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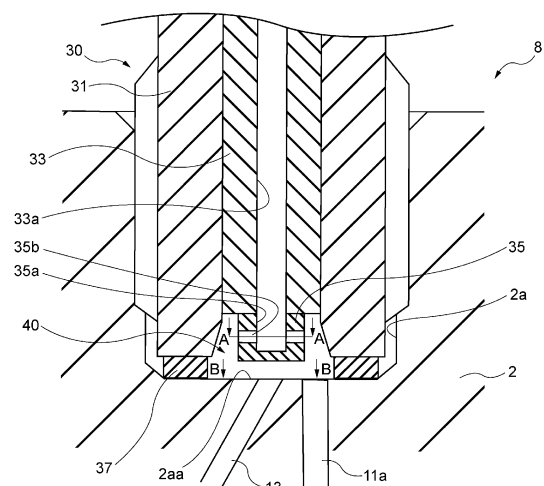
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(54) **FUEL INJECTION VALVE**

(57) Provided is a fuel injection valve where it is possible to suppress the occurrence of a damage on a valve seat portion of a control valve of a back pressure control part caused by a foreign substance in high pressure fuel.

An inlet connector having an introducing passage for high pressure fuel is mounted on an inlet opening portion of a housing, a fuel chamber is formed between an end surface portion of the inlet connector and a bottom surface portion of the inlet opening portion, a first fuel passage which communicates with a nozzle side opens at an outer peripheral portion of the bottom surface portion within a region of the fuel chamber, and a second fuel passage which communicates with a back pressure control part side opens at a center portion, and the inlet connector is configured such that high pressure fuel introduced into the fuel chamber from the inlet connector is capable of forming a swirl flow.

[FIG.2]



Description

Technical Field

[0001] The present invention relates to a fuel injection valve used in an accumulator-type fuel injection control device of an internal combustion engine.

Background Art

[0002] Conventionally, there has been known a fuel injection valve which is used in an accumulator-type fuel injection control device of an internal combustion engine, where the fuel injection valve injects high pressure fuel supplied from a common rail (accumulator) into cylinders of the internal combustion engine. The fuel injection valve includes a housing, a nozzle body, a valve needle, and a back pressure control part.

[0003] The fuel injection valve includes an inlet connector. A high pressure pipe having one end thereof connected to the common rail is connected to the inlet connector. High pressure fuel is introduced into the inside of the fuel injection valve through a fuel passage formed in the inside of the inlet connector. The introduced high pressure fuel is supplied to a fuel injection hole side formed in the nozzle body and, at the same time, the introduced high pressure fuel is also supplied to a control chamber side of the back pressure control part. In the back pressure control part, the fuel injection is controlled in such a manner that the valve needle is advanced or retracted by adjusting a pressure in a control chamber thus controlling the opening and the closing of a fuel injection hole.

[0004] In such a fuel injection valve, when a hard foreign substance is mixed into the fuel, a valve seat face of a control valve in the back pressure control part corrodes thus giving rise to a possibility that the fuel injection valve loses accurate fuel injection control performance. Accordingly, there have been proposed fuel injection valves which are configured such that a filter is arranged in an inlet connector so as to collect a foreign substance in high pressure fuel introduced into the fuel injection valve (see PTL 1 or PTL 2).

[0005] To be more specific, the fuel injection valve described in PTL 1 is configured such that an edge filter is press-fitted into an inlet connector, and a foreign substance is collected by using gaps formed by the edge filter as filter meshes.

[0006] The fuel injection valve described in PTL 2 is configured such that a large number of holes are formed in a portion of a filter body formed into a bag shape which faces an inner wall surface of an inlet portion. With such a configuration, a foreign substance in high pressure fuel can be collected by a body portion.

Citation List

Patent Literature

5 **[0007]**

PTL 1: JP-A-2006-105092, Fig. 2

PTL 2: JP-A-2009-203843

10 Summary of Invention

Technical Problem

[0008] However, the structure of the filter described in PTL 1 has a length in an axial direction of the inlet connector thus giving rise to a possibility that a foreign substance larger than a formed gap passes through the gap. On the other hand, in the filter described in PTL 2, a reduction in a size of the hole formed in the body portion is limited and hence, it is difficult for the filter to collect a foreign substance having a size of several μm which reaches the fuel injection valve.

[0009] Particularly, recently, performance of a fuel main filter mounted on a portion of an accumulator-type fuel injection control device other than the fuel injection valve is improved. Accordingly, a foreign substance which reaches the fuel injection valve is smaller than the gaps of the filter structure of the fuel injection valve and hence, it has become difficult to collect a foreign substance in fuel using the conventional filter structure. Further, due to the further increase of a fuel pressure which is required to cope with recent strict regulation on an exhaust gas, there is a possibility that the erosion of a valve seat face of the control valve in the back pressure control part caused by the above-mentioned foreign substance may be accelerated.

[0010] The invention has been made in view of these problems, and it is an object of the invention to suppress the occurrence of a damage on a valve seat portion of a control valve of a back pressure control part caused by a foreign substance in high pressure fuel.

Solution to Problem

[0011] According to the invention, there is provided a fuel injection valve which includes: a housing having a first fuel passage communicating with a fuel injection hole and a second fuel passage communicating with a pressure control chamber; a valve needle movably disposed in the inside of the housing in an advancing and retracting manner; and a control valve performing an open-close control of the fuel injection hole by advancing or retracting the valve needle by adjusting a pressure in the pressure control chamber, wherein the housing includes an inlet opening portion, and an inlet connector having an introducing passage for high pressure fuel is mounted on the inlet opening portion, a fuel chamber is formed between an end surface portion of the inlet connector and a bottom

surface portion of the inlet opening portion, the first fuel passage opens at an outer peripheral portion of the bottom surface portion within a region of the fuel chamber, and the second fuel passage opens at a center portion of the bottom surface portion, and the inlet connector is configured such that high pressure fuel introduced into the fuel chamber from the inlet connector is capable of forming a swirl flow. Such a fuel injection valve can overcome the above-mentioned drawbacks.

[0012] In the fuel injection valve of the invention, the inlet connector may have: an axial passage extending in an axial direction; and a circumferential passage extending in a circumferential direction from the axial passage, disposed offset from the center of the axial passage, and opens in the fuel chamber.

[0013] In the fuel injection valve of the invention, an end portion of the axial passage on a fuel chamber side may be closed.

[0014] In the fuel injection valve of the invention, a plurality of the circumferential passages may be provided.

[0015] In the fuel injection valve of the invention, a diameter of the circumferential passage may be set equal to or less than a diameter of the fuel injection hole.

[0016] In the fuel injection valve of the invention, a plurality of the circumferential passages may be provided, and a sum of cross-sectional areas of the circumferential passages may be set equal to or more than a total cross-sectional area of the fuel injection hole.

[0017] In the fuel injection valve of the invention, the number of the circumferential passages may be decided by taking into an account a diameter of the circumferential passage and the sum of the cross-sectional areas of the circumferential passages.

Advantageous Effect of Invention

[0018] According to the fuel injection valve of the invention, it is possible to suppress a foreign substance in high pressure fuel which reaches the fuel injection valve from reaching a back pressure control part side and hence, it is possible to reduce a damage of a valve seat face of a control valve.

Brief Description of Drawings

[0019]

[Fig. 1] Fig. 1 is a view for explaining the overall constitution of an accumulator-type fuel injection control device equipped with a fuel injection valve according to this embodiment.

[Fig. 2] Fig. 2 is a view for explaining an inlet portion of the fuel injection valve according to this embodiment.

[Fig. 3] Fig. 3 is a view for explaining a swirl flow forming portion of an inlet connector.

[Fig. 4] Fig. 4 is a view for explaining a bottom surface portion of a fuel chamber.

[Fig. 5] Fig. 5 is a view showing the flow of fuel which flows into the fuel chamber.

Description of Embodiments

[0020] Hereinafter, an embodiment relating to a fuel injection valve of the invention is specifically explained. However, this embodiment merely describes one mode of the invention and does not limit the invention. The invention can be altered as desired within the scope of the invention.

[0021] When the same symbol is used in the respective drawings, the symbol indicates an identical member unless otherwise specified.

[0022] Fig. 1 is a view schematically showing one example of the overall constitution of an accumulator-type fuel injection control device equipped with a fuel injection valve 1 according to this embodiment. In Fig. 1, the fuel injection valve 1 is shown in cross section.

[0023] The accumulator-type fuel injection control device includes, as main constitutional elements thereof: a supply pump 52 which supplies fuel from a fuel tank 51 under pressure; a common rail 12 in which high pressure fuel supplied by the supply pump 52 under pressure is accumulated; and the fuel injection valve 1 which injects high pressure fuel accumulated in the common rail 12 to the inside of a cylinder of an internal combustion engine (not shown in the drawing). The overall constitution of this accumulator-type fuel injection control device per se is substantially equal to the constitution of a conventionally known accumulator-type fuel injection control device.

[0024] In such an accumulator-type fuel injection control device, the fuel injection valve 1 includes, as main constitutional elements thereof: an injector housing 2; a nozzle body 3; a valve needle 4; a valve piston 5; a valve body 6; a back pressure control part 7; and an inlet portion 8. In this embodiment, the injector housing 2 and the nozzle body 3 correspond to "housing" of the invention.

[0025] The nozzle body 3 is fastened to a distal end portion (a lower end side in Fig. 1) of the injector housing 2 by a nozzle nut 9. In the injector housing 2 and the nozzle body 3, first fuel passages 11a, 11b through which high pressure fuel introduced from the inlet portion 8 is supplied to a fuel reservoir chamber 14 of the nozzle body 3 are formed. Further, in the injector housing 2, a second fuel passage 13 through which fuel introduced from the inlet portion 8 is supplied to a control chamber 19 of the back pressure control part 7 is formed.

[0026] The fuel reservoir chamber 14 is formed in the nozzle body 3 at a position where the fuel reservoir chamber 14 faces a pressure receiving portion 4A of the valve needle 4 in an opposed manner. A fuel injection hole 16 is formed in a distal end portion of the nozzle body 3. The fuel injection hole 16 is closed when a distal end portion of the valve needle 4 is seated on a seat portion 17 communicating with the fuel injection hole 16, while the fuel injection hole 16 is opened by separating (lifting) the valve needle 4 from the seat portion 17. With such a configu-

ration, the injection of fuel can be started or stopped.

[0027] In the inside of the injector housing 2 to which the nozzle body 3 is fastened, a spring chamber 22 having a center thereof on a center axis of the injector housing 2 is formed, and a nozzle spring 18 for biasing the valve needle 4 in the direction toward the seat portion 17 is arranged in the spring chamber 22. Further, the valve piston 5 is inserted into a hole 2A formed in the injector housing 2, the valve piston 5 is slidably inserted into a slide hole 6A formed in the valve body 6, and is arranged so as to be positioned in an upper portion of the valve needle 4.

[0028] The control chamber 19 is formed in a portion of the valve body 6 where a top portion 5A of the valve piston 5 is positioned, and the top portion 5A of the valve piston 5 is faced from a lower side (fuel injection hole 16 side). The control chamber 19 communicates with an introducing side orifice 20 formed in the valve body 6. The introducing side orifice 20 communicates with the second fuel passage 13 through a pressure introducing chamber 21 formed annularly in a circumferential direction of the valve body 6 between the valve body 6 and the injector housing 2. With such a configuration, an introduced pressure from the common rail 12 is supplied to the control chamber 19.

[0029] The control chamber 19 is also communicating with an open-close orifice 23, and the open-close orifice 23 is openable and closable by operating an electromagnetic valve 28 of the back pressure control part 7 described later. A pressure receiving area of the top portion 5A of the valve piston 5 in the control chamber 19 is set larger than a pressure receiving area of the pressure receiving portion 4A of the valve needle 4.

[0030] The back pressure control part 7 includes, as main elements thereof: the electromagnetic valve 28; a holder 29; and the control chamber 19. The electromagnetic valve 28 includes: a magnet 25; an armature 27; and a control valve element 24. When a drive signal is supplied to the magnet 25 from a control circuit, the armature 27 is attracted to the magnet 25 against a biasing force of the valve spring 26, the control valve element 24 is lifted from a valve seat face continuously formed with the open-close orifice 23 so that a pressure in the control chamber 19 can be released to a fuel return passage 15. In this manner, a pressure in the control chamber 19 is controlled by operating the control valve element 24 thus controlling a back pressure of the valve needle 4 by way of the valve piston 5 whereby seating of the valve needle 4 on the seat portion 17 and lifting of the valve needle 4 from the seat portion 17 can be controlled.

[0031] In the fuel injection valve 1 having such a configuration, high pressure fuel from the common rail 12 acts on the pressure receiving portion 4A of the valve needle 4 in the inside of the fuel reservoir chamber 14 from the inlet portion 8 through the first fuel passages 11a, 11b, and also acts on the top portion 5A of the valve piston 5 in the inside of the control chamber 19 through the second fuel passage 13 and the pressure introducing

chamber 21.

[0032] Accordingly, in a state where the control chamber 19 is cut off from a fuel low pressure side by the control valve element 24, the valve needle 4 is seated to the seat portion 17 of the nozzle body 3 due to a back pressure of the control chamber 19 which the valve needle 4 receives by way of the valve piston 5 and a biasing force of the nozzle spring 18 and hence, the fuel injection hole 16 is closed.

[0033] On the other hand, by supplying the drive signal to the magnet 25 at predetermined timing, the armature 27 is attracted by the magnet 25 so that the control valve element 24 releases the open-close orifice 23. As a result, a high pressure in the control chamber 19 returns to the fuel tank 51 through the fuel return passage 15 by way of the open-close orifice 23. Accordingly, a high pressure acting on the top portion 5A of the valve piston 5 in the control chamber 19 is released so that the valve needle 4 is lifted from the seat portion 17 against a biasing force of the nozzle spring 18 due to a high pressure acting on the pressure receiving portion 4A whereby the fuel injection hole 16 is released and fuel injection is performed.

[0034] Then, when the magnet 25 is demagnetized so that the open-close orifice 23 is closed by the control valve element 24, the valve needle 4 is seated to the seat portion 17 at a seating position by way of the valve piston 5 due to a pressure in the control chamber 19 and a biasing force of the nozzle spring 18 so that the fuel injection hole 16 is closed and the fuel injection is finished.

[0035] Next, the inlet portion 8 of the fuel injection valve 1 according to this embodiment is explained in detail.

[0036] Fig. 2 is an enlarged cross-sectional view of the inlet portion 8 of the fuel injection valve 1 shown in Fig. 1.

[0037] The inlet portion 8 is configured such that an inlet connector 30 is mounted in an inlet opening portion 2a formed in the injection housing 2. In this embodiment, the inlet connector 30 is liquid-tightly and threadably engaged with the inside of the inlet opening portion 2a.

[0038] The inlet connector 30 includes: a cylindrical connector body 31 having both axial ends thereof opened; a flow passage forming member 33 held in the inside of the connector body 31; and a swirl flow forming portion 35 fixed to a distal end of the flow passage forming member 33. An outer peripheral portion of the flow passage forming member 33 is fixed to the inside of the connector body 31 liquid-tightly by press-fitting, welding or the like. The swirl flow forming portion 35 is fixed to a distal end surface of the flow passage forming member 33 by welding or the like.

[0039] An axial passage 33a which opens at both axial ends of the flow passage forming member 33 and constitutes an inflow passage for high pressure fuel is formed in the flow passage forming member 33. In the swirl flow forming portion 35, an axial passage 35a and a circumferential passage 35b are formed. The axial passage 35a is formed such that the axial passage 35a opens on one axial side of the swirl flow forming portion 35, an end

portion of the axial passage 35a on a fuel chamber 40 side described later is closed and the above-mentioned opening communicates with the axial passage 33a of the flow passage forming member 33. The circumferential passage 35b is formed in an offset manner from the center of the axial passage 35a, and connects the axial passage 35a and an outer peripheral portion of the swirl flow forming portion 35 to each other.

[0040] Fig. 3 is a cross sectional view taken along a line A-A in Fig. 2 and viewed from a direction indicated by an arrow. As shown in Fig. 3, the swirl flow forming portion 35 includes a plurality of circumferential passages 35b formed in an extending manner in a tangential direction from the axial passage 35a at the center. In the example shown in Fig. 3, eight circumferential passages 35b extending in the tangential direction respectively are formed at equal intervals.

[0041] By mounting the inlet connector 30 having such a configuration in the inside of the inlet opening portion 2a, the fuel chamber 40 is formed by a distal end portion (a lower side portion shown in Fig. 2) of the inlet connector 30 and a bottom surface portion 2aa of the inlet opening portion 2a. In this embodiment, a shim member 37 is sandwiched between a front-end-side surface (a lower side surface shown in Fig. 2) of the inlet connector 30 and the bottom surface portion 2aa of the inlet opening portion 2a so that leakage of high pressure fuel through a gap formed between the inlet connector 30 and the bottom surface portion 2aa of the inlet opening portion 2a can be suppressed.

[0042] The first fuel passage 11a communicating with the fuel reservoir chamber 14 of the nozzle body 3 and the second fuel passage 13 communicating with the control chamber 19 of the back pressure control part 7 open at the bottom surface portion 2aa of the inlet opening portion 2a in a region of the fuel chamber 40.

[0043] Fig. 4 is a view taken along a plane BB (the bottom surface portion 2aa of the inlet opening portion 2a) in Fig. 2 as viewed from a direction indicated by an arrow. As shown in Fig. 4, on the bottom surface portion 2aa of the inlet opening portion 2a in the region of the fuel chamber 40, the first fuel passage 11a opens at an outer peripheral portion of the bottom surface portion 2aa, and the second fuel passage 13 opens at a center portion of the bottom surface portion 2aa.

[0044] High pressure fuel supplied from the common rail 12 and introduced into the inlet connector 30 flows through the axial passages 33a, 35a formed in the inside of the inlet connector 30 and, thereafter, is introduced into the fuel chamber 40 through the circumferential passages 35b. At this stage of operation, since the circumferential passages 35b are formed offset from the center of the axial passage 35a, particularly, the circumferential passages 35b are formed in the tangential direction in this embodiment, as shown in Fig. 5, the fuel introduced into the fuel chamber 40 forms a swirl flow.

[0045] Accordingly, a foreign substance mixed into high pressure fuel moves toward the outer peripheral por-

tion of the fuel chamber 40 due to a centrifugal force and hence, the foreign substance minimally flows into the second fuel passage 13 communicating with the control chamber 19 of the back pressure control part 7. That is, in the fuel injection valve 1 of this embodiment, in place of collecting a foreign substance having a size of several μm in fuel supplied to the inlet connector 30 from the common rail 12, the foreign substance is separated to the outer peripheral portion of the fuel chamber 40 and is made to flow into a first fuel passage 11a side whereby fuel having relatively high cleanliness is made to flow into the control chamber 19 side of the back pressure control part 7. As a result, the erosion of the valve seat face of the electromagnetic valve 28 of the back pressure control part 7 by a foreign substance can be reduced.

[0046] In the fuel injection valve 1 of this embodiment, a diameter of the circumferential passage 35b of the swirl flow forming portion 35 is designed to a value equal to or less than a diameter of the fuel injection hole 16. For example, the diameter of the fuel injection hole 16 is approximately 100 μm when the diameter of the fuel injection hole is small and hence, the diameter of the circumferential passage 35b can be set to approximately 100 μm . Accordingly, a foreign substance having a size which clogs the fuel injection hole 16 cannot pass through the circumferential passage 35b in advance and hence, clogging of the fuel injection hole 16 can be prevented.

[0047] Further, in the fuel injection valve 1 of this embodiment, a sum of cross-sectional areas of the circumferential passages 35b of the swirl flow forming portion 35 is designed to be equal to or more than a total cross-sectional area of the fuel injection hole 16. Accordingly, a pressure loss of high pressure fuel supplied to the fuel injection valve 1 from the common rail 12 is minimally generated.

[0048] That is, the diameter of the circumferential passage 35b is decided to be equal to or more than the diameter of the fuel injection hole 16 and, at the same time, the number of the circumferential passages 35b is decided such that the sum of cross-sectional areas of the circumferential passages 35b becomes equal to or more than the total cross-sectional area of the fuel injection hole 16. By forming the circumferential passages 35b in this manner, a pressure loss of high pressure fuel can be prevented and, at the same time, clogging of the fuel injection hole 16 by a foreign substance can be prevented.

Claims

1. A fuel injection valve comprising:

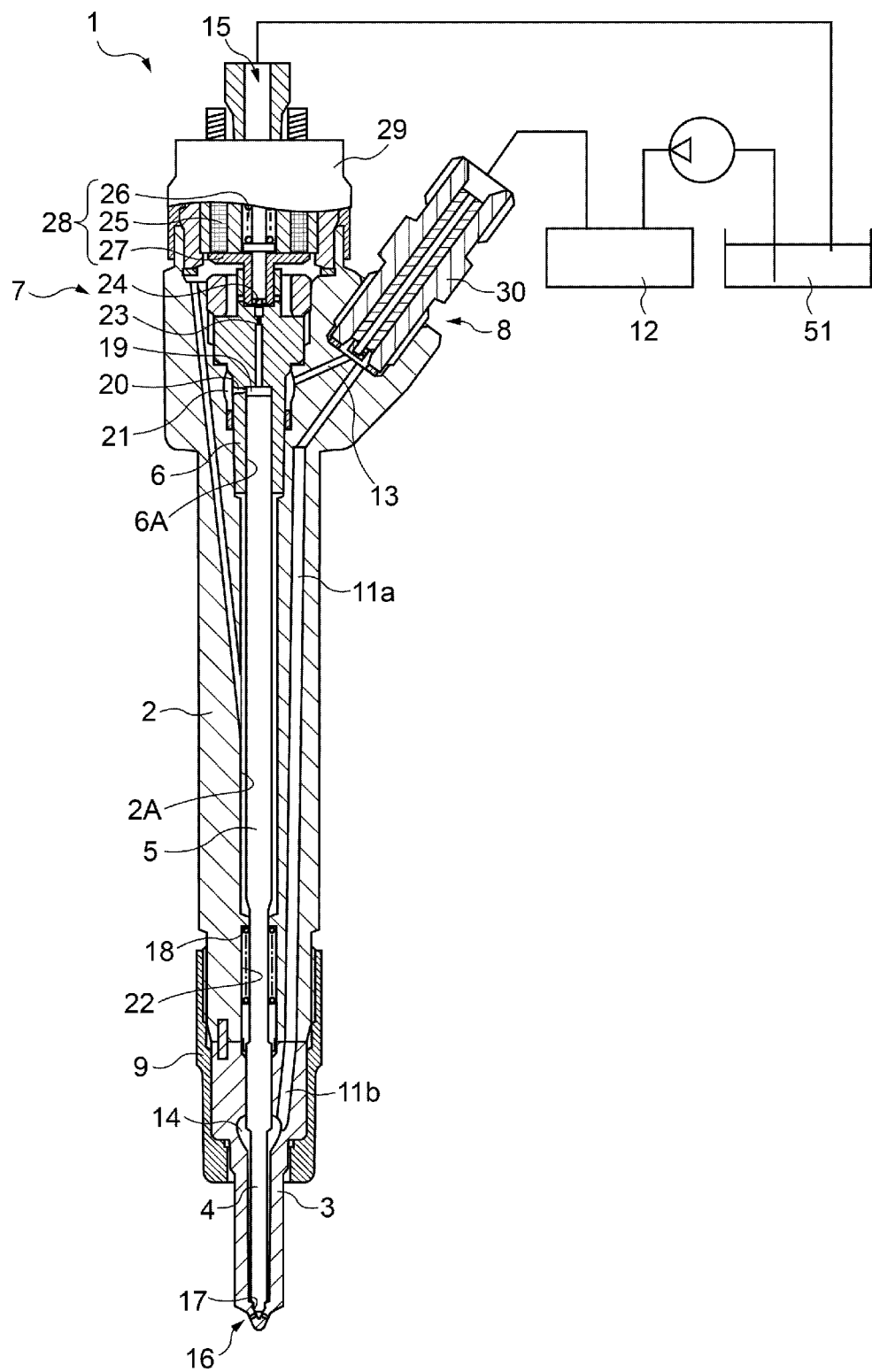
- a housing having a first fuel passage communicating with a fuel injection hole and a second fuel passage communicating with a pressure control chamber;
- a valve needle movably disposed in the inside

of the housing in an advancing and retracting manner; and

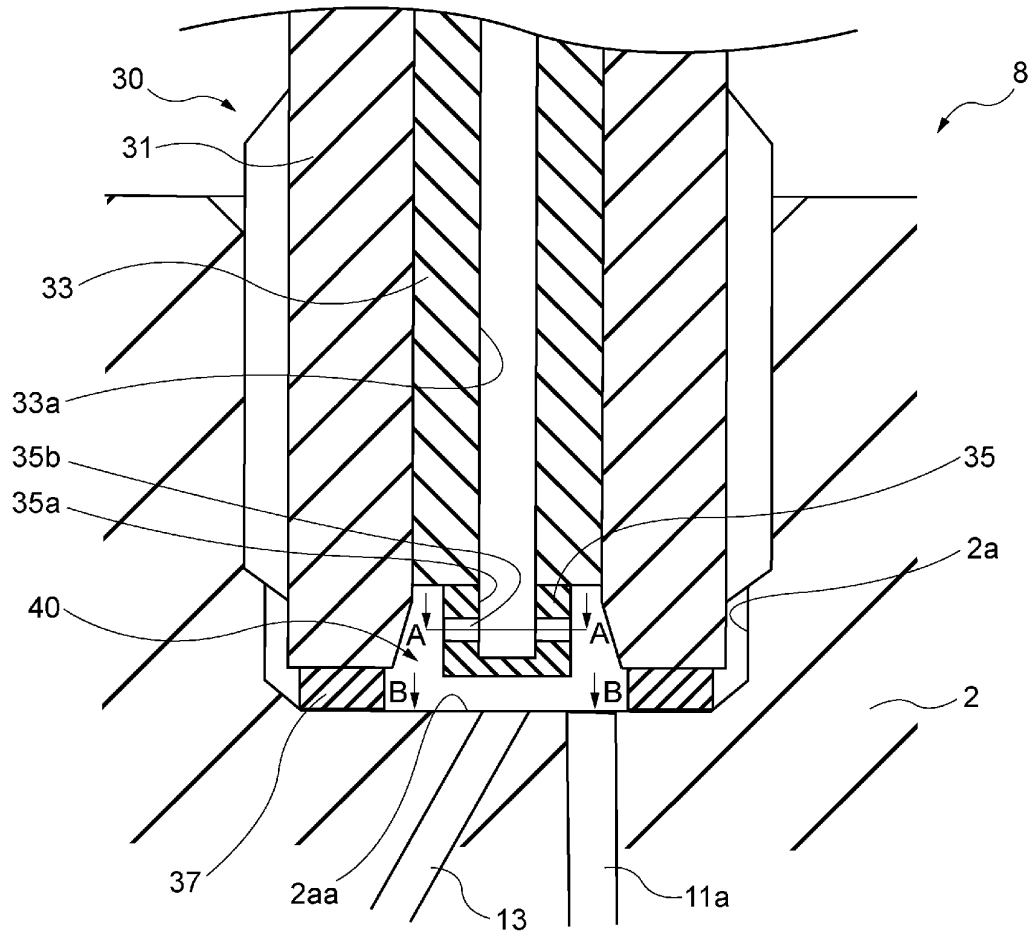
a control valve performing an open-close control of the fuel injection hole by advancing or retracting the valve needle by adjusting a pressure in the pressure control chamber, wherein the housing includes an inlet opening portion, and an inlet connector having an introducing passage for high pressure fuel is mounted on the inlet opening portion, a fuel chamber is formed between an end surface portion of the inlet connector and a bottom surface portion of the inlet opening portion, the first fuel passage opens at an outer peripheral portion of the bottom surface portion within a region of the fuel chamber, and the second fuel passage opens at a center portion of the bottom surface portion, and the inlet connector is configured such that high pressure fuel introduced into the fuel chamber from the inlet connector is capable of forming a swirl flow.

2. The fuel injection valve according to claim 1, wherein the inlet connector has: an axial passage extending in an axial direction; and a circumferential passage extending in a circumferential direction from the axial passage, disposed offset from the center of the axial passage, and opens in the fuel chamber.
3. The fuel injection valve according to claim 2, wherein an end portion of the axial passage on a fuel chamber side is closed.
4. The fuel injection valve according to claim 2 or 3, wherein a plurality of the circumferential passages are provided.
5. The fuel injection valve according to any one of claims 2 to 4, wherein a diameter of the circumferential passage is set equal to or less than a diameter of the fuel injection hole.
6. The fuel injection valve according to any one of claims 2 to 5, wherein a plurality of the circumferential passages are provided, and a sum of cross-sectional areas of the circumferential passages is set equal to or more than a total cross-sectional area of the fuel injection hole.
7. The fuel injection valve according to any one of claims 2 to 6, wherein the number of the circumferential passages is decided by taking into an account a diameter of the circumferential passage and the sum of the cross-sectional areas of the circumferential passages.

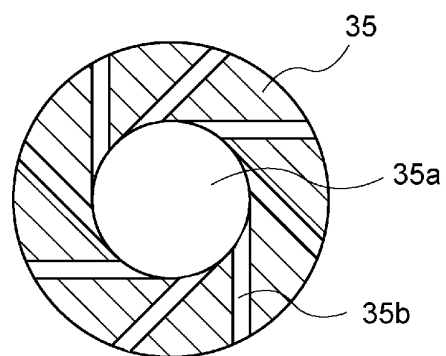
[FIG. 1]



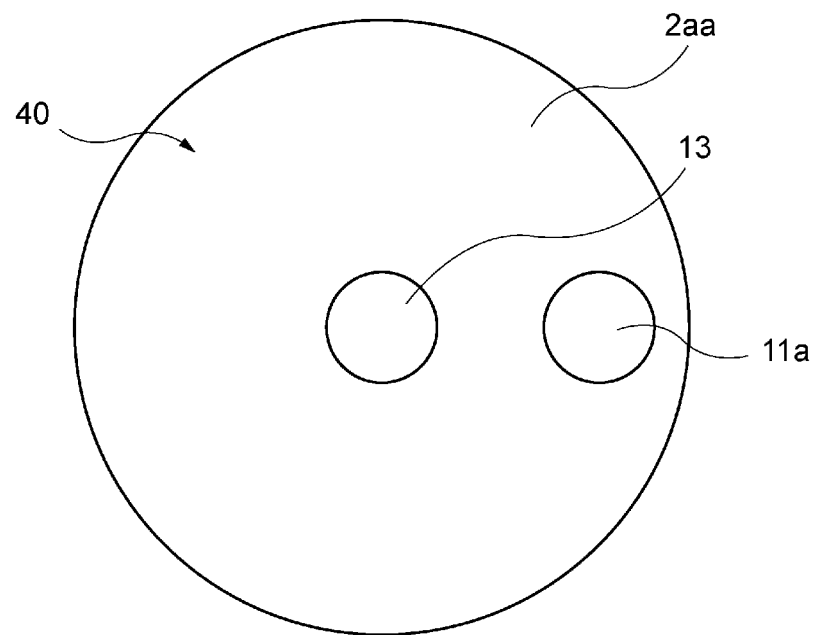
[FIG.2]



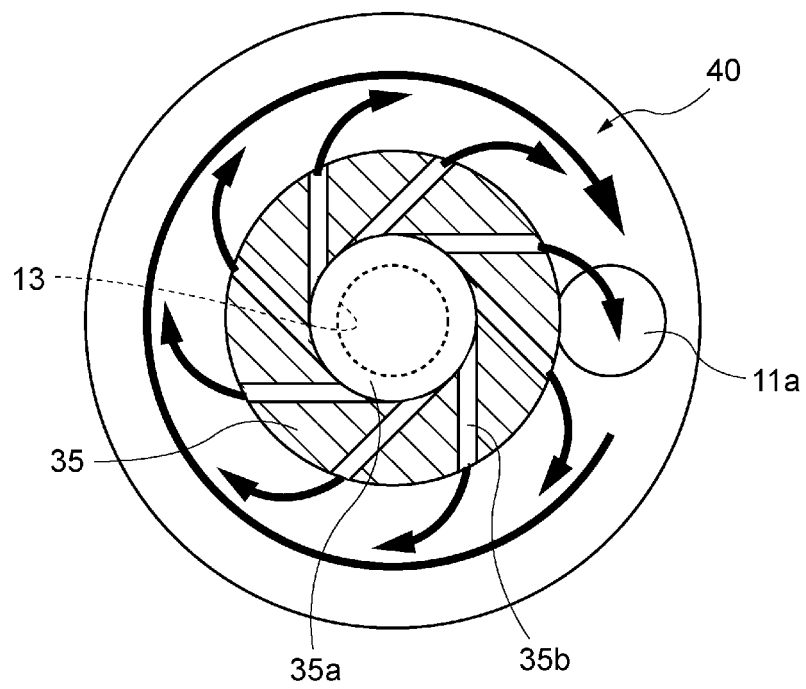
[FIG.3]



[FIG. 4]



[FIG. 5]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/063183

A. CLASSIFICATION OF SUBJECT MATTER

F02M47/00(2006.01) i, F02M61/16(2006.01) i

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)

F02M47/00, F02M61/16

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	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

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.
Y A	JP 2010-031854 A (C.R.F. Societa Consortile per Azioni), 12 February 2010 (12.02.2010), paragraphs [0013] to [0034]; fig. 1 & US 2009/0320802 A1 paragraphs [0023] to [0044]; fig. 1 & EP 2138707 A1 & CN 101614174 A & KR 10-2010-0002199 A & AT 503106 T	1 2-7
Y A	JP 2008-163811 A (Denso Corp.), 17 July 2008 (17.07.2008), paragraphs [0023] to [0028]; fig. 1 to 4 (Family: none)	1 2-7

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
16 June, 2014 (16.06.14)Date of mailing of the international search report
24 June, 2014 (24.06.14)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/063183

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 065440/1989 (Laid-open No. 006052/1991) (Toyota Motor Corp.), 22 January 1991 (22.01.1991), page 6, line 17 to page 8, line 19; fig. 1 to 3 (Family: none)	1 2-7
A	JP 08-246993 A (Nippondenso Co., Ltd.), 24 September 1996 (24.09.1996), paragraphs [0013] to [0020]; fig. 1, 4 to 7 (Family: none)	1, 2
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Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2009203843 A [0007]