is an enlarged plan view of a seal plate shown in Fig. 1;

Fig. 4 is a view for explaining the constitution of a conventional fuel injector; and

Fig. 5 is an enlarged cross-sectional view of an essential part showing a valve body and a back pressure control part shown in Fig. 4.

Best mode for carrying out the invention

[0024] For explaining the present invention in more detail, the present invention is explained in conjunction with attached drawings.

[0025] Fig. 1 is a view showing one embodiment of a fuel injector according to the present invention, and Fig. 2 is an enlarged view of an essential part shown in Fig. 1. To explain the present invention in conjunction with Fig. 1 and Fig. 2, a fuel injector 30 includes an injector housing 32, a nozzle body 33, a nozzle needle 34, a valve piston 35, a valve body 36, a back pressure control portion 37, and an inlet connector 38. A nozzle body 33 is mounted on a distal end portion of the injector housing 32 using a nozzle nut 39, and the inlet connector 38 is mounted on an upper portion of the injector housing 32. The fuel injector 30 serves also, in the same manner as the fuel injector 1 shown in Fig. 4 and Fig. 5, to supply a high pressure fuel which is stored in the inside of a common rail into the inside of a cylinder of a diesel internal combustion engine not shown in the drawing.

[0026] In the inside of the injector housing 32, a fuel passage 38A which extends to a nozzle body 33 from the inlet connector 38 is formed, and a fuel reserving chamber 33A is formed such that the fuel reserving chamber 33A faces a pressure receiving portion 34A of a nozzle needle 34. Since the constitution of the nozzle portion has the known constitution substantially equal to the constitution shown in Fig. 4, the detailed explanation of the constitution is omitted.

[0027] The valve body 36 is a member which includes a large-diameter portion 361 and a small-diameter portion 362 and has an approximately cylindrical shape as a whole. In the inside of a valve body accommodating chamber 321 formed in the inside of the injector housing 32, the valve body 36 is accommodated coaxially with the injector housing 32. A slide hole 363 which opens at a small-diameter-portion-362 side is formed in the valve body 36, while a rear end portion 351 of a valve piston 35 is inserted in the slide hole 363 in an axially slidable manner while maintaining an oil sealed state.

[0028] The slide hole 363 extends to the inside of the large-diameter portion 361 and a control pressure chamber 364 is formed in the inside of the large-diameter portion 361 opposite to an opening end of the slide hole 363, wherein one end of the valve piston 35 faces the control pressure chamber 364. The control pressure chamber 364 is also communicated with an open/close orifice 365, while the open/close orifice 365 can be opened or closed by a valve ball 371 of the back pressure control portion 37. Here, a pressure receiving area of a top portion 35A of the valve piston 35 in the control pressure chamber 364 is set larger than a pressure receiving area of a pressure receiving portion 34A (Fig. 1) of the nozzle needle 34.

[0029] The back pressure control portion 37 is configured such that the back pressure control portion 37 includes a magnet 372, an armature 373, and a valve ball 371 which is integrally formed with the armature 373, wherein in response to the supply of a drive signal to the magnet 372, the magnet 372 attracts the armature 373 against a biasing force of the valve spring 374 so as to lift the valve ball 371 from the open/close orifice 365 thus releasing a pressure of the control pressure chamber 364 to a low fuel pressure side by way of a fuel return flow passage not shown in the drawing.

[0030] Accordingly, by controlling the pressure of the control pressure chamber 364 with the above-mentioned operation of the valve body 371, a back pressure of the nozzle needle 34 can be controlled by way of the valve piston 35 thus controlling the lifting of the nozzle needle 34. Since the constitution of the back pressure control for the above-mentioned fuel injection control per se is known, the further detailed explanation of the constitution is omitted.

[0031] Next, the constitution which feeds the high pressure fuel supplied from the inlet connector 38 to the control pressure chamber 364 in the inside of the valve body 36 through the injector housing 32 is explained.

[0032] The valve body accommodating chamber 321 which accommodates the valve body 36 defines a space of a size and a shape which correspond to a size and a shape of the valve body 36. The valve body 36 is accommodated in the inside of the valve body accommodating chamber 321 such that an annular projecting portion 361A of a large-diameter portion 361 is seated on the annular stepped portion 321A by way of a seal plate 50.

[0033] The valve body 36 which is accommodated in the inside of the valve body accommodating chamber 321 is pushed into the inside of the valve body accommodating chamber 321 by the fastening nut 40 and hence, the seal plate 50 is hermetically sandwiched between an upper surface 321Aa of the annular stepped portion 321A and a lower surface 361Aa of the annular projection portion 361A thus establishing a state in which an oil sealed state between the upper surface 321Aa and the lower surface 361Aa is held favorably.

[0034] As shown in Fig. 3, the seal plate 50 is an annular member having an orifice 501 and is made of an iron-based metal material which contains chromium. Further, spot facing is applied to upper and lower surfaces of the seal plate 50 for stabilizing a sealing performance except for a periphery of the orifice 501, and a portion of an inner peripheral portion and a portion of an outer peripheral portion of the seal plate 50. Numerals 502, 503 indicate positioning holes. With the use of these holes 502, 503, it is possible to easily arrange the seal plate 50 between the injector housing 32 and the valve body 36 such that the orifice 501 faces the fuel supply passage 38A in an opposed manner. An axis of the orifice 501 is

arranged parallel to the injector axis of the fuel injector 30.

[0035] As shown in Fig. 2, a high-pressure fuel supply chamber 41 is formed in the annular stepped portion 321A in the inside of the injector housing 32 such that the high-pressure fuel supply chamber 41 faces the orifice 501 in an opposed manner, wherein a high-pressure fuel supplied from the inlet connector 38 is introduced into the high-pressure fuel supply chamber 41 through the fuel passage 38A. On the other hand, in the inside of the large-diameter portion 361 of the valve body 36, a passage 42 which has one end thereof communicated with the control pressure chamber 364 and another end thereof opened at a lower surface 361Aa such that the another end faces the orifice 501 in an opposed manner is formed. Due to such a constitution, it is possible to constitute a high-pressure fuel passage in which the high-pressure fuel supplied from the fuel passage 38A enters the inside of the passage 42 formed in the inside of the large-diameter portion 361 by way of the orifice 501, and is supplied to the control pressure chamber 364. As has been explained heretofore, the fuel injector is configured such that the high-pressure fuel from the inlet connector 38 is supplied to the control pressure chamber 364 through the orifice 501 formed in the seal plate 50 and hence, it is unnecessary to temporarily reserve the high-pressure fuel between the injector housing 32 and the valve body 36 whereby the fuel is directly supplied to the valve body 36 side from the injector housing 32 side through the orifice 501.

[0036] The seal plate 50 is hermetically brought into contact with the upper surface 321Aa of the annular stepped portion 321A and the lower surface 361Aa of the annular projection portion 361A thus establishing a state in which an oil sealed state between the upper surface 321Aa and the lower surface 361Aa is favorably held. Accordingly, the high-pressure fuel in the inside of the high-pressure fuel supply chamber 41 is supplied to the inside of the control pressure chamber 364 without generating the leaking of the high-pressure fuel between the valve body 36 and the injector housing 32. Further, since the control pressure chamber 364 is formed in the inside of the large-diameter portion 361 of the valve body 36, even when the high-pressure fuel is fully filled in the inside of the control pressure chamber 364, the deformation of the large-diameter portion 361 can be suppressed to a small value due to a large wall thickness of the large-diameter portion 361. As a result, it is possible to reduce the deformation of the whole valve body 36 to a small value and hence, it is possible to provide the smooth sliding movement of the valve piston 35 in the inside of the slide hole 363 and, at the same time, the adjustment of performance is facilitated.

[0037] Since the fuel injector 30 is constituted in the above-mentioned manner, it is possible to increase the thickness in the injector axis direction of the large-diameter portion 361 of the valve body 36. As a result, when the valve body 36 is fastened to the injector housing 32 using the fastening nut 40, the deformation of the large-diameter portion 361 of the valve body 36 attributed to the fastening stress can be suppressed and hence, the irregularities of the injector injection amount can be reduced. Further, since the passage 42 and the control pressure chamber 364 are formed in the inside of the large-diameter portion 361, the deformation of the valve body 36 attributed to the supply of the high-pressure fuel can be effectively suppressed thus realizing the fuel injector 30 of high performance.

Industrial Applicability

[0038] According to the present invention, the deformation of the large-diameter portion of the valve body can be suppressed and hence, the irregularities of the injection amount can be reduced whereby the present invention is useful in the improvement of the fuel injector.

Claims

1. A fuel injector in which a valve body which allows a valve piston to be slidably inserted therein is arranged in the inside of an injector housing, one end of the valve piston is arranged to face a control pressure chamber formed in the inside of the valve body, and a high-pressure fuel is supplied to the inside of the control pressure chamber from the injector housing, wherein
in the inside of the injectorhousing, on an annular stepped portion which is configured to be aligned with an injector axis, a large-diameter portion of the valve body which forms the control pressure chamber therein and corresponds to the annular stepped portion is seated by way of a seal plate in which an orifice parallel to the injector axis is formed, and high pressure fuel supplied from the injector housing side is supplied to the inside of the control pressure chamber through an oil passage formed in the inside of the large-diameter portion by way of the orifice.

2. A fuel injector according to claim 1, wherein a high-pressure fuel chamber which faces the orifice formed in the seal plate in an opposed manner is formed in the inside of the injector housing, and the high-pressure fuel in the inside of the fuel passage is supplied to the orifice by way of the high-pressure fuel chamber.

3. A fuel injector according to claim 1 or 2, wherein spot facing is applied to upper and lower surfaces of the seal plate except for a periphery of the orifice and a portion of an inner peripheral portion and a portion of an outer peripheral portion of the seal plate.

4. A fuel injector according to any one of claims 1 to 3, wherein a positioning hole is formed in the seal plate.

5. A fuel injector according to any one of claims 1 to 4, wherein the valve body is fixed to the injector housing by a fastening nut.

FIG.1

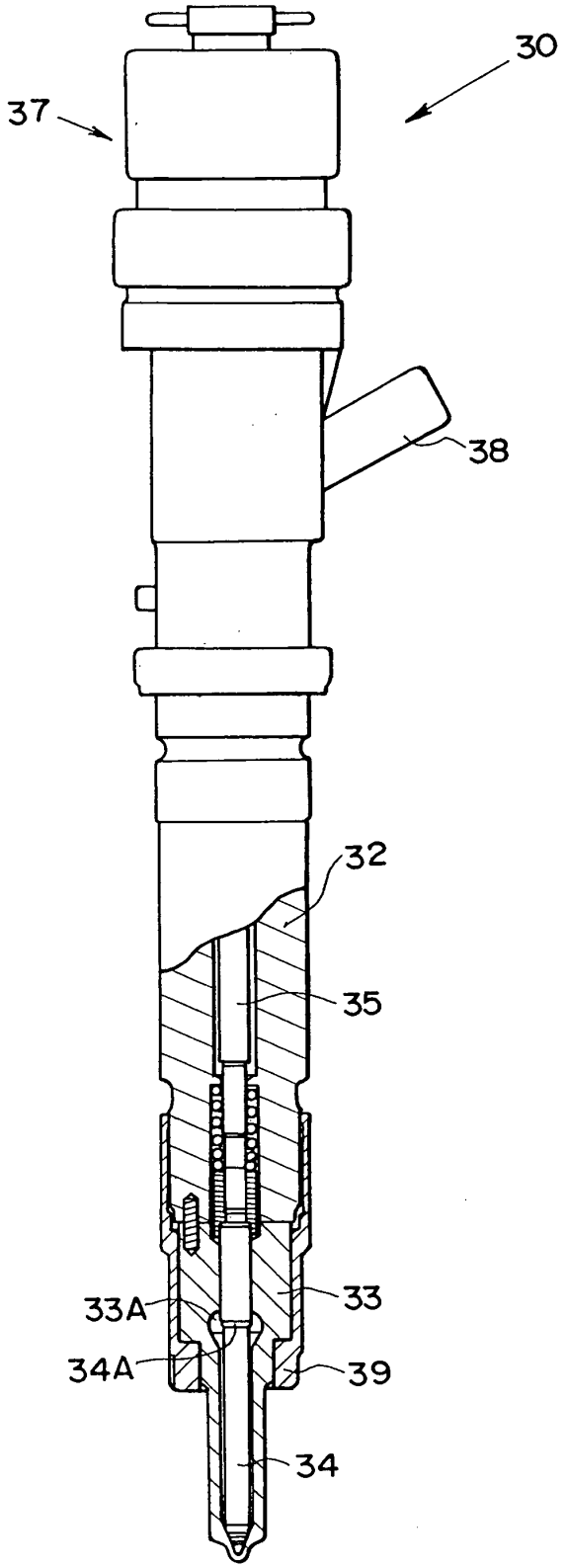

FIG.2

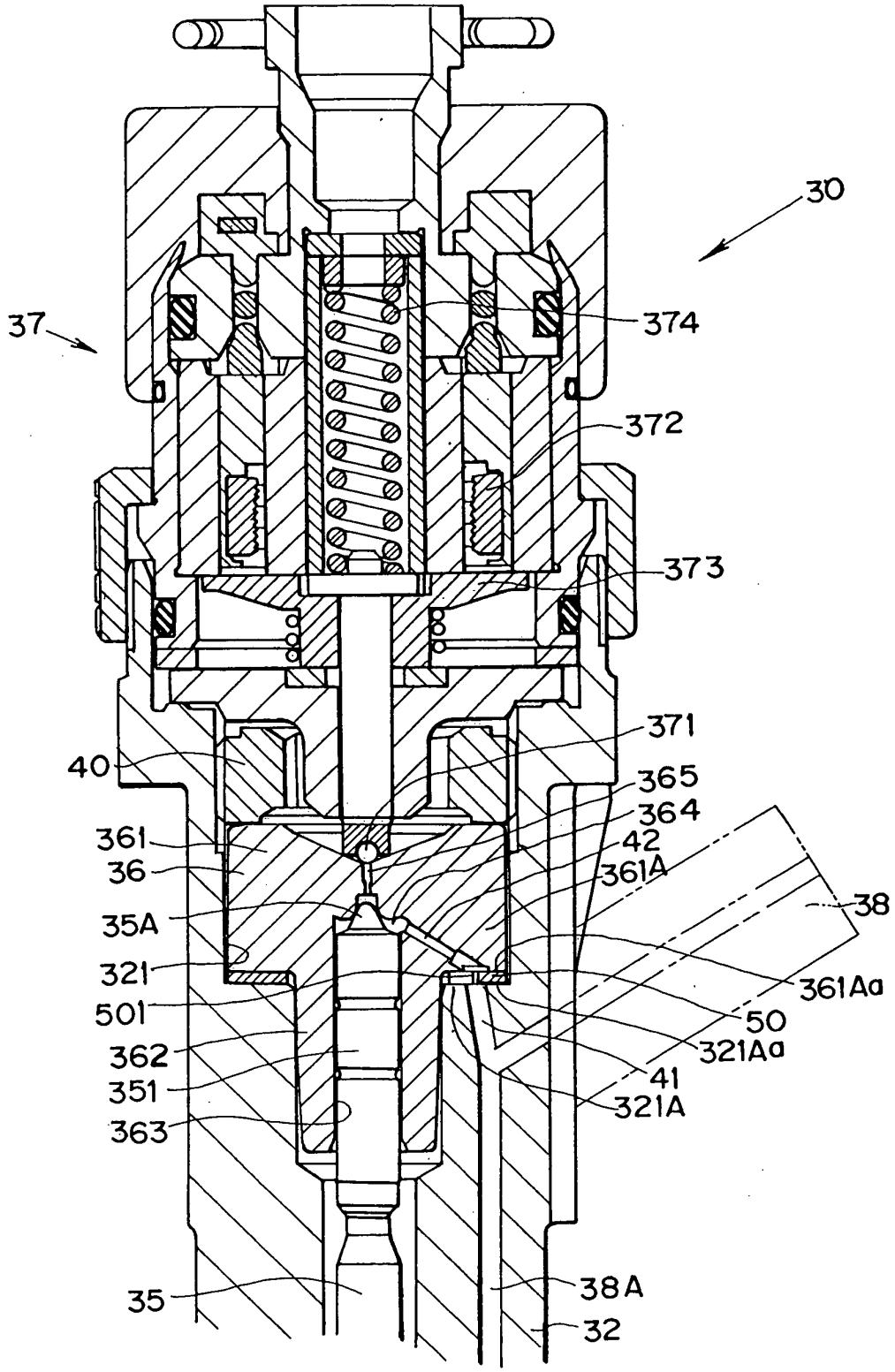
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FIG.3

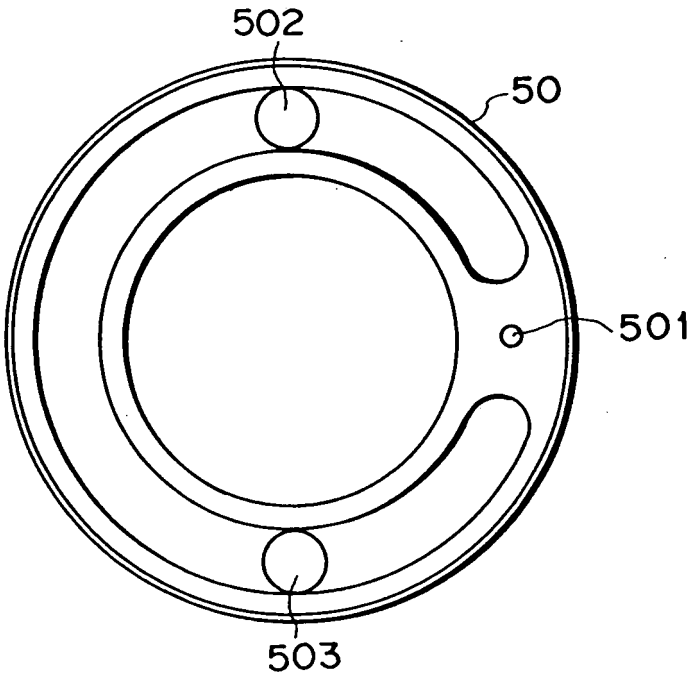

FIG.4

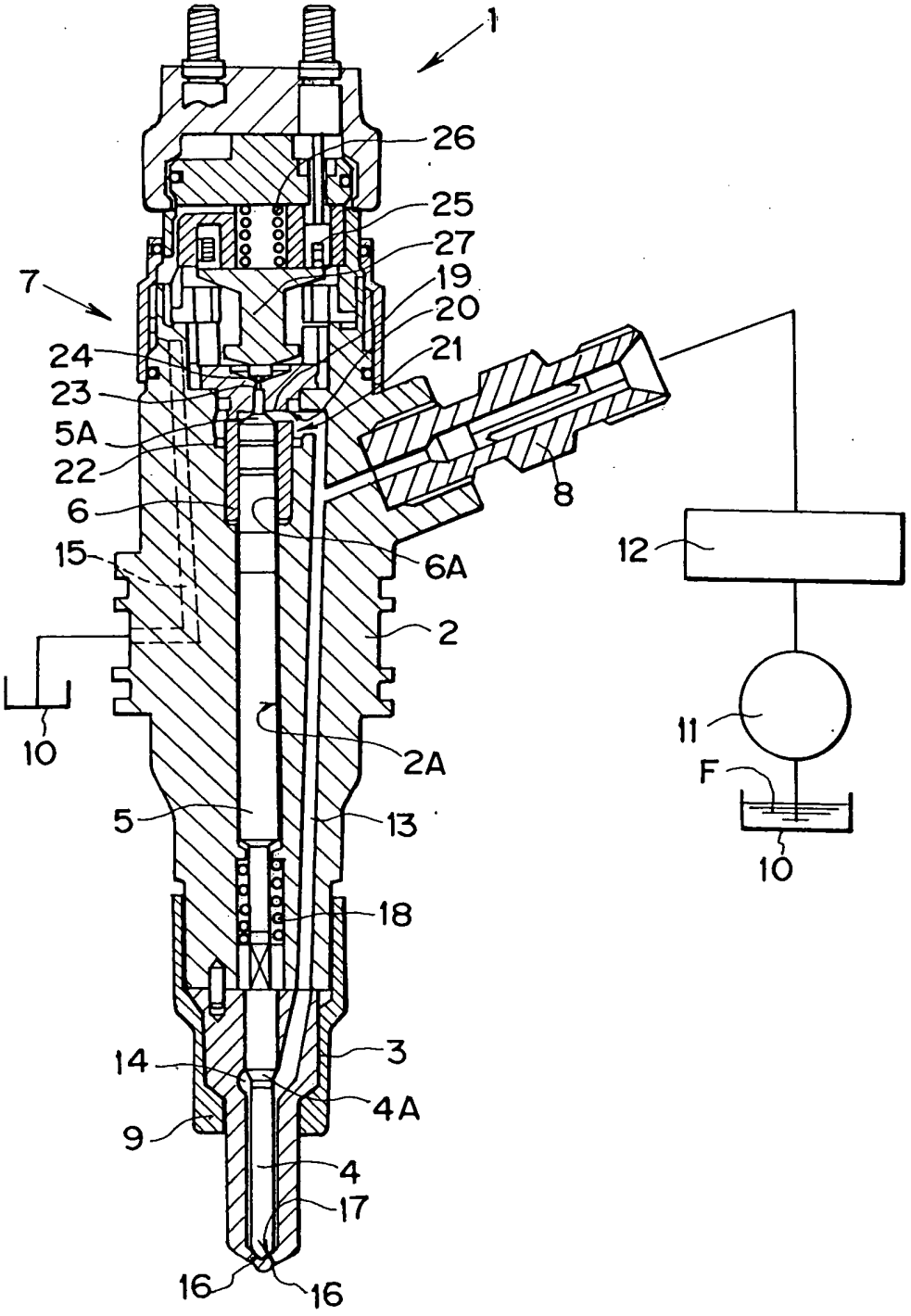
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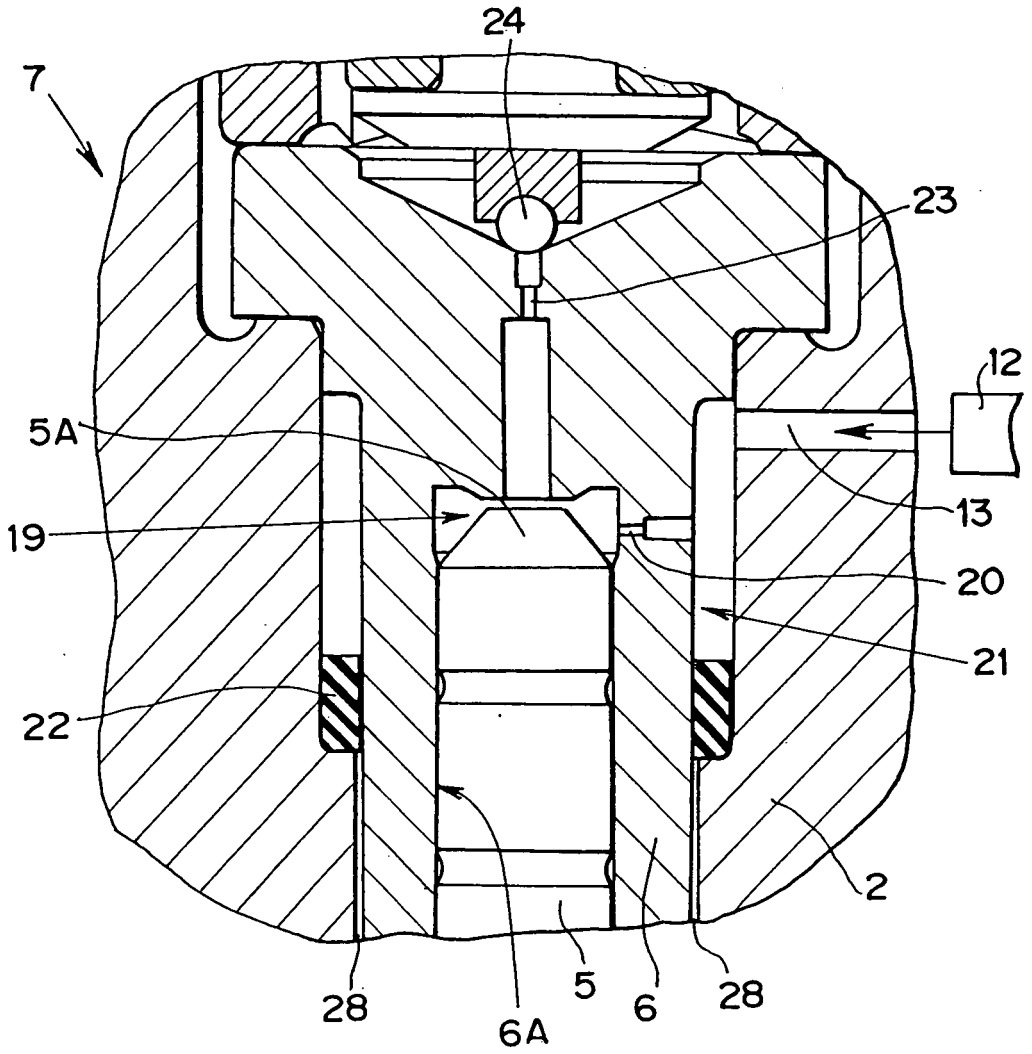
FIG.5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/010527

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F02M47/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F02M47/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2005
Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 19937677 A1 (SIEMENS AG.), 22 February, 2001 (22.02.01), Full text; all drawings (Family: none)	1-5
A	JP 10-153154 A (Denso Corp.), 09 June, 1998 (09.06.98), Par. Nos. [0021] to [0022]; Figs. 1, 5 & US 6027037 A & EP 0844385 A1 & DE 69719461 T	1-5
A	US 4566416 A (Stanadyne Inc.), 28 January, 1986 (28.01.86), Fig. 2 & DE 3227742 A1 & AT 0337181 A	1-5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 August, 2005 (19.08.05)	06 September, 2005 (06.09.05)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/010527

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	JP 8-270530 A (Zexel Corp.), 15 October, 1996 (15.10.96), Par. No. [0036]; all drawings (Family: none)	3

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REFERENCES CITED IN THE DESCRIPTION

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