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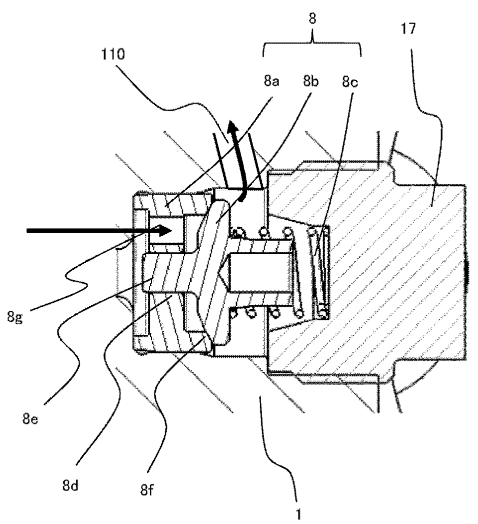
(54) HIGH-PRESSURE FUEL SUPPLY PUMP

(57) Provided is a high-pressure fuel supply pump that maintains oil-tight performance even when the fuel pressure is high, and includes a small and lightweight discharge valve structure. The structure prevents the reduction in oil-tight performance caused by the deformation of the seat part due to the high back pressure that the discharge valve receives. The structure also makes the provision of a flow path compatible with the size reduction and weight reduction of the discharge valve.

The valve body of the discharge valve includes a guide part and a curved contact surface. Thus, the seat part is formed with Hertzian contact and this formation exerts high oil-tightness even when a high back pressure is applied to the valve body. The guide part is provided to the valve body. This provision determines the position of the curved contact surface. This determination reduces the size and weight of the valve body.

FIG. 5



EP 3 135 900 A1

Description

Technical Field

[0001] The present invention relates to the structure of a discharge valve of a high-pressure fuel supply pump for an internal-combustion engine of a vehicle.

Background Art

[0002] A plunger high-pressure fuel supply pump to increase the pressure of the fuel is often used in a direct-injection internal-combustion engine in which the fuel is directly injected to the inside of the combustion chamber among internal-combustion engines, for example, of vehicles.

[0003] JP 2011-80391 A describes a discharge valve unit in which a valve body, a seat, and a spring are formed and embedded. The surface of the seat of the discharge valve is flat. The contact part in which the valve body has contact with the seat is accurately ground. This can provide an oil-tight performance (see PTL 1).

[0004] JP 394413 B1 describes that a ball is used as a valve body. The ball receives a back pressure and has contact with the surface of the seat by Hertzian contact. This can provide an oil-tight performance.

Citation List

Patent Literature

[0005]

PTL 1: JP 2011-80391 A
PTL 2: JP 394413 B1

Summary of Invention

Technical Problem

[0006] However, in the technique in PTL 1, when the pump operates at a notably high pressure, the valve body receives a high back pressure. This deforms the flat seat part and sometimes decreases the oil-tight performance.

[0007] On the other hand, in the technique in PTL 2, the ball shape of the valve body enhances the Hertzian contact between the valve body and the seat part even when the valve body receives a high back pressure. This can provide high oil-tightness. However, the ball-shaped valve body geometrically causes the seat part to be smaller than the diameter of the ball (for example, provided that the seat angle is 90 degrees, the diameter of the seat is $1/\sqrt{2}$ times as large as the diameter of the ball). This reduces the space for placing a flow path. When the diameter of the ball is increased in order to widen the flow path, the increase in diameter leads to the increase in mass of the valve body. This makes it inevitable to impair the responsiveness of the valve body. Additionally, this increases the size of a part to hold the ball, and thus increases the entire size of the discharge valve.

[0008] An objective of the present invention is to provide a high-pressure fuel supply pump that maintains the oil-tight performance even when the fuel pressure is high, and includes a small and lightweight discharge valve structure.

Solution to Problem

[0009] To solve the problem, a high-pressure fuel supply pump according to the present invention includes: a cylinder provided to a pump; a plunger slidably provided in the cylinder and reciprocating in accordance with the rotation of a cam; a fluid pressurizing chamber formed between the plunger and the cylinder; an electromagnetic valve provided to the space between the pressurizing chamber and a fluid intake path; and a discharge valve provided to a space formed between the pressurizing chamber and a fluid discharge path. The discharge valve includes: a seat member having a conical seat surface of which diameter gradually decreases toward the pressurizing chamber; a valve member that comes into contact with the seat member; a guide mechanism that holds the valve member so that the valve member can axially slide; a curved surface part formed on the contact surface on which the valve member has contact with the seat; and a spring that biases the valve member toward the seat.

[0010] More preferably, the guide mechanism includes a support part integrally formed with the valve body.

[0011] More preferably, the guide mechanism is formed closer to the seat than the valve body.

[0012] More preferably, the diameter of the spring is smaller than the seat diameter.

[0013] More preferably, the seat member is provided with a guide hole that guides the support part.

[0014] More preferably, the seat member is provided with a plurality of communication paths that communicate the pressurizing chamber with the discharge path. The communication paths are arranged around the guide hole.

Advantageous Effects of Invention

[0015] According to the structure of the high-pressure fuel supply pump described above, the valve body of the discharge valve includes a curved contact surface. Thus, when a high back pressure is applied to the valve body, Hertzian contact slightly deforms the seat part and forms a seal surface. This exerts high oil-tightness. Additionally, only the contact surface of the valve body needs to have a curved shape. The part of the valve body outside the contact surface with the seat part can be omitted. This makes the valve body smaller and lighter than a merely ball-shaped valve body. In order to cause the curved surface part to surely come into contact with the seat, a guide mechanism that prevents the inclination of the valve body is required. A guide mechanism that holds the valve body so that the valve body can axially slide can implement the guide mechanism described above.

[0016] Furthermore, the guide mechanism is formed closer to the seat than the valve body. This formation can decrease the entire length of the discharge valve.

[0017] Furthermore, the diameter of the spring is decreased to a length shorter than the diameter of the seat. This decrease can keep the outer diameter of the discharge valve small.

[0018] Furthermore, the guide hole for the support part of the valve body is provided to the seat member. This makes the guide mechanism small and simple.

[0019] Furthermore, a plurality of communication paths is provided around the guide hole. This can decrease the circumferential deviation of fluid force acting on the valve body.

[0020] The effects described above can provide a high-pressure fuel supply pump that maintains the oil-tight performance even when the fuel pressure is high, and includes a small and lightweight discharge valve structure.

Brief Description of Drawings

[0021]

[FIG. 1] FIG. 1 is a vertical cross-sectional view of the whole of a high-pressure fuel supply pump of a first embodiment in which the present invention is implemented.

[FIG. 2] FIG. 2 is a cross-sectional view of the high-pressure fuel supply pump of the first embodiment, viewed from another angle.

[FIG. 3] FIG. 3 is a horizontal cross-sectional view of the high-pressure fuel supply pump of the first embodiment.

[FIG. 4] FIG. 4 is a view of the whole of a system including the high-pressure fuel pump.

[FIG. 5] FIG. 5 is a cross-sectional view of a discharge valve mechanism of the first embodiment in which the present invention is implemented.

[FIG. 6] FIG. 6 is an exploded view of the discharge valve mechanism in which the present invention is implemented.

[FIG. 7] FIG. 7 is a projection view of a discharge valve seat member.

[FIG. 8] FIG. 8 is a cross-sectional view of a discharge valve member.

[FIG. 9] FIG. 9 is a cross-sectional view of a discharge valve member of a second embodiment.

[FIG. 10] FIG. 10 is a cross-sectional view of a discharge valve member of a third embodiment.

[FIG. 11] FIG. 11 illustrates another embodiment.

Description of Embodiments

[0022] Hereinafter, an embodiment according to the present invention will be described.

First Embodiment

[0023] The configuration and operation of a system will be described with reference to the view of the whole configuration of the system illustrated in FIG. 4.

[0024] A part surrounded by a dashed line is the body of a high-pressure fuel supply pump (hereinafter, referred to as a high-pressure pump). The mechanism and parts in the dashed line are integrally embedded in a high-pressure pump body 1. The fuel in a fuel tank 20 is pumped up by a feed pump 21, and fed via an intake pipe 28 to an intake joint 10a of the pump body 1.

[0025] After passing through the intake joint 10a, the fuel passes through a pressure pulsation reducing mechanism 9, and an intake path 10b, and reaches an intake port 30a of an electromagnetic inlet valve 30 included in a flow rate control mechanism. The pulsation preventing mechanism 9 will be described below.

[0026] The electromagnetic inlet valve 30 includes an electromagnetic coil 308. When the electromagnetic coil 308 does not conduct electricity, the difference between the biasing force of an anchor spring 303 and the biasing force of a valve spring 304 biases an inlet valve body 301 in a valve-opening direction in which the inlet valve body 301 is opened, and this opens the intake opening 30d. Note that the biasing force of the anchor spring 303 and the biasing force of the valve spring 304 are set so that the biasing force of the anchor spring 303 > the biasing force of the valve spring 304
holds.

[0027] When the electromagnetic coil 308 conducts electricity, a state in which an anchor 305 is moved to the left side of FIG. 4 and the anchor spring 303 is compressed is maintained. An inlet valve body 301 with which the tip of an electromagnetic plunger 305 coaxially has contact seals the intake opening 30d connected to a pressurizing chamber 11 of the high-pressure pump using the biasing force of the valve spring 304.

[0028] The operation of the high-pressure pump will be described hereinafter.

[0029] When the rotation of a cam described below displaces a plunger 2 downward in FIG. 4 and the plunger 2 is in an intake process, the volume of the pressurizing chamber 11 is increased and the fuel pressure in the pressurizing chamber 11 is decreased. In the intake process, when the fuel pressure in the pressurizing chamber 11 is reduced to a pressure lower than the pressure in the intake path 10b (the intake port 30a), the fuel passes through the opened intake opening 30d and flows into the pressurizing chamber 11. When the plunger 2 completes the intake process and moves to a compression process, the plunger 2 moves to the compression process (a state in which the plunger 2 moves upward in FIG. 1). At that time, a state in which the electromagnetic coil 308 does not conduct electricity is maintained, and thus magnetic biasing force does not act. Thus, the inlet valve body 301 is still opened by the biasing force of the anchor spring 303. The volume of the pressurizing chamber 11 decreases with the compressing motion of the plunger 2. In such a state, the fuel sucked in the pressurizing chamber 11 is returned through the opened inlet valve body 301 to the intake path 10b (the intake port 30a). Thus, the pressure in the pressurizing chamber is not increased. This process is referred to as a return process.

[0030] When a control signal from an engine control unit 27 (hereinafter, referred to as ECU) is applied to the electromagnetic inlet valve 30 in the return process, a current flows through the electromagnetic coil 308 of the electromagnetic inlet valve 30. The magnetic biasing force moves the electromagnetic plunger 305 to the left side of FIG. 4 and a state in which the anchor spring 303 is compressed is maintained. As a result, the biasing force of the anchor spring 303 does not act on the inlet valve body 301. The fluid force due to the biasing force of the valve spring 304 and the flow of the fuel into the intake path 10b (the intake port 30a) acts. This closes the inlet valve 301 and thus closes the intake opening 30d. When the intake opening 30d is closed, the fuel pressure in the pressurizing chamber 11 starts increasing with the upward motion of the plunger 2. When the fuel pressure is larger than or equal to the pressure in the fuel outlet 12, the fuel remaining in the pressurizing chamber 11 is discharged at high pressure through the discharge valve mechanism 8, and fed to the common rail 23. This process is referred to as a discharge process.

[0031] In other words, the compression process of the plunger 2 (a process in which the plunger 2 rises from a lower starting point to an upper starting point) includes the return process and the discharge process. Controlling the timing at which the electromagnetic coil 308 of the electromagnetic inlet valve 30 conducts electricity can control the amount of the high-pressure fuel to be discharged. When the timing at which the electromagnetic coil 308 conducts electricity is hastened, the proportion of the return process is low and the proportion of the discharge process is high to the compression process. In other words, the amount of fuel to be returned to the intake path 10b (the intake port 30a) is decreased and the amount of fuel to be discharged at high pressure is increased. On the other hand, when the timing at which the electromagnetic coil 308 conducts electricity is delayed, the proportion of the return process is high and the proportion of the discharge process is low to the compression process. In other words, the amount of fuel to be returned to the intake path 10b is increased and the amount of fuel to be discharged at high pressure is decreased. The timing at which the electromagnetic coil 308 conducts electricity is controlled by the instructions from the ECU.

[0032] The configuration described above controls the timing at which the electromagnetic coil 308 conducts electricity. This can control the amount of fuel to be discharged at high pressure in accordance with the amount of fuel that the internal-combustion engine requires.

[0033] The outlet of the pressurizing chamber 11 is provided with a discharge valve mechanism 8. The discharge valve mechanism 8 includes a discharge valve seat 8a, a discharge valve 8b, and a discharge valve spring 8c. When there is no fuel differential pressure between the pressurizing chamber 11 and the fuel outlet 12, the discharge valve 8b is pressed and fixed to the discharge valve seat 8a and closed by the biasing force of the discharge valve spring 8c. When the fuel pressure in the pressurizing chamber 11 exceeds the fuel pressure in the fuel outlet 12, the discharge valve 8b is opened against the discharge valve spring 8c and the fuel in the pressurizing chamber 11 is discharged at high pressure through the fuel outlet 12 to the common rail 23.

[0034] As described above, the fuel guided to the intake joint 10a is pressurized at high pressure by the reciprocation of the plunger 2 in the pressurizing chamber 11 of the pump body 1 as much as necessary, and fed from the fuel outlet 12 to the common rail 23 by the pressure.

[0035] Injectors 24 for direct injection (namely, a direct-injection injectors) and a pressure sensor 26 are attached to the common rail 23. The number of the attached direct-injection injectors 24 corresponds to the number of cylinder engines of the internal-combustion engine. The direct-injection injectors 24 open and close in accordance with the control signal from the engine control unit (ECU) 27 so as to inject the fuel in the cylinder.

[0036] Hereinafter, the configuration and operation of the high-pressure fuel pump will be described in more detail with reference to FIGS. 1 to 3.

[0037] A high-pressure pump is typically adhered and fixed to a cylinder head 41 of an internal-combustion engine. An O-ring 61 is fitted to the pump body 1 so that the airtightness between the cylinder head and the pump body is retained.

[0038] A cylinder 6 is attached to the pump body 1. The cylinder 6 is formed in a cylinder with a bottom on an end so that the cylinder 6 guides the back-and-forth movement of the plunger 2 and the pressurizing chamber 11 is formed in the cylinder 6. The pressurizing chamber 11 is provided with a plurality of communication holes 11a so that the pressurizing chamber 11 communicates with the electromagnetic inlet valve 30 configured to feed the fuel and the discharge valve mechanism 8 configured to discharge the fuel from the pressurizing chamber 11 to the discharge path.

[0039] A cylinder 6 includes a large-diameter part and a small-diameter part on its outer diameter. The small-diameter part is press and inserted into the pump body 1, and the surface of a width difference 6a between the large-diameter part and the small-diameter part is press-fitted to the pump body 1. This seals the pressurizing chamber 11 so as to prevent the fuel pressurized in the pressurizing chamber 11 from leaking to a lower pressure side.

[0040] The lower end of the plunger 2 is provided with a tappet 3 that converts the rotation movement of a cam 5 attached to a camshaft of the internal-combustion engine into up-and-down movement, and transmits the up-and-down movement to the plunger 2. The plunger 2 is pressed and fixed to the tappet 3 through a retainer 15 with a spring 4. This can move (reciprocate) the plunger 2 up and down with the rotation movement of the cam 5.

[0041] A plunger seal 13 held on the lower end of the inner periphery of the seal holder 7 has slidably contact with the outer periphery of the plunger 2 on the lower end of the cylinder 6 in the drawing. This seals the blow-by gap between the plunger 2 and the cylinder 6 and prevents the fuel from leaking to the outside of the pump. Meanwhile, this prevents the lubricant (including engine oil) that smoothly moves a sliding part of the internal-combustion engine from leaking through the blow-by gap into the pump body 1.

[0042] The fuel sucked by the feed pump 21 is fed through the intake joint 10a coupled with the intake pipe 28 to the pump body 1.

[0043] A damper cover 14 is coupled with the pump body 1 and forms a low-pressure fuel chamber 10. The fuel passing through the inlet joint 10a flows into the low-pressure fuel chamber 10. In order to remove an obstacle such as a metal powder in the fuel, a fuel filter 102 is attached to the upstream part of the low-pressure fuel chamber 10, for example, while being pressed and inserted in the pump body 1.

[0044] A pressure pulsation reducing mechanism 9 is installed in the low-pressure fuel chamber 10 so that the pressure pulsation reducing mechanism 9 reduces the spread of the pressure pulsation generated in the high-pressure pump to a fuel pipe 28. When the fuel sucked in the pressurizing chamber 11 is returned through the opened inlet valve body 301 to the intake path 10b (the intake port 30a) under a state in which the flow rate of the fuel is controlled, the fuel returned to the intake path 10b (the intake port 30a) generates the pressure pulsation in the low-pressure fuel chamber 10. However, the pressure pulsation is absorbed and reduced by the expansion and contraction of a metal damper 9a forming the pressure pulsation reducing mechanism 9 provided to the low-pressure fuel chamber 10. The metal damper 9a is formed of two corrugated metal disks of which outer peripheries are bonded together. Inert gas such as argon is injected in the metal damper 9a. Mounting hardware 9b is configured to fix the metal damper 9a on the inner periphery of the pump body 1.

[0045] The electromagnetic inlet valve 30 is a variable control mechanism that includes the electromagnetic coil 308. The electromagnetic inlet valve 30 is connected to the ECU through the terminal 307 and repeats conduction and non-conduction of electricity so as to open and close the inlet valve and control the flow rate of the fuel.

[0046] When the electromagnetic coil 308 does not conduct electricity, the biasing force of the anchor spring 303 is transmitted to the inlet valve body 301 through the anchor 305 and the anchor rod 302 integrally formed with the anchor 305. The biasing force of the valve spring 304 installed in the inlet valve body is set so that

the biasing force of the anchor spring 303 > the biasing force of the valve spring 304

holds. As a result, the inlet valve body 301 is biased in a valve-opening direction in which the inlet valve body 301 is opened. The intake opening 30d is opened. Meanwhile, the anchor rod 302 has contact with the inlet valve body 301 at a part 302b (in a state illustrated FIG. 1).

[0047] The setting for the magnetic biasing force generated by the electricity conduction through the coil 308 is configured to enable the anchor 305 to overcome the biasing force of the anchor spring 303 and be sucked into a stator 306. When the coil 308 conducts electricity, the anchor 303 moves toward the stator 306 (the left side of the drawing) and a stopper 302a formed on an end of the anchor rod 302 has contact with an anchor rod bearing 309 and is seized. At that time, the clearance is set so that the travel distance of the anchor 301 > the travel distance of the inlet valve body 301

holds. The contact part 302b opens between the anchor rod 302 and the inlet valve body 301. As a result, the inlet valve body 301 is biased by the valve spring 304 and the intake opening 30d is closed.

[0048] The electromagnetic inlet valve 30 is fixed to the pump body 1 while an inlet valve seat 310 is hermetically inserted in a tubular boss 1b so that the inlet valve body 301 can seal the intake opening 30d to the pressurizing chamber. When the electromagnetic inlet valve 30 is attached to the pump body 1, the intake port 30a is connected to the intake path 10b.

[0049] The discharge valve mechanism 8 of the present embodiment will be described with reference to FIGS. 5 and 6. The discharge valve mechanism 8 includes the discharge valve seat member 8a provided with a bearing 8d that can sustain the sliding reciprocation of the discharge valve body 8b at the center of the discharge valve seat member 8a, and the discharge valve member 8b provided with a central shaft 8e that can slide along the bearing of the discharge valve seat member 8a. A circular contact surface 8f is formed on the discharge valve member 8b. The circular contact surface 8f can maintain oil-tightness by having contact with the discharge valve seat member 8a. The discharge valve spring 8c is provided so as to bias the discharge valve member 8b in a valve-closing direction in which the discharge valve member 8b is closed. The discharge valve seat member 8a is provided with a plurality of communication paths 8g concentrically drilled around the bearing 8d. The discharge valve seat member 8a is held in the pump body 1, for example, by press-insertion. The discharge valve member 8b and the discharge valve spring 8c are further inserted in the pump body 1. Then, a sealing plug 17 seals the pump body 1. This forms the discharge valve mechanism 8. The discharge valve mechanism 8 functions as a check valve that controls the direction in which the fuel flows. In the present embodiment, after passing through the discharge valve seat member 8a, the fuel passes through the discharge path 110 and the fuel outlet 12 and flows downstream. The position of the discharge path varies depending on the design. For example, the discharge path is directly provided to the sealing plug 17. This can also implement the discharge valve mechanism intended in the present invention.

[0050] With reference to FIG. 7, the discharge valve seat member 8a will be described. Three communication paths 8g are concentrically arranged around the bearing 8d as described above. The number of communication paths 8g is three in the present embodiment. However, the number and size of communication paths 8g are designed in consideration, for example, of the necessary flow rate, the pressure loss, and the balance. In other words, the number and size of communication paths 8g can vary depending on the design to form the discharge valve intended in the present invention. The seat surface 8i having contact with the discharge valve member 8b is formed in a conical shape. The cross-sectional surface of the seat surface 8i has a tapered shape.

[0051] With reference to FIG. 8, the discharge valve member 8b will be described. The discharge valve member 8b is provided with a curved surface 8h. The position provided with the curved surface 8h comes into contact with the discharge valve seat member 8a. This contact forms the circular contact surface 8f. The curved surface 8h of the present embodiment has a radius curvature R.

[0052] When the curved surface 8h of the discharge valve member 8b is pressed to the seat surface 8i of the discharge valve seat member 8a, the curved surface 8h is slightly deformed and is formed into the circular contact surface 8f that can maintain the oil-tightness. The entire circumference of the contact part of the curved surface 8h has the even radius curvature R. Thus, the circular contact surface 8f can form an even seat surface on the entire circumference. The curved surface 8h is pressed and deformed. This deformation forms the seat surface. Thus, the higher the pressure (back pressure) acting on the valve body is, the wider the seat surface is and the smaller the gap between the seat part and the seat surface 8i is. The mechanism of the slight deformation of the curved surface and the seat part can be explained as the deformation with publicly known Hertzian contact.

[0053] Furthermore, the curved surface 8h includes not only the part that is the circular contact surface 8f but also parts with the same radius curvature R extending on both sides of the circular contact surface 8f (on the peripheries inside and outside the circular contact surface 8f). Thus, the curved surface 8i pressed to the discharge valve seat member 8a has the even radius curvature and can form the circular contact surface 8f that can maintain the oil-tightness even when the guide part is inclined to some extent. Only the seat part and the parts on both sides of the seat part have the even radius curvature. This makes the valve body smaller and lighter than a spherical valve body. The weight reduction of the valve body is preferable in order to increase the responsiveness of the discharge valve. Furthermore, the discharge valve spring 8c is provided to the side of the central shaft. This can decrease the diameter of the entire discharge valve mechanism 8. In the present embodiment, the discharge valve spring 8c is provided inside the circular contact surface 8f. However, the discharge valve spring 8c can be provided outside the circular contact surface 8f. This can also implement the discharge valve mechanism according to claims 1 and 2.

Second Embodiment

[0054] With reference to FIGS. 9 and 10, another embodiment will be described.

[0055] A discharge valve mechanism 8' includes a discharge valve seat member 8a', a discharge valve member 8b', and a discharge valve spring 8c'. A sealing plug 17' that seals the discharge valve mechanism 8' is provided to the downstream part of the discharge valve mechanism 8'. The sealing plug 17' is provided with a discharge path 110'.

[0056] The discharge valve member 8b' includes a curved surface 8h'. A guide part 8e' is provided to the outer periphery of the valve body. The maximum diameter of the discharge valve member is almost the same as the maximum diameter of the curved surface 8h'. Thus, the maximum diameter of the discharge valve member can be kept smaller than the maximum diameter of a perfectly spherical valve body. The spring 8c is embedded in the inner peripheral wall of the guide part 8e'. In the structure of the present embodiment, the guide part of the discharge valve member and a spring storage part are arranged in parallel. This arrangement can reduce the entire length of the discharge valve member. The reasons described above can make the discharge valve member relatively small and light.

Third Embodiment

[0057] With reference to FIG. 11, another embodiment will be described. A discharge valve member in the present embodiment includes a tapered part 8j and is provided with a short curved surface 8h" on an end of the tapered part 8j. The curved surface 8" is the part that comes into contact with a discharge valve seat member and forms a circular contact surface that can maintain the oil-tightness. The guide mechanism is accurately designed so that the range of the inclination of the discharge valve member is narrowed. This enables the short curved surface 8" to surely have contact with a seat surface. Also in the present embodiment, basically, the curved surface comes into contact with the seat and this contact forms the circular contact surface. This can implement the discharge valve intended in the present invention. In the present embodiment, the flexibility of the radius curvature R is increased. A more appropriate radius curvature can be selected depending on the usage environment. Similarly to the second embodiment, the size reduction and weight reduction of the discharge valve member can also be achieved.

Reference Signs List

[0058]

1	pump body
2	plunger
6	cylinder
8	discharge valve mechanism
9	pressure pulsation reducing mechanism
30	electromagnetic inlet valve
100	pressure relief valve mechanism

Claims

1. A high-pressure fuel pump that is a plunger high-pressure fuel pump, comprising:

a cylinder provided to a pump;
a plunger that is slidably provided in the cylinder and reciprocates in accordance with rotation of a cam;
a fluid pressurizing chamber formed between the plunger and the cylinder;
an electromagnetic valve provided to a space formed between the pressurizing chamber and a fluid intake path; and
a discharge valve provided to a space formed between the pressurizing chamber and a fluid discharge path,

wherein the discharge valve includes:

a seat member including a seat surface formed in a conical shape having a diameter gradually decreasing toward the pressurizing chamber;
a valve member that comes into contact with the seat member;
a guide mechanism that holds the valve member so that the valve member can axially slide;
a curved surface part formed on a contact surface on which the valve member has contact with the seat; and
a spring that biases the valve member toward the seat.

2. The high-pressure fuel pump according to claim 1, wherein the guide mechanism includes a support part integrally formed with the valve body.

3. The high-pressure fuel pump according to claims 1 and 2, wherein the guide mechanism is formed closer to the seat than the valve body.

4. The high-pressure fuel pump according to claims 1 to 3, wherein a diameter of the spring is smaller than a diameter of the seat.

5. The high-pressure fuel pump according to claims 2 to 4, wherein the seat member is provided with a guide hole that guides the support part.

6. The high-pressure fuel pump according to claim 5, wherein the seat member is provided with a plurality of communication paths that communicate the pressurizing chamber with the discharge path, and the communication paths are arranged around the guide hole.

FIG. 1

CROSS-SECTIONAL SURFACE TAKEN ALONG LINE A—A'

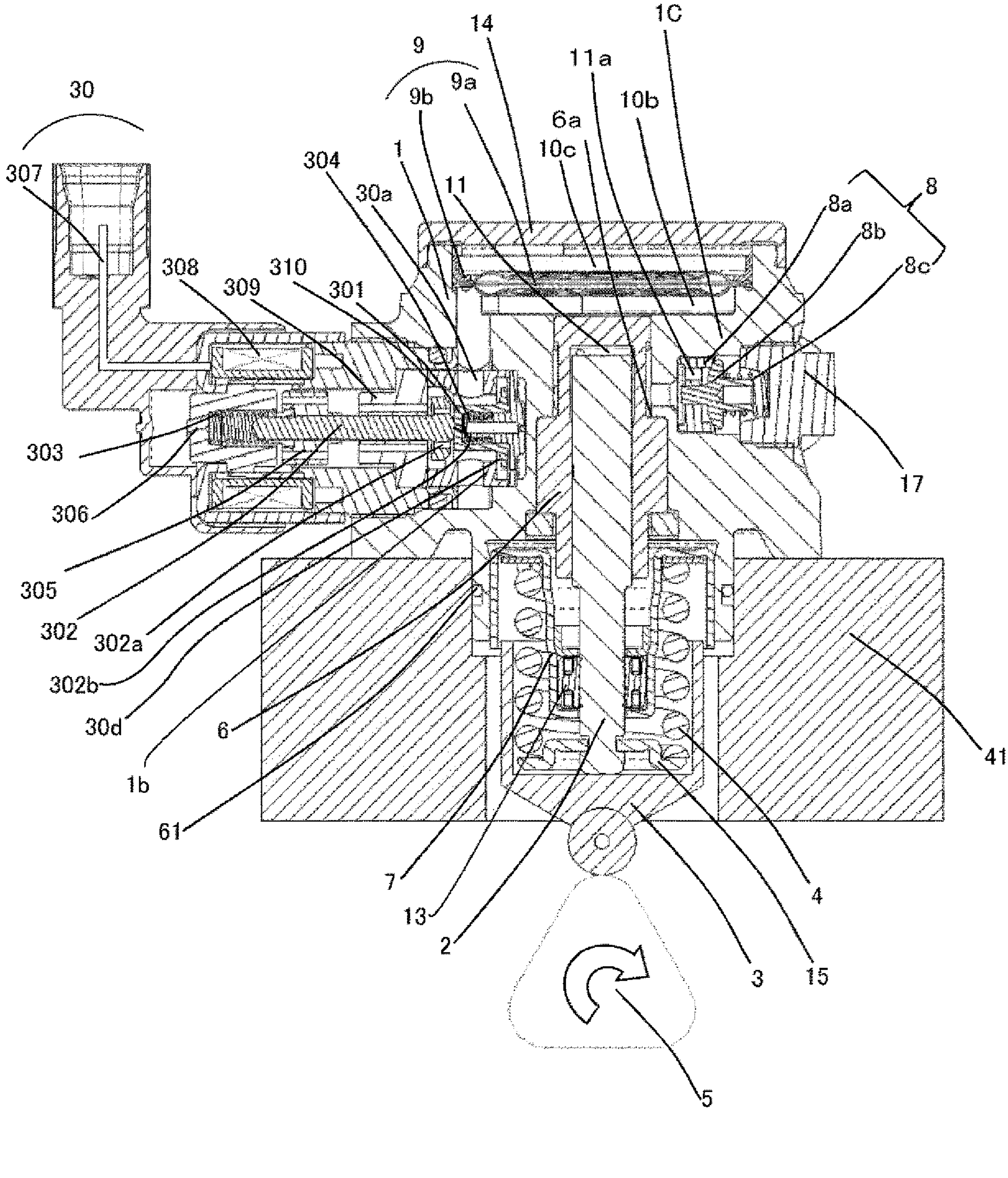


FIG. 2

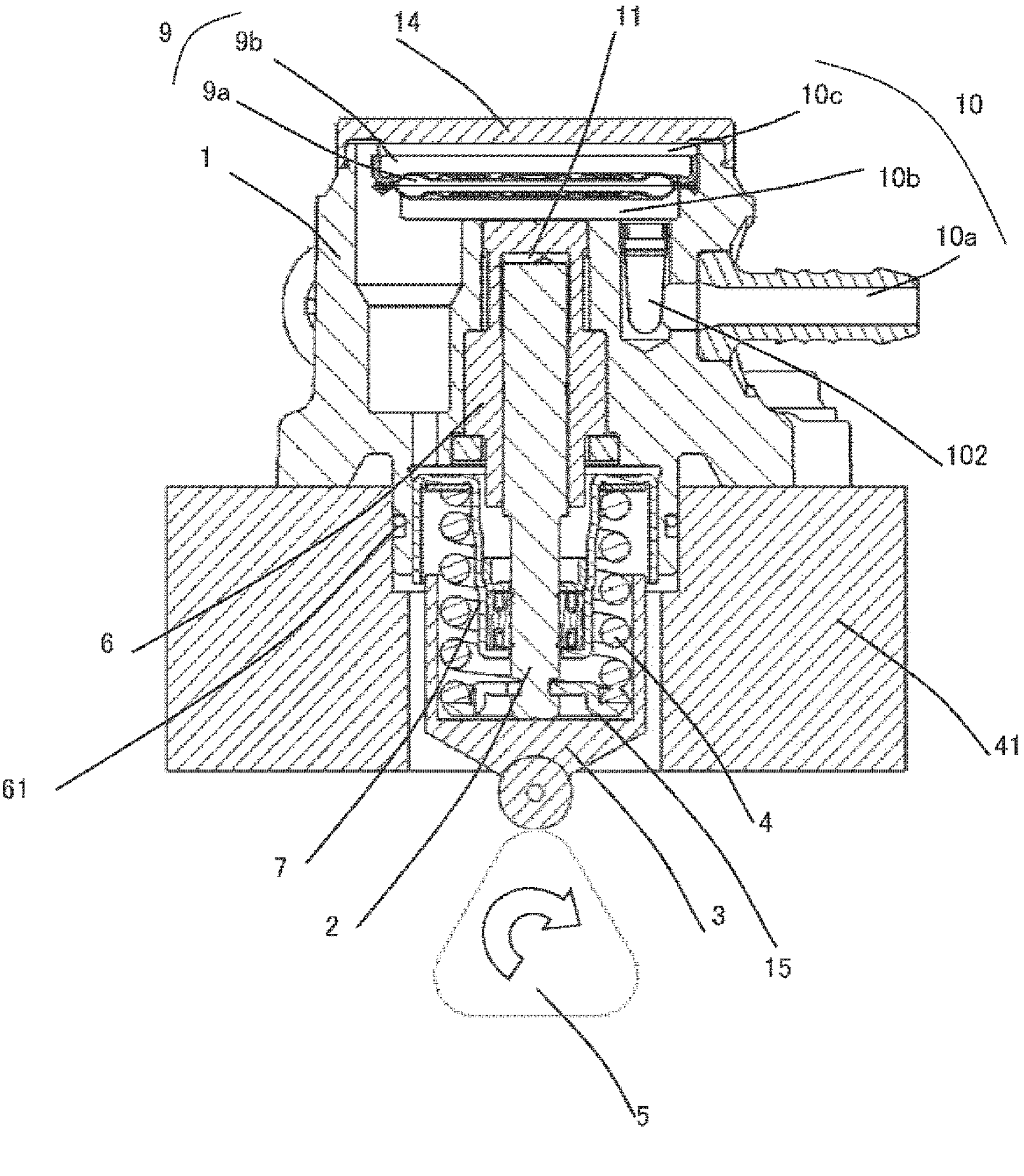


FIG. 3

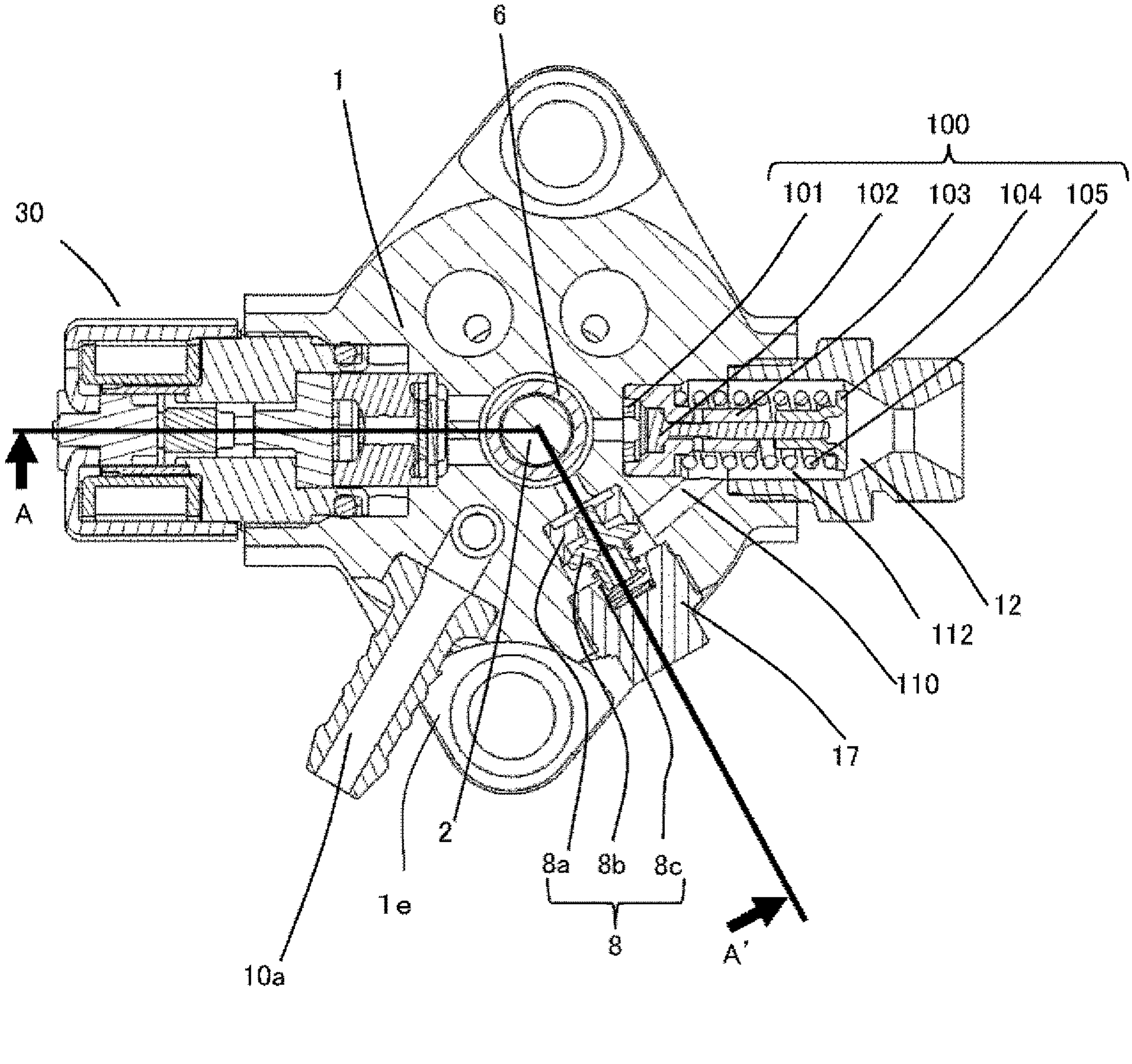
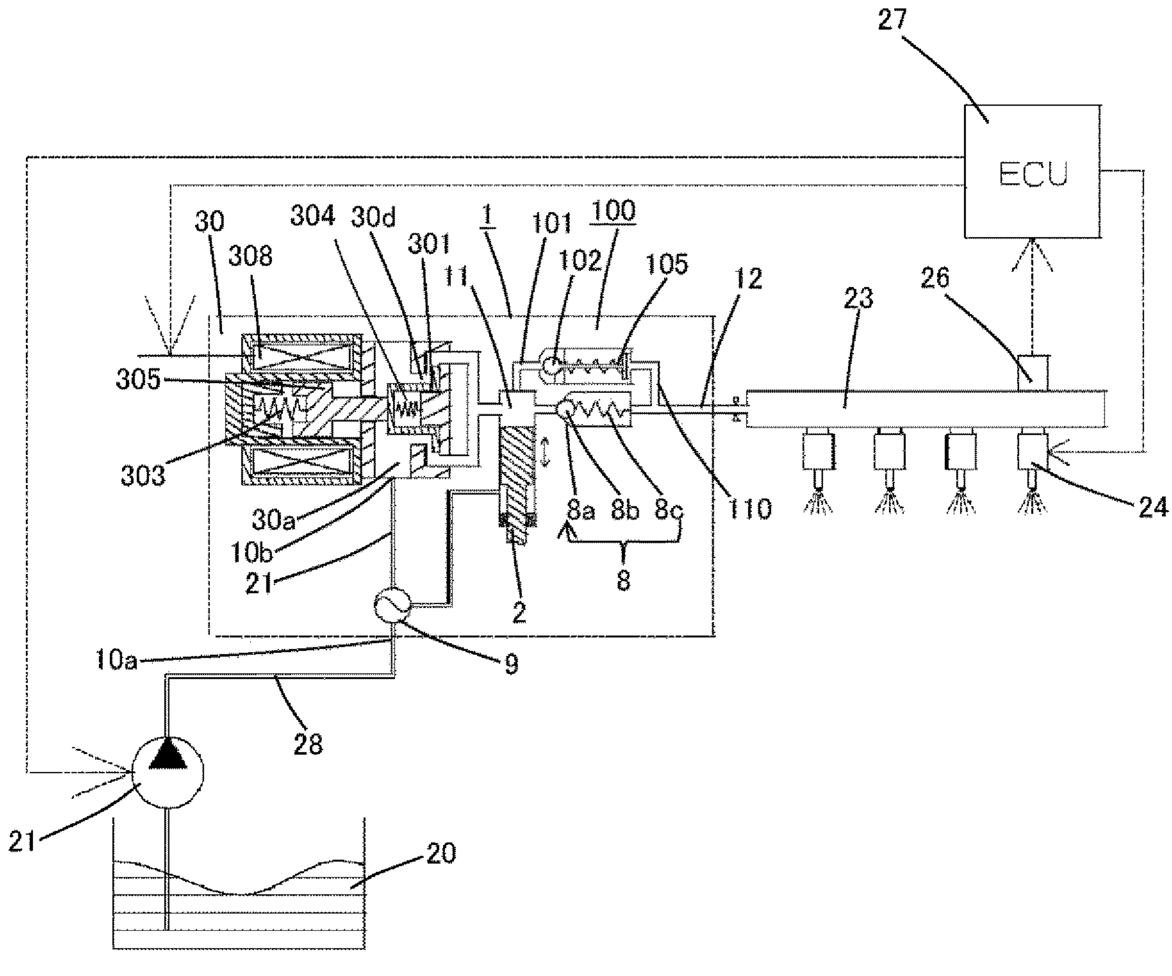


FIG. 4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ECU
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21
8a
8b
8c
8
2
110
24
10a
9
28
21
20

FIG. 5

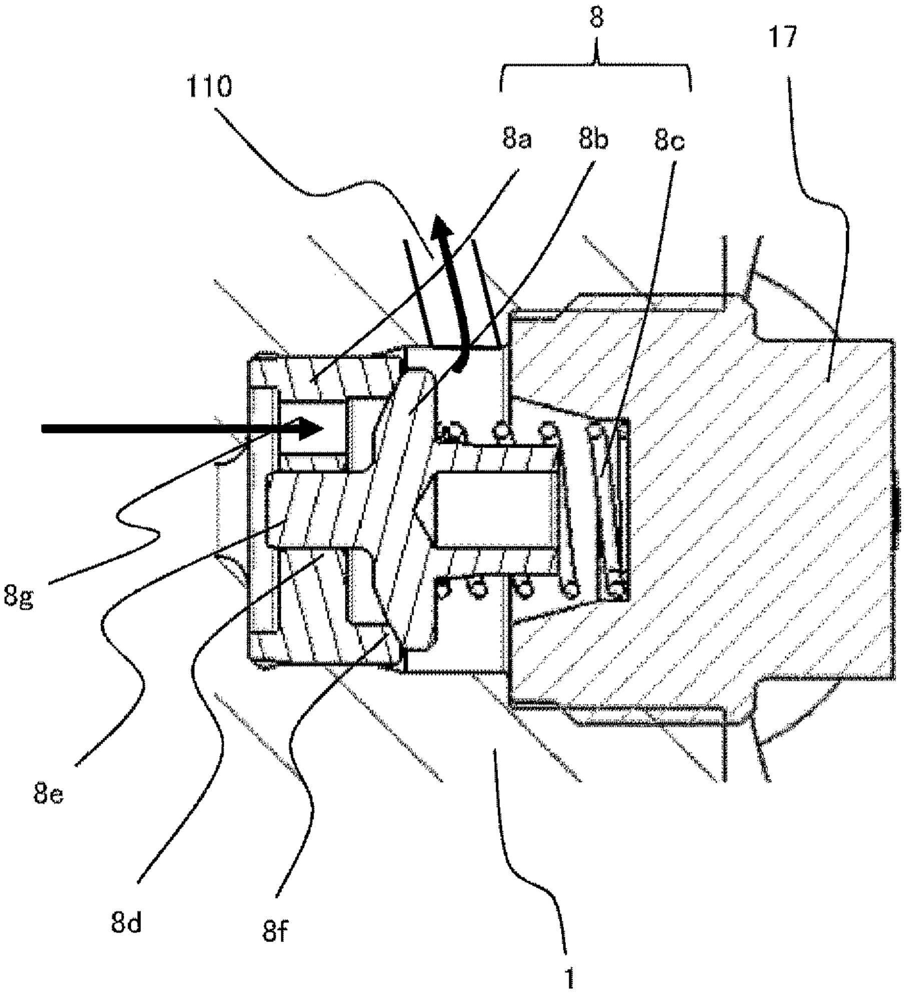


FIG. 6

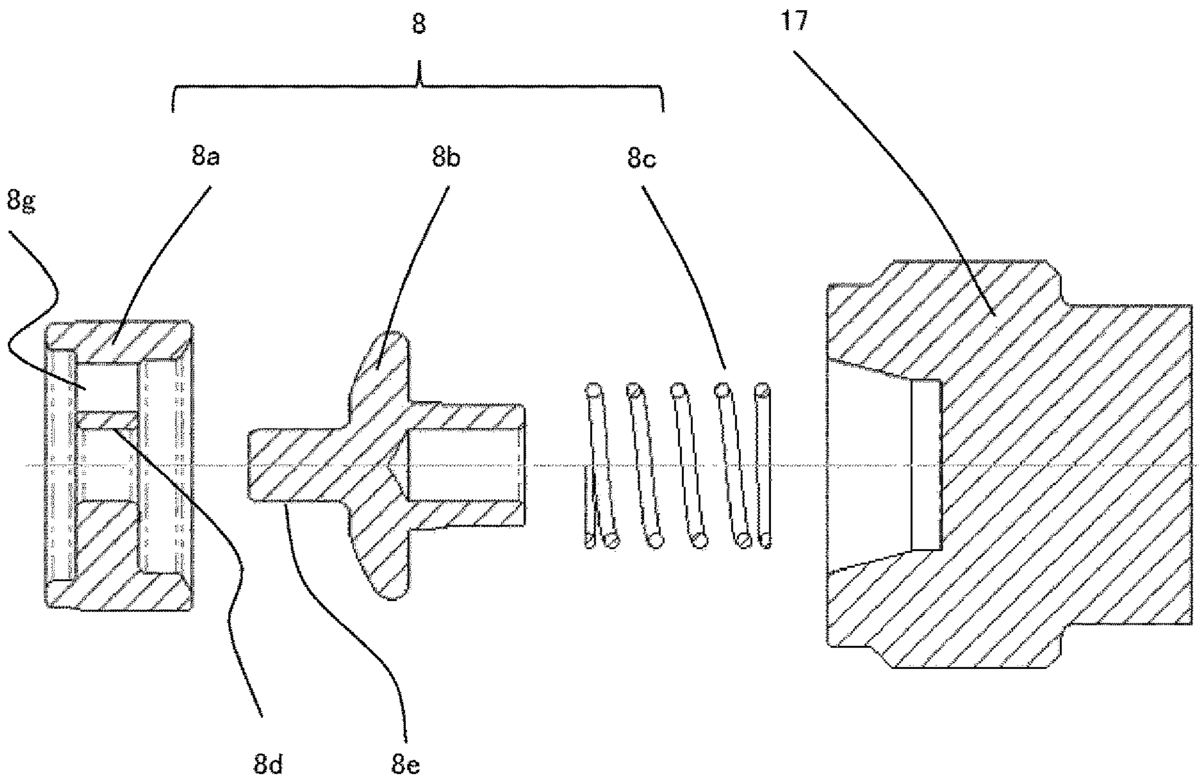


FIG. 7

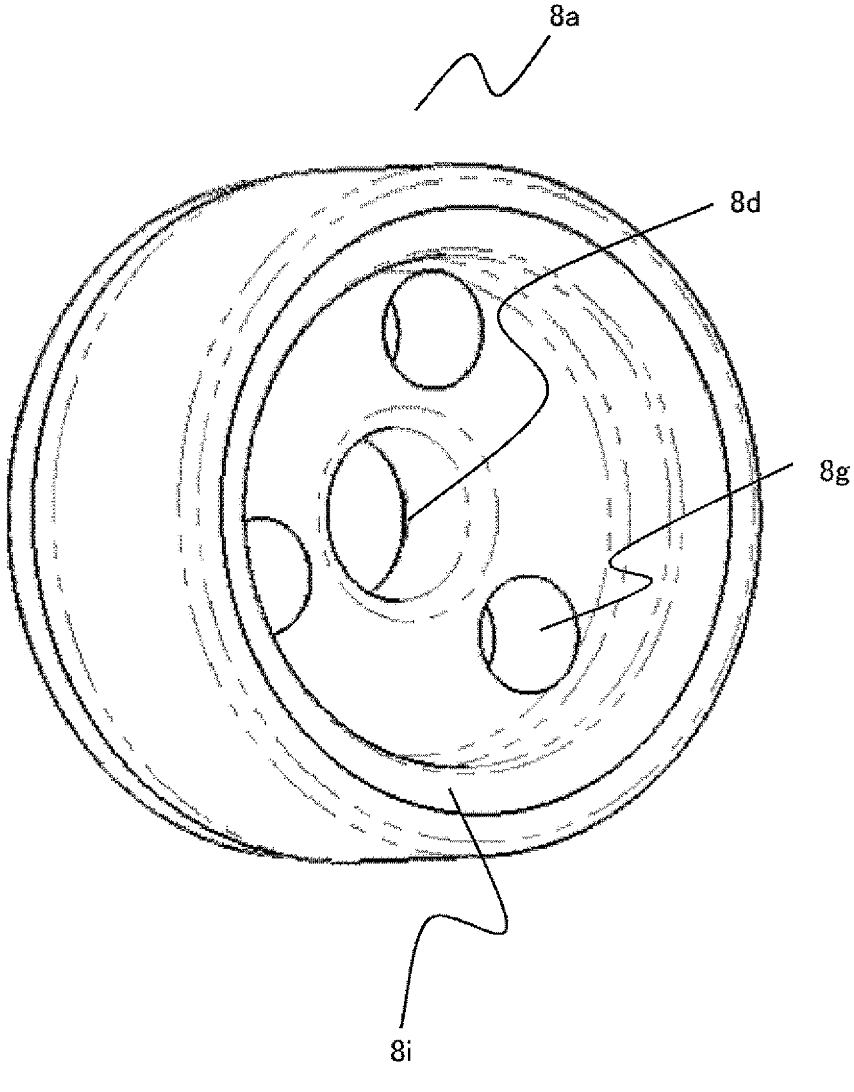


FIG. 8

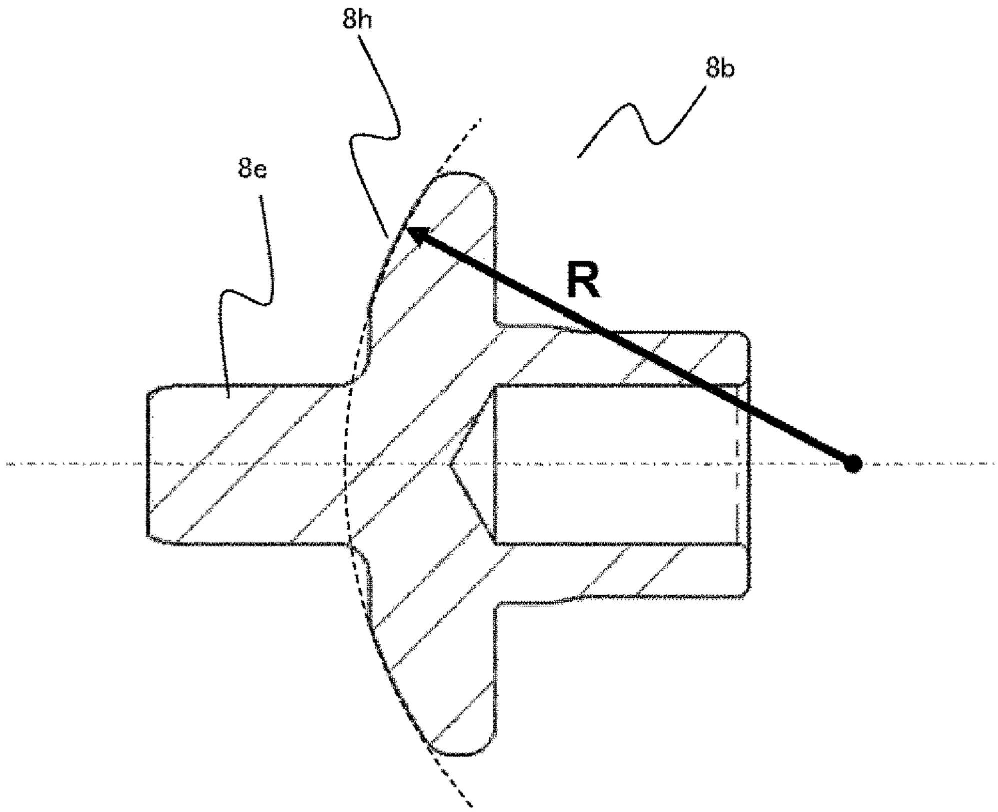


FIG. 9

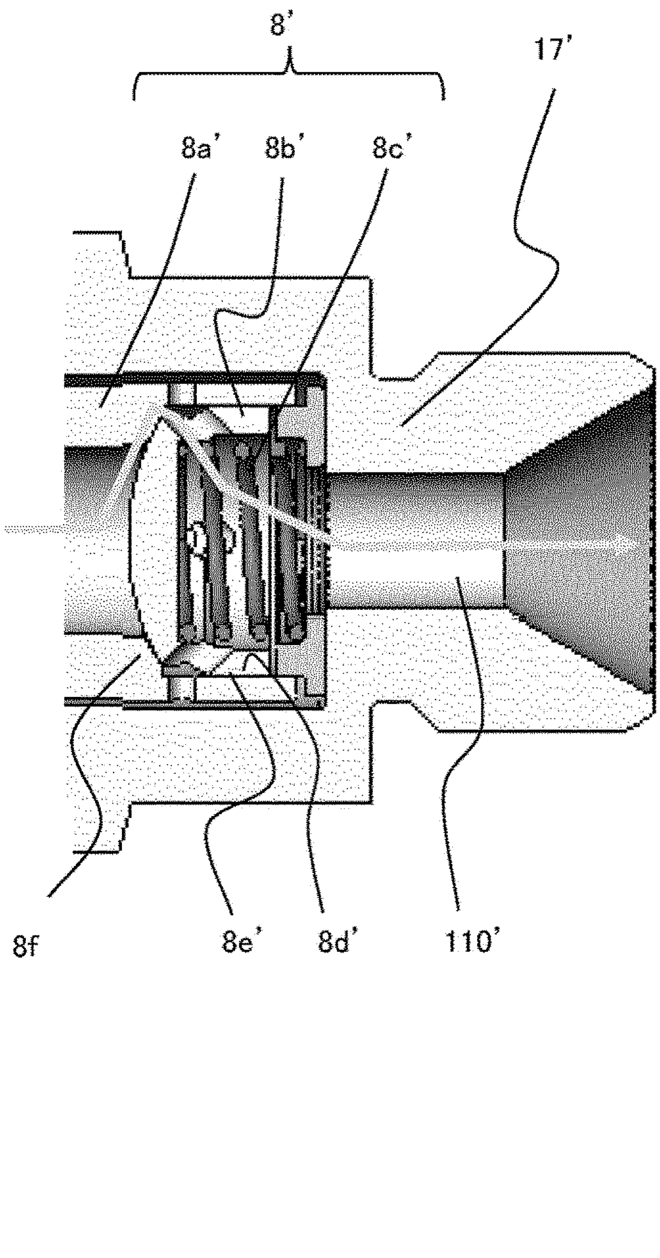


FIG. 10

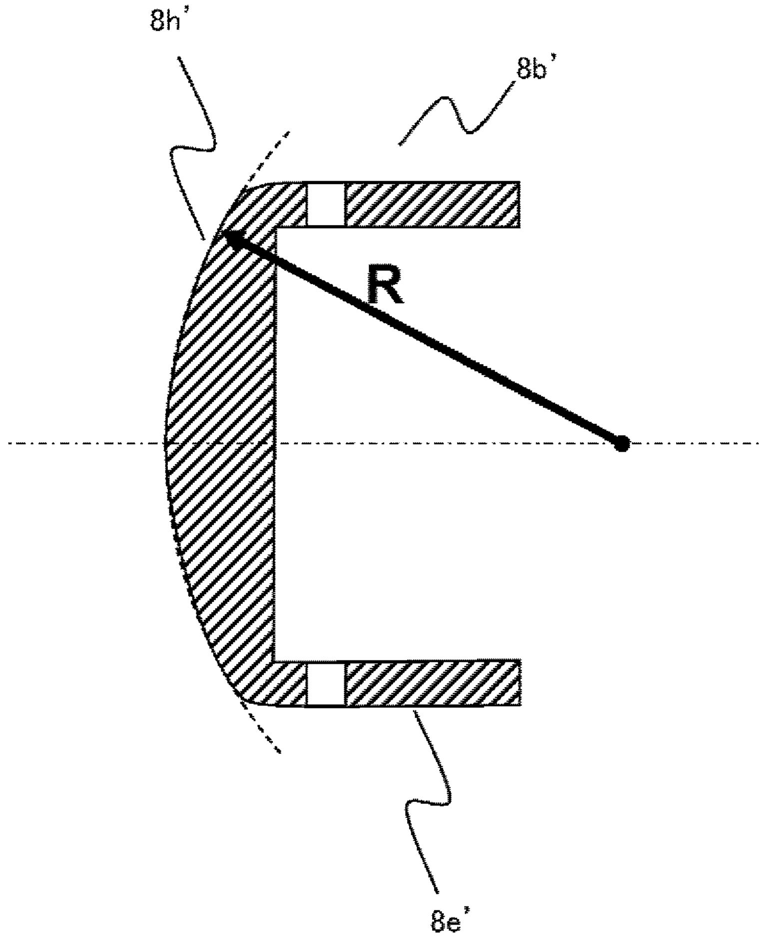
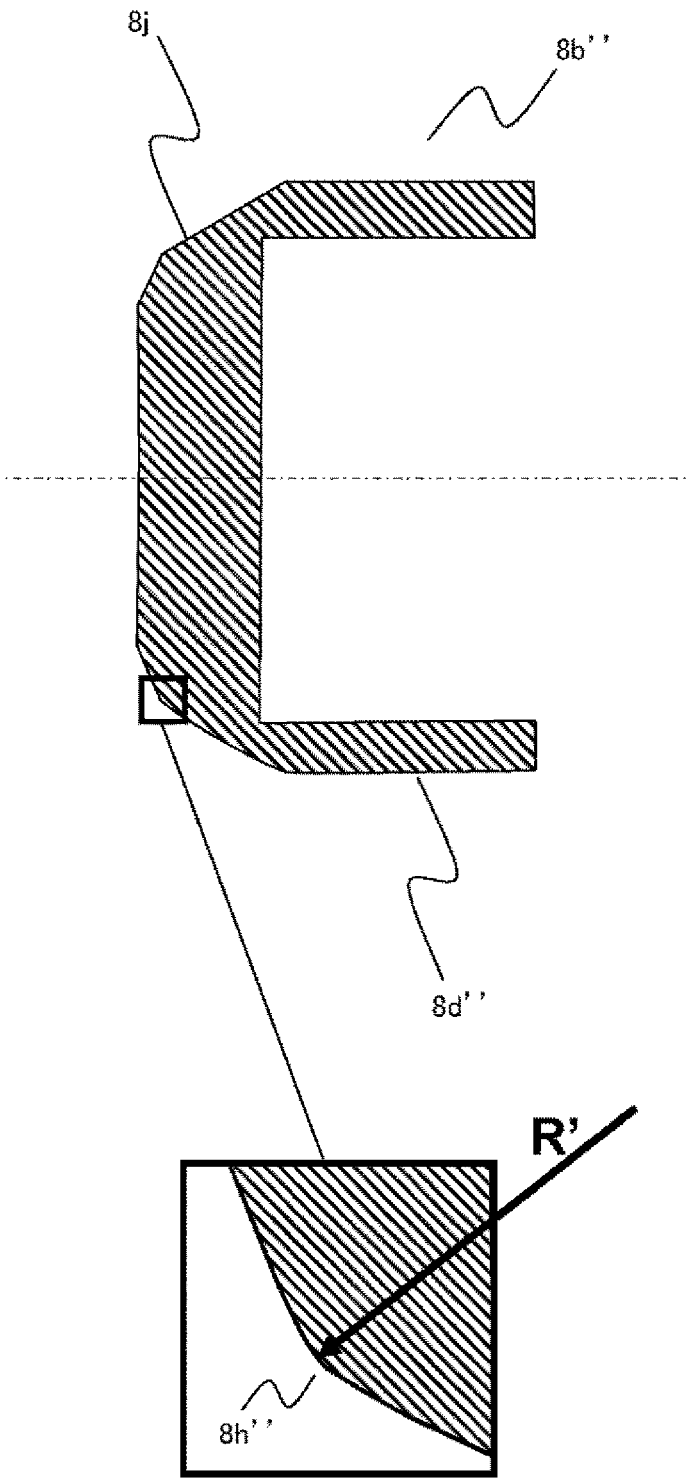


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2015/061777

A. CLASSIFICATION OF SUBJECT MATTER
F02M59/46(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)
F02M59/46

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	1996-2015
Kokai Jitsuyo Shinan Koho	1971-2015	Toroku Jitsuyo Shinan Koho	1994-2015

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	JP 2002-266726 A (Hitachi, Ltd.), 18 September 2002 (18.09.2002), paragraphs [0008] to [0037]; fig. 1 to 6 (Family: none)	1-6
Y	JP 11-100750 A (BAEK KYUNG TAE), 13 April 1999 (13.04.1999), paragraph [0019]; fig. 7 & TW 428059 B	1-6

☒ 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
09 July 2015 (09.07.15)	21 July 2015 (21.07.15)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2015/061777

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 61374/1993(Laid-open No. 44361/1995) (Science Kabushiki Kaisha), 14 November 1995 (14.11.1995), paragraphs [0009] to [0016]; fig. 1 (Family: none)	1-6
A	JP 60-159477 A (Atsugi Motor Parts Co., Ltd.), 20 August 1985 (20.08.1985), page 3; fig. 1 (Family: none)	1-6
A	JP 2014-001738 A (Hitachi Automotive Systems, Ltd.), 09 January 2014 (09.01.2014), entire text; all drawings (Family: none)	1-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011080391 A **[0003] [0005]**
- JP 394413 B **[0004] [0005]**