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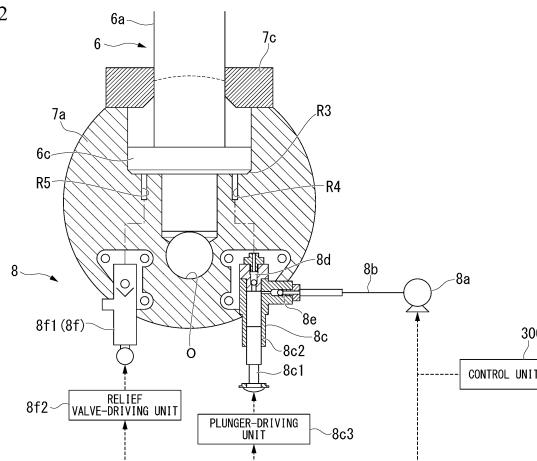
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(54) **VARIABLE COMPRESSION DEVICE, AND ENGINE SYSTEM**

(57) The variable compression device (A) includes: a piston rod (6) whose end portion is provided with a flange (6c); a fluid chamber (R3) that causes the piston rod to be moved in a direction in which a compression ratio is increased by a pressurized working fluid being supplied thereto; a regulation member (7c) that is provided such that the flange is interposed between the regulation member and the fluid chamber, and regulates movement of the piston rod in the direction in which the compression ratio is increased; a regulation mem-

ber-side fluid chamber (R7) that is provided between the flange and the regulation member with the flange forming a bottom surface of the regulation member-side fluid chamber; a supply flow path (R6) that supplies a cooling fluid to the regulation member-side fluid chamber; and a piston rod internal flow path (R8) that includes an opening end on the bottom surface and guides the cooling fluid in the regulation member-side fluid chamber to an inside of the piston rod.

FIG. 2



Description

Technical Field

[0001] The present disclosure relates to a variable compression device and an engine system.

[0002] Priority is claimed on Japanese Patent Application No. 2017-228333 filed on November 28, 2017, the content of which is incorporated herein by reference.

Background Art

[0003] For example, Patent Document 1 discloses a large reciprocating piston combustion engine including a crosshead. The large reciprocating piston combustion engine of Patent Document 1 is a dual fuel engine that can be operated using both a liquid fuel such as heavy oil and a gas fuel such as natural gas. In order for the large reciprocating piston combustion engine of Patent Document 1 to adapt to both a compression ratio suitable for operation using a liquid fuel and a compression ratio suitable for operation using a gas fuel, an adjustment mechanism that changes the compression ratio by moving a piston rod due to a hydraulic pressure is provided in a crosshead portion.

Document of Related Art

Patent Document

[0004] [Patent Document 1] Japanese Unexamined Patent Application, First Publication No. 2014-20375

Summary of Invention

Technical Problem

[0005] In an engine system including a compression adjustment device that changes the compression ratio as described above, part of a working fluid to be supplied to the adjustment mechanism (hydraulic chamber) may be supplied, as a cooling fluid, to the inside of a piston through a piston rod. In order to supply the cooling fluid to the inside of the piston through the piston rod, it is conceivable to use a working fluid leaking out from the hydraulic chamber, or to supply the cooling fluid through an opening formed on the side of the piston rod. However, in a case where the working fluid leaking out from the fluid chamber (hydraulic chamber) is used, it may be difficult to stably supply the working fluid. Further, in a case where the cooling fluid is supplied to the inside of the piston rod through the opening formed on the side of the piston rod, since the relative position between the piston rod and the fluid chamber varies depending on the compression ratio, it is necessary to provide the opening of the piston rod to be large, whereby the movable range of the piston rod may be limited.

[0006] The present disclosure is made in consideration

of the above-described circumstances, and an object thereof is to stably supply a cooling fluid to the inside of a piston and to increase the movable range of a piston rod.

Solution to Problem

[0007] In order to solve the above-described problems, a variable compression device of a first aspect of the present disclosure includes: a piston rod whose end portion is provided with a flange; a fluid chamber that causes the piston rod to be moved in a direction in which a compression ratio is increased by a pressurized working fluid being supplied thereto; a regulation member that is provided such that the flange is interposed between the regulation member and the fluid chamber, and regulates movement of the piston rod in the direction in which the compression ratio is increased; a regulation member-side fluid chamber that is provided between the flange and the regulation member with the flange forming a bottom surface of the regulation member-side fluid chamber; a supply flow path that supplies a cooling fluid to the regulation member-side fluid chamber; and a piston rod internal flow path that includes an opening end on the bottom surface and guides the cooling fluid in the regulation member-side fluid chamber to an inside of the piston rod.

[0008] A second aspect of the present disclosure is that in the first aspect, a surface of the regulation member facing the regulation member-side fluid chamber is provided with an opening end of the supply flow path.

[0009] A third aspect of the present disclosure is that the variable compression device of the first aspect further includes a fluid chamber-forming member that configures the regulation member-side fluid chamber by the end portion of the piston rod being inserted thereto, wherein the bottom surface is provided with a notch, a surface of the fluid chamber-forming member facing the regulation member-side fluid chamber is provided with an opening end of the supply flow path, and the notch is provided with the opening end of the piston rod internal flow path.

[0010] A fourth aspect of the present disclosure is that in any one of the first to third aspects, the flange includes a groove flow path in an area overlapping the opening end of the piston rod internal flow path.

[0011] An engine system of a fifth aspect of the present disclosure includes the variable compression device of any one of the first to fourth aspects.

Effects of Invention

[0012] According to the present disclosure, a cooling fluid is guided to the piston rod internal flow path from the flow path opening provided in the flange of the piston rod, and the flange forms the bottom surface of the regulation member-side fluid chamber. Thereby, it is not necessary to form a flow path in the radial direction, which is connected to the piston rod internal flow path from the

side of the flange, when the cooling fluid is supplied to the piston. Therefore, there is no limitation on the thickness of the flange of the piston rod, and thus it is possible to sufficiently secure the amount of movement of the flange inside the fluid chamber, that is, the amount of movement of the piston rod in the variable compression device while the cooling fluid is stably supplied.

Brief Description of Drawings

[0013]

FIG. 1 is a cross-sectional view of an engine system of an embodiment of the present disclosure.

FIG. 2 is a schematic cross-sectional view showing a portion of the engine system of the embodiment of the present disclosure.

FIG. 3 is a schematic cross-sectional view showing a flow of hydraulic oil of the engine system of the embodiment of the present disclosure.

FIG. 4 is a schematic cross-sectional view showing a flow of hydraulic oil of a modification of the engine system of the embodiment of the present disclosure.

Description of Embodiments

[0014] Hereinafter, an embodiment of a two-stroke engine of the present disclosure will be described with reference to the drawings.

(First Embodiment)

[0015] An engine system 100 of this embodiment is mounted on a ship such as a large tanker and includes an engine 1, a turbocharger 200 and a control unit 300 as shown in FIG. 1. Note that in this embodiment, the turbocharger 200 is regarded as an auxiliary machine and will be described as a separate body from the engine 1 (main machine). However, the turbocharger 200 may be configured as a portion of the engine 1. In addition, the turbocharger 200 is not an essential component for the engine system 100 of this embodiment and may not be provided in the engine system 100.

[0016] FIG. 1 is a longitudinal cross-sectional view along a central axis of a cylindrical cylinder liner 3a to be described later provided in the engine system 100. In FIG. 1, a side on which an exhaust valve unit 5 to be described later is provided may be referred to as an upper side, and a side on which a crankshaft 11 to be described later is provided may be referred to as a lower side. A direction intersecting the central axis of the cylinder liner 3a may be referred to as a radial direction. A diagram seen in a direction of the central axis of the cylinder liner 3a may be referred to as a plan view.

[0017] The engine 1 is a multi-cylinder uniflow scavenging diesel engine and is a dual fuel engine that can carry out a gas operation mode in which a gas fuel such as natural gas is burned together with a liquid fuel such

as heavy oil and a diesel operation mode in which a liquid fuel such as heavy oil is burned. Note that in the gas operation mode, only a gas fuel may be burned. The engine 1 includes a frame 2, a cylinder unit 3, a piston 4, the exhaust valve unit 5, a piston rod 6, a crosshead 7, a hydraulic portion 8 (pressure-increasing mechanism), a connecting rod 9, a crank angle sensor 10, the crankshaft 11, a scavenging reservoir 12, an exhaust reservoir 13 and an air cooler 14. In addition, a cylinder is configured of the cylinder unit 3, the piston 4, the exhaust valve unit 5 and the piston rod 6.

[0018] The frame 2 is a rigid member that supports the entire engine 1 and accommodates the crosshead 7, the hydraulic portion 8 and the connecting rod 9. In addition, the frame 2 is configured such that a crosshead pin 7a to be described later of the crosshead 7 can reciprocate inside the frame 2.

[0019] The cylinder unit 3 includes the cylindrical cylinder liner 3a, a cylinder head 3b and a cylinder jacket 3c. The cylinder liner 3a is a cylindrical member, and a sliding surface with the piston 4 is formed on an inner side (inner circumferential surface) of the cylinder liner 3a. The space surrounded by the inner circumferential surface of the cylinder liner 3a and the piston 4 is a combustion chamber R1. In addition, a plurality of scavenging ports S are provided in a lower portion of the cylinder liner 3a. The scavenging ports S are openings that are arranged along the circumferential surface of the cylinder liner 3a and provide communication between a scavenging chamber R2 inside the cylinder jacket 3c and the inside of the cylinder liner 3a. The cylinder head 3b is a lid member that is provided in an upper end portion of the cylinder liner 3a. An exhaust port H is provided in a central portion of the cylinder head 3b in a plan view and is connected to the exhaust reservoir 13. In addition, the cylinder head 3b is provided with a fuel injection valve (not shown). Further, a cylinder internal pressure sensor (not shown) is provided in the vicinity of the fuel injection valve of the cylinder head 3b. The cylinder internal pressure sensor detects a pressure inside the combustion chamber R1 and transmits the detected pressure value to the control unit 300. The cylinder jacket 3c is a cylindrical member that is provided between the frame 2 and the cylinder liner 3a and into which a lower end portion of the cylinder liner 3a is inserted, and the scavenging chamber R2 is formed inside the cylinder jacket 3c. In addition, the scavenging chamber R2 of the cylinder jacket 3c is connected to the scavenging reservoir 12.

[0020] The piston 4 has a substantially columnar shape, is connected to the piston rod 6 to be described later and is disposed inside the cylinder liner 3a. In addition, piston rings (not shown) are provided on the outer circumferential surface of the piston 4 to seal a gap between the piston 4 and the cylinder liner 3a. The piston 4 slides inside the cylinder liner 3a together with the piston rod 6 in an up-down direction due to a change in pressure in the combustion chamber R1. Further, the piston 4 is hollow therein, and ejection ports 4a of an

outer flow path R8 to be described later are provided on a lower surface of the inside of the piston 4.

[0021] The exhaust valve unit 5 includes an exhaust valve 5a, an exhaust valve cage 5b and an exhaust valve-driving unit 5c. The exhaust valve 5a is provided inside the cylinder head 3b and closes the exhaust port H of the cylinder unit 3 by the exhaust valve-driving unit 5c. The exhaust valve cage 5b is a cylindrical housing that accommodates an end portion of the exhaust valve 5a. The exhaust valve-driving unit 5c is an actuator that moves the exhaust valve 5a in a direction parallel with a stroke direction (a sliding direction, the up-down direction) of the piston 4.

[0022] The piston rod 6 is an elongate member having one end (upper end) connected to the piston 4 and the other end (lower end) coupled to the crosshead pin 7a. The end portion (lower end portion) of the piston rod 6 is inserted into the crosshead pin 7a, and the connecting rod 9 is rotatably coupled to the end portion of the piston rod 6. In addition, the piston rod 6 includes a flange 6c formed such that the diameter of a portion of an end portion of the piston rod 6, the end portion being close to the crosshead pin 7a, is increased (refer to FIG. 2). In addition, as shown in FIG. 3, the piston rod 6 has a double pipe structure, which is configured of an outer pipe 6a and an inner pipe 6b that is accommodated in the outer pipe 6a. The flange 6c is provided so as to protrude outward in the radial direction from the lower end portion (the portion inserted into the crosshead pin 7a) of the outer circumferential surface of the outer pipe 6a. The inner pipe 6b includes a tubular main body accommodated in the outer pipe 6a and extending in the up-down direction, and a plate-shaped diameter-increased portion extending, inside the piston 4, outward in the radial direction from an upper end of the main body. The diameter-increased portion is provided with a plurality of protrusion portions each having a tubular shape with a top portion and extending upward, and the top portion of each of the protrusion portions is provided with the ejection port 4a penetrating in up-down direction. The piston rod 6 is provided with the outer flow path R8 (a piston rod internal flow path), and the outer flow path R8 extends downward (in a direction toward the lower surface of the flange 6c) from an upper surface (a surface facing a lid member 7c to be described later) of the flange 6c, is bent toward the inner pipe 6b disposed on the inner side in the radial direction, and passes between the outer pipe 6a and the inner pipe 6b. In other words, the outer flow path R8 includes a first flow path extending downward from the upper surface of the flange 6c, a second flow path extending inward in the radial direction from a lower end of the first flow path, a third flow path connected to a radially inner end of the second flow path and provided between the outer pipe 6a and the inner pipe 6b, and a fourth flow path connected to an upper end of the third flow path and provided between the above diameter-increased portion of the inner pipe 6b and a bottom wall portion (lower wall portion) of the piston 4. That is, the

upper surface of the flange 6c of the piston rod 6 is provided with a flow path opening (opening end) of the outer flow path R8. In addition, the inner pipe 6b is provided with an inner flow path R9 communicating with the hollow inside the piston 4 and extending to the lower end (the end close to the crosshead 7) of the piston rod 6. In other words, the inside of the above main body of the inner pipe 6b configures the inner flow path R9.

[0023] The crosshead 7 includes the crosshead pin 7a (a fluid chamber-forming member), a guide shoe 7b and the lid member 7c (a regulation member). The crosshead pin 7a is a columnar member that movably connects the piston rod 6 and the connecting rod 9 to each other, an end portion (lower end portion) of the piston rod 6 and the flange 6c are inserted into the crosshead pin 7a, and a fluid chamber R3 (a fluid chamber, a compression ratio-changing fluid chamber) to and from which hydraulic oil (working fluid) is supplied and discharged is provided between the crosshead pin 7a and the flange 6c of the piston rod 6. A central axis of the crosshead pin 7a extends in a direction orthogonal to the up-down direction. An upper portion of the crosshead pin 7a is provided with an insertion recessed portion that opens upward and into which the flange 6c is inserted so as to be slidable in the up-down direction. The above fluid chamber R3 is provided between a bottom surface of the insertion recessed portion and the lower surface of the flange 6c. A portion lower than the center of the crosshead pin 7a is provided with a discharge port O penetrating the crosshead pin 7a in an axial direction of the crosshead pin 7a. The discharge port O is an opening from which hydraulic oil (cooling fluid) having passed through the inner flow path R9 of the piston rod 6 is discharged. In addition, the crosshead pin 7a is provided with a supply flow path R4 connecting the fluid chamber R3 and a plunger pump 8c to be described later to each other, and a relief flow path R5 connecting the fluid chamber R3 and a relief valve 8f to be described later to each other.

[0024] The guide shoe 7b is a member that rotatably supports the crosshead pin 7a and moves together with the crosshead pin 7a on a guide rail (not shown) in the stroke direction of the piston 4. The guide shoe 7b moves along the guide rail, so that the movement of the crosshead pin 7a in a direction other than a linear direction parallel with the stroke direction of the piston 4 is regulated. The rotary motion of the crosshead pin 7a around the central axis thereof is also regulated. The lid member 7c is an annular member that is fixed to the upper portion of the crosshead pin 7a and into which the end portion of the piston rod 6 is inserted. The lid member 7c is provided at an opening peripheral edge of the insertion recessed portion of the crosshead pin 7a. The inner diameter of the lid member 7c is equal to the outer diameter of the outer pipe 6a of the piston rod 6 and is less than the outer diameter of the flange 6c. In addition, a sliding surface with the piston rod 6 (a surface on an inner side in the radial direction) of the lid member 7c is provided with a seal ring (not shown). Thereby, an upper hydraulic

chamber R7 (a regulation member-side fluid chamber) is formed, which is surrounded by the crosshead pin 7a, the lid member 7c and the flange 6c of the piston rod 6. That is, the upper hydraulic chamber R7 is a space surrounded by the upper surface of the flange 6c, an inner side surface of the insertion recessed portion of the crosshead pin 7a, a lower surface of the lid member 7c, and an outer circumferential surface of the outer pipe 6a. In addition, the lid member 7c is provided with a portion of a cooling oil supply flow path R6 (supply flow path) that guides hydraulic oil to be supplied to the upper hydraulic chamber R7. The other portion of the cooling oil supply flow path R6 is provided in the crosshead pin 7a. The cooling oil supply flow path R6 includes two flow paths that guide part of hydraulic oil, which is pressure-supplied by a supply pump 8a to be described later, to the upper hydraulic chamber R7 through the lid member 7c from the crosshead pin 7a. That is, the cooling oil supply flow path R6 is connected to the supply pump 8a. A supply opening (opening end) of each of the two cooling oil supply flow paths R6 is provided on a surface (lower surface) of the lid member 7c close to the upper hydraulic chamber R7. In addition, the crosshead 7 transmits the linear motion of the piston 4 to the connecting rod 9.

[0025] As shown in FIG. 2, the hydraulic portion 8 includes the supply pump 8a, a swing pipe 8b, the plunger pump 8c, a first check valve 8d and a second check valve 8e connected to the plunger pump 8c, and the relief valve 8f. In addition, the piston rod 6, the crosshead 7, the hydraulic portion 8 and the control unit 300 may function as a variable compression device A of the present disclosure. The variable compression device A is configured to be able to change the compression ratio of the engine 1.

[0026] The supply pump 8a is a pump that pressurizes hydraulic oil supplied from a hydraulic oil tank (not shown) and supplies the pressurized hydraulic oil to the plunger pump 8c based on instructions given from the control unit 300. The supply pump 8a is driven by electric power of a battery of the ship and can operate before a liquid fuel is supplied to the combustion chamber R1. The swing pipe 8b is a pipe that connects the supply pump 8a and the plunger pump 8c of each cylinder to each other and is swingable between the plunger pump 8c moving in association with the crosshead pin 7a and the fixed supply pump 8a.

[0027] The plunger pump 8c is fixed to the crosshead pin 7a and includes a rod-shaped plunger 8c1, a tubular cylinder 8c2 that slidably accommodates the plunger 8c1, and a plunger-driving unit 8c3. The plunger pump 8c slides inside the cylinder 8c2 by the plunger 8c1 being connected to a driving unit (not shown) to pressurize hydraulic oil and to supply the pressurized hydraulic oil to the fluid chamber R3. In addition, the first check valve 8d is provided at an opening of an end portion of the cylinder 8c2, from which hydraulic oil is discharged, and the second check valve 8e is provided at an opening provided on a side circumferential surface of the cylinder 8c2, to

which hydraulic oil is sucked. The plunger-driving unit 8c3 is connected to the plunger 8c1 and makes the plunger 8c1 reciprocate based on instructions given from the control unit 300.

[0028] The first check valve 8d is configured to be closed by a valve body thereof being pushed inward of the cylinder 8c2 by a pushing member (not shown) and prevents hydraulic oil supplied to the fluid chamber R3 from reverse flowing to the cylinder 8c2. In addition, when the pressure of the hydraulic oil in the cylinder 8c2 becomes equal to or higher than the pushing force (valve-opening pressure) of the pushing member of the first check valve 8d, the first check valve 8d is opened by the valve body thereof being pushed by the hydraulic oil. The second check valve 8e is pushed outward of the cylinder 8c2 by a pushing member (not shown) and prevents hydraulic oil supplied to the cylinder 8c2 from reverse flowing to the supply pump 8a. In addition, when the pressure of the hydraulic oil supplied from the supply pump 8a becomes equal to or higher than the pushing force (valve-opening pressure) of the pushing member of the second check valve 8e, the second check valve 8e is opened by a valve body thereof being pushed by the hydraulic oil. Further, the valve-opening pressure of the first check valve 8d is higher than the valve-opening pressure of the second check valve 8e, and the first check valve 8d is not opened due to the pressure of hydraulic oil supplied from the supply pump 8a during a normal operation in which the operation is performed at a predetermined compression ratio.

[0029] The relief valve 8f is provided in the crosshead pin 7a and includes a main body 8f1 and a relief valve-driving unit 8f2. The main body 8f1 is a valve connected to the fluid chamber R3 and the hydraulic oil tank (not shown). The relief valve-driving unit 8f2 is connected to a valve body of the main body 8f1 and opens and closes the main body 8f1 based on instructions given from the control unit 300. The relief valve 8f is opened by the relief valve-driving unit 8f2, so that hydraulic oil stored in the fluid chamber R3 is returned to the hydraulic oil tank.

[0030] As shown in FIG. 1, the connecting rod 9 is an elongate member, which is coupled to the crosshead pin 7a and is coupled to the crankshaft 11. The connecting rod 9 converts the linear motion of the piston 4 transmitted to the crosshead pin 7a into rotary motion. The crank angle sensor 10 is a sensor that measures a crank angle of the crankshaft 11 and transmits a crank pulse signal for calculating the crank angle to the control unit 300.

[0031] The crankshaft 11 is an elongate member that is connected to the connecting rod 9 provided in the cylinder, and is rotated by rotary motion transmitted from each connecting rod 9 to transmit motive power to, for example, a screw or the like. The scavenging reservoir 12 is provided between the cylinder jacket 3c and the turbocharger 200, and air pressurized by the turbocharger 200 flows into the scavenging reservoir 12. In addition, the air cooler 14 is provided inside the scavenging reservoir 12. The exhaust reservoir 13 is a pipe-shaped

member, which is connected to the exhaust port H of each cylinder and is connected to the turbocharger 200. Gas discharged from the exhaust port H is temporarily stored in the exhaust reservoir 13 to limit pulsation and is then supplied to the turbocharger 200. The air cooler 14 is a device that cools air inside the scavenging reservoir 12.

[0032] The turbocharger 200 is a device that pressurizes air sucked from an intake port (not shown) by a turbine that is rotated by gas discharged from the exhaust port H, and supplies the pressurized air to the combustion chamber R1.

[0033] The control unit 300 is a computer that controls the amount of fuel to be supplied, and the like based on operations performed by an operator of a ship, or the like. In addition, the control unit 300 changes the compression ratio in the combustion chamber R1 by controlling the hydraulic portion 8. Specifically, the control unit 300 changes the position of the piston rod 6 to change the compression ratio by controlling the plunger pump 8c, the supply pump 8a and the relief valve 8f to adjust the amount of hydraulic oil in the fluid chamber R3.

[0034] The engine system 100 is a device that makes the piston 4 slide inside the cylinder liner 3a to rotate the crankshaft 11 by igniting and exploding fuel injected into the combustion chamber R1 from the fuel injection valve (not shown). In detail, the fuel supplied to the combustion chamber R1 is mixed with air flowing in from the scavenging ports S and is then compressed due to the piston 4 moving in a direction toward the top dead center, thereby increasing the temperature thereof and causing spontaneous ignition. Further, in the case of using a liquid fuel, the liquid fuel is vaporized due to an increase in temperature in the combustion chamber R1, thereby causing spontaneous ignition.

[0035] Then, the fuel in the combustion chamber R1 rapidly expands due to its spontaneous ignition, and a pressure is applied to the piston 4 in a direction toward the bottom dead center. Thereby, the piston 4 moves in the direction toward the bottom dead center, the piston rod 6 moves together with the piston 4, and the crankshaft 11 is rotated through the connecting rod 9. Further, the piston 4 is moved to the bottom dead center, so that pressurized air flows into the combustion chamber R1 from the scavenging ports S. The exhaust port H is opened by the exhaust valve unit 5 being driven, and exhaust gas in the combustion chamber R1 is pushed out to the exhaust reservoir 13 by the pressurized air.

[0036] In a case where the compression ratio is increased, the control unit 300 drives the supply pump 8a to supply hydraulic oil to the plunger pump 8c. Then, the control unit 300 drives the plunger pump 8c to pressurize hydraulic oil up to a pressure capable of lifting the piston rod 6, and supplies the pressurized hydraulic oil to the fluid chamber R3. The flange 6c of the piston rod 6 is lifted by the pressure of the hydraulic oil in the fluid chamber R3, and accordingly, the position of the top dead center of the piston 4 is changed upward (toward the exhaust

port H).

[0037] In a case where the compression ratio is decreased, the control unit 300 drives the relief valve 8f to provide communication between the fluid chamber R3 and the hydraulic oil tank (not shown). Then, the weight of the piston rod 6 is applied to the hydraulic oil in the fluid chamber R3, and the hydraulic oil in the hydraulic chamber R3 is pushed out to the hydraulic oil tank through the relief valve 8f. Thereby, the hydraulic oil in the fluid chamber R3 is reduced, the piston rod 6 is moved downward (toward the crankshaft 11), and accordingly, the position of the top dead center of the piston 4 is changed downward.

[0038] Next, the flow of hydraulic oil on the piston rod 6-side will be described.

[0039] As shown in FIG. 3, part of hydraulic oil supplied from the supply pump 8a passes through the cooling oil supply flow path R6 and is supplied to the upper hydraulic chamber R7 from the lid member 7c. Thereby, the upper hydraulic chamber R7 is filled with the hydraulic oil. Then, the hydraulic oil in the upper hydraulic chamber R7 flows into the outer flow path R8 from the flow path opening formed on the upper surface (a bottom surface of the upper hydraulic chamber R7) of the flange 6c of the piston rod 6, is guided upward (in a compression direction) along the piston rod 6, and is ejected to the inside of the piston 4 from the ejection ports 4a. The hydraulic oil ejected to the inside of the piston 4 comes into contact with the inner surface of the piston 4, so that the piston 4 can be cooled. Further, the hydraulic oil ejected to the inside of the piston 4 is guided to the inner flow path R9, is ejected from the lower end of the piston rod 6, and is discharged to the outside from the discharge port O.

[0040] According to this embodiment, hydraulic oil is supplied from above the upper hydraulic chamber R7, and is guided to the outer flow path R8 from the flow path opening provided in the flange 6c of the piston rod 6, the flange 6c forming the bottom surface of the upper hydraulic chamber R7. Thereby, it is not necessary to form an opening in the outer circumferential surface (the sliding surface with the crosshead pin 7a) of the flange 6c when hydraulic oil (cooling oil) is supplied to the piston 4. Therefore, there is no limitation on the thickness of the flange 6c, and thus it is possible to sufficiently secure the amount of movement of the flange 6c inside the crosshead pin 7a, that is, the amount of movement of the piston rod 6 in the variable compression mechanism.

[0041] In addition, according to this embodiment, hydraulic oil is supplied toward the upper hydraulic chamber R7 disposed below from the opening of the cooling oil supply flow path R6 provided in the lid member 7c. Thereby, it is possible to supply hydraulic oil regardless of the position of the piston rod 6 relative to the crosshead pin 7a accompanying a change in the compression ratio.

(Second Embodiment)

[0042] A modification of the first embodiment will be

described as a second embodiment with reference to FIG. 4. Note that components of the second embodiment, which are common to the first embodiment, are represented by common reference signs, and descriptions thereof will be omitted. Further, in FIG. 4, showing the configuration of the hydraulic portion 8 is omitted.

[0043] In this embodiment, a notch having a step shape is provided in a surface of the flange 6c of the piston rod 6 facing the lid member 7c (the upper surface of the flange 6c, the bottom surface of the upper hydraulic chamber R7). That is, a radially outer end portion of the upper surface of the flange 6c is cut out. In addition, an opening of the outer flow path R8 is provided in the notch formed on the flange 6c of the piston rod 6. Note that in this embodiment, the opening of the outer flow path R8 is formed on a bottom surface (a surface facing upward) of the notch, but may be formed on a side surface (a surface facing outward in the radial direction) of the notch. The cooling oil supply flow path R6 is a linear flow path provided in the crosshead pin 7a and extending inward from the outside in the radial direction of the piston rod 6, and a supply opening (opening end) of the cooling oil supply flow path R6 is formed on a side circumferential surface of the upper hydraulic chamber R7 (an inner side of the crosshead pin 7a, the inner side surface of the insertion recessed portion). Note that the supply opening is formed on an upper side in the up-down direction (in the vicinity of the lid member 7c of the crosshead pin 7a) of the inner side surface of the insertion recessed portion. Thereby, even when the piston rod 6 is moved in a direction in which the compression ratio is increased (is moved upward) and the flange 6c comes into contact with (or is close to) the lid member 7c, the supply opening of the cooling oil supply flow path R6 faces the notch of the flange 6c and thus can be made to communicate with the outer flow path R8 through the upper hydraulic chamber R7. In this case, it is not necessary to form the cooling oil supply flow path R6 in the lid member 7c, and thus the cooling oil supply flow path R6 can be easily formed.

[0044] A variable compression device A of the above embodiments includes: a piston rod 6 whose end portion is provided with a flange 6c; a fluid chamber R3 that causes the piston rod 6 to be moved in a direction in which a compression ratio is increased by a pressurized working fluid being supplied thereto; a lid member 7c that is provided such that the flange 6c is interposed between the lid member 7c and the fluid chamber R3, and regulates movement of the piston rod 6 in the direction in which the compression ratio is increased; an upper hydraulic chamber R7 that is provided between the flange 6c and the lid member 7c with the flange 6c forming a bottom surface of the upper hydraulic chamber R7; a cooling oil supply flow path R6 that supplies a cooling fluid (cooling oil) to the upper hydraulic chamber R7; and an outer flow path R8 that includes an opening end on the bottom surface and guides the cooling fluid in the upper hydraulic chamber R7 to the inside of the piston rod 6.

[0045] A surface of the lid member 7c facing the upper

hydraulic chamber R7 may be provided with an opening end of the cooling oil supply flow path R6.

[0046] The variable compression device A of the above embodiments may further include a crosshead pin 7a that configures the upper hydraulic chamber R7 by the end portion of the piston rod 6 being inserted thereto, the bottom surface may be provided with a notch, a surface of the crosshead pin 7a facing the upper hydraulic chamber R7 (an inner side surface of the insertion recessed portion) may be provided with an opening end of the cooling oil supply flow path R6, and the notch may be provided with the opening end of the outer flow path R8.

[0047] The flange 6c may include a groove flow path in an area overlapping the opening end of the outer flow path R8.

[0048] An engine system 100 includes the variable compression device A of the above embodiments.

[0049] Hereinbefore, while preferred embodiments of the present disclosure have been described with reference to the drawings, the present disclosure is not limited to the above embodiments. Shapes, combinations and the like of the components described in the above embodiments are examples, and various modifications can be made based on design requests and the like within the scope of the present disclosure.

[0050] In the above embodiments, the flange 6c of the piston rod 6 (the upper surface of the flange 6c) may be provided with a groove flow path passing through a position overlapping the flow path opening of the outer flow path R8 in a plan view. In this case, it is possible to efficiently guide hydraulic oil having flowed into the upper hydraulic chamber R7 to the flow path opening through the groove flow path.

[0051] Further, in the second embodiment, the notch formed in the flange 6c has a step shape, but the present disclosure is not limited thereto. For example, an edge portion (a radially outer edge portion) of a surface of the flange 6c, the surface facing the lid member 7c, may be cut out to have a tapered shape, and the flow path opening of the outer flow path R8 may be formed on the tapered surface. Also in this case, effects similar to the second embodiment can be obtained.

[0052] Further, in the above embodiments, hydraulic oil is supplied as cooling oil to the upper hydraulic chamber R7 from the supply pump 8a, but the present disclosure is not limited thereto. For example, a cooling oil pump may be provided separately from the supply pump 8a, and cooling oil may be supplied through a separate system from hydraulic oil.

Description of Reference Signs

[0053]

- | | |
|---|---------------|
| 1 | Engine |
| 2 | Frame |
| 3 | Cylinder unit |

3a	Cylinder liner			a piston rod whose end portion is provided with a flange;
3b	Cylinder head			a fluid chamber that causes the piston rod to be moved in a direction in which a compression ratio is increased by a pressurized working fluid being supplied thereto;
3c	Cylinder jacket			a regulation member that is provided such that the flange is interposed between the regulation member and the fluid chamber, and regulates movement of the piston rod in the direction in which the compression ratio is increased;
4	Piston			a regulation member-side fluid chamber that is provided between the flange and the regulation member with the flange forming a bottom surface of the regulation member-side fluid chamber;
4a	Ejection port	5		a supply flow path that supplies a cooling fluid to the regulation member-side fluid chamber; and
5	Exhaust valve unit			a piston rod internal flow path that includes an opening end on the bottom surface and guides the cooling fluid in the regulation member-side fluid chamber to an inside of the piston rod.
5a	Exhaust valve			
5b	Exhaust valve cage			
5c	Exhaust valve-driving unit			
6	Piston rod	10		
6a	Outer pipe			
6b	Inner pipe			
6c	Flange			
7	Crosshead			
7a	Crosshead pin (fluid chamber-forming member)	15		
7b	Guide shoe			
7c	Lid member (regulation member)			
8	Hydraulic portion			
8a	Supply pump			
8b	Swing pipe	20		
8c	Plunger pump			
8c1	Plunger			
8c2	Cylinder			
8c3	Plunger-driving unit			
8d	First check valve	25	2.	The variable compression device according to claim 1, wherein a surface of the regulation member facing the regulation member-side fluid chamber is provided with an opening end of the supply flow path.
8e	Second check valve			
8f	Relief valve			
8f1	Main body			
8f2	Relief valve-driving unit			
9	Connecting rod	30	3.	The variable compression device according to claim 1, further comprising:
10	Crank angle sensor			
11	Crankshaft			
12	Scavenging reservoir			
13	Exhaust reservoir			
14	Air cooler	35		a fluid chamber-forming member that configures the regulation member-side fluid chamber by the end portion of the piston rod being inserted thereto, wherein
100	Engine system			the bottom surface is provided with a notch,
200	Turbocharger			a surface of the fluid chamber-forming member facing the regulation member-side fluid chamber is provided with an opening end of the supply flow path, and
300	Control unit			the notch is provided with the opening end of the piston rod internal flow path.
A	Variable compression device			
H	Exhaust port	40		
O	Discharge port			
R1	Combustion chamber			
R2	Scavenging chamber			
R3	Fluid chamber			
R4	Supply flow path	45	4.	The variable compression device according to any one of claims 1 to 3, wherein the flange includes a groove flow path in an area overlapping the opening end of the piston rod internal flow path.
R5	Relief flow path			
R6	Cooling oil supply flow path (supply flow path)			
R7	Upper hydraulic chamber (regulation member-side fluid chamber)			
R8	Outer flow path (piston rod internal flow path)	50	5.	An engine system comprising the variable compression device according to any one of claims 1 to 4.
R9	Inner flow path			
S	Scavenging port			

Claims

55

1. A variable compression device comprising:

FIG. 1

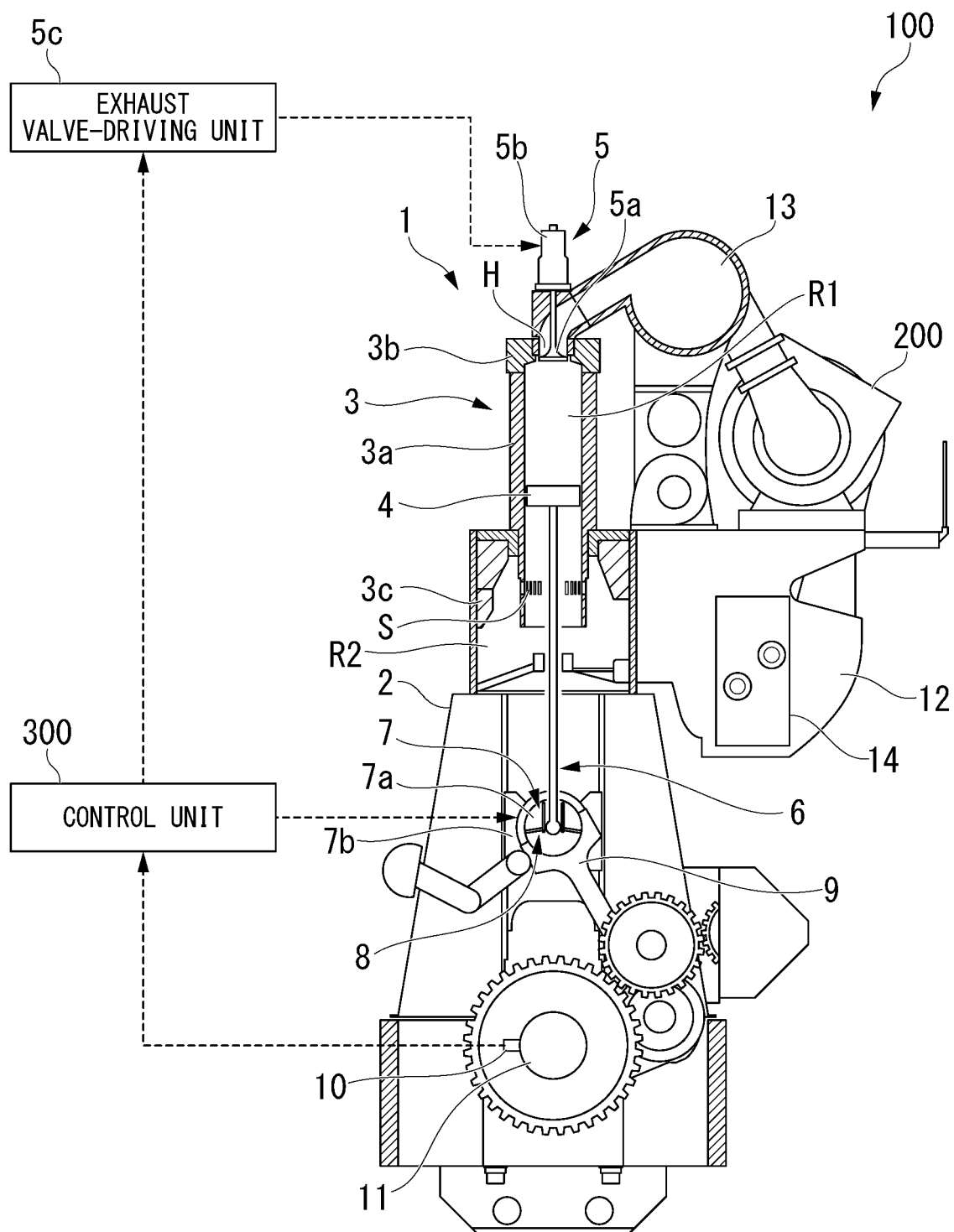


FIG. 2

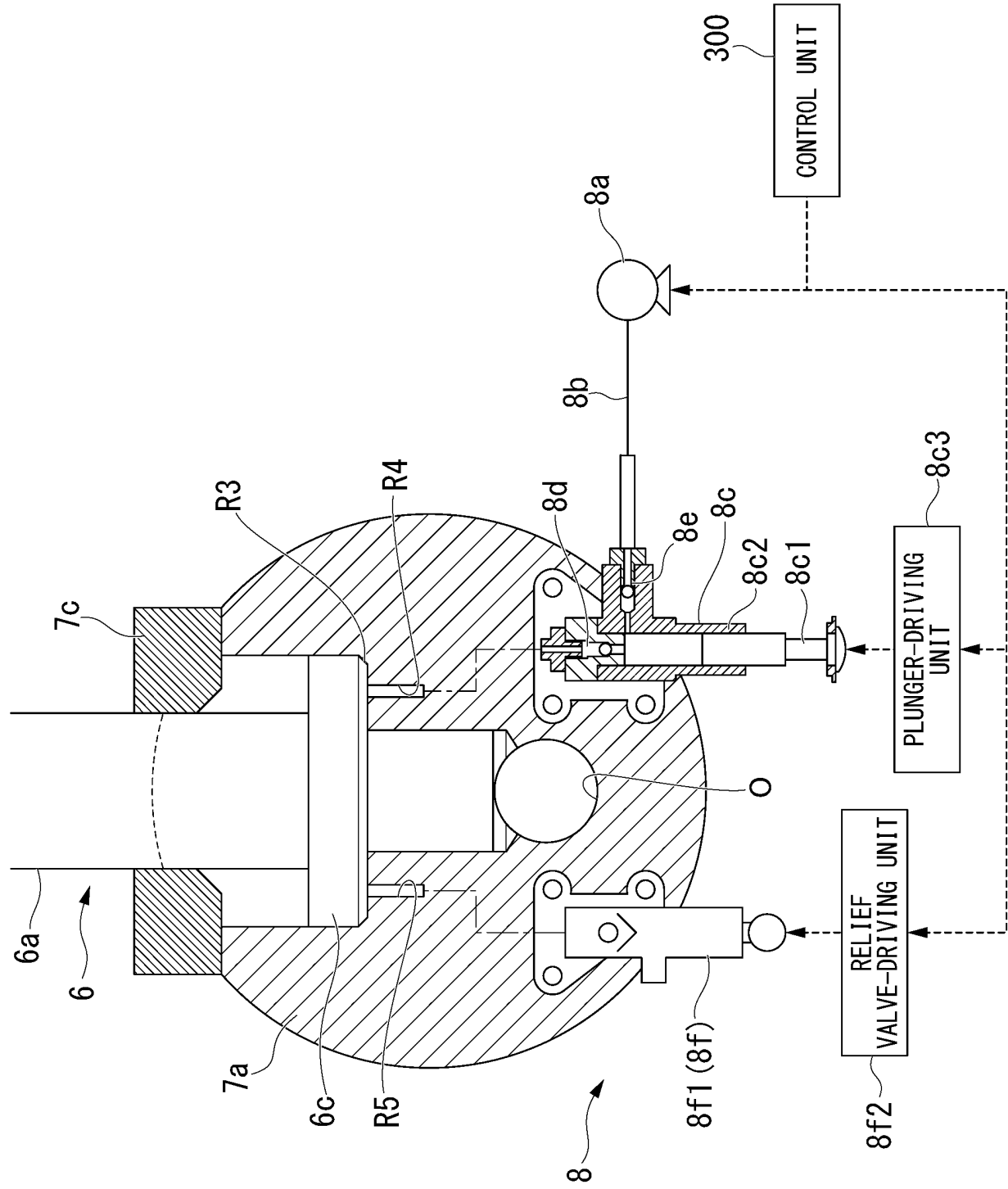


FIG. 3

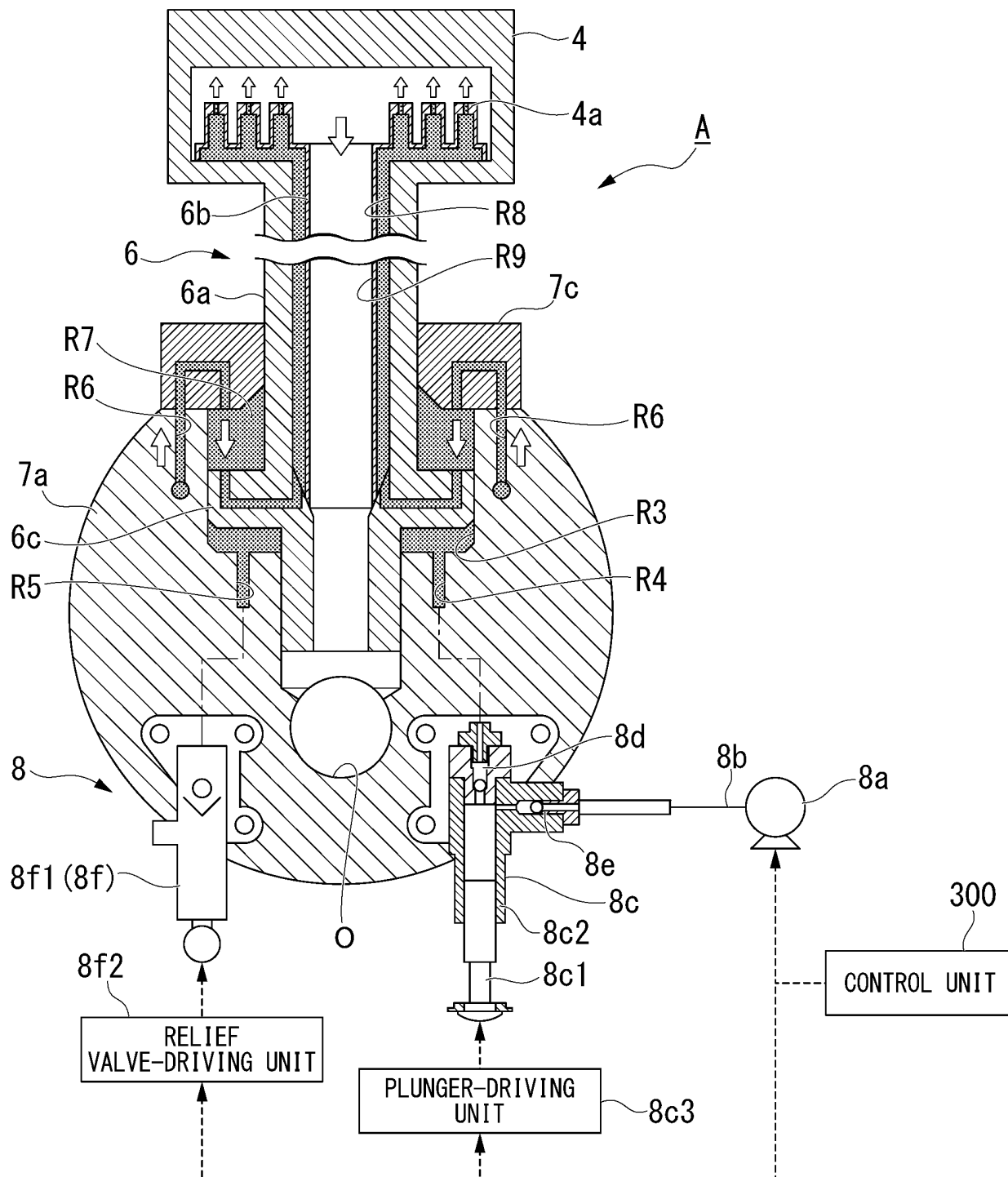
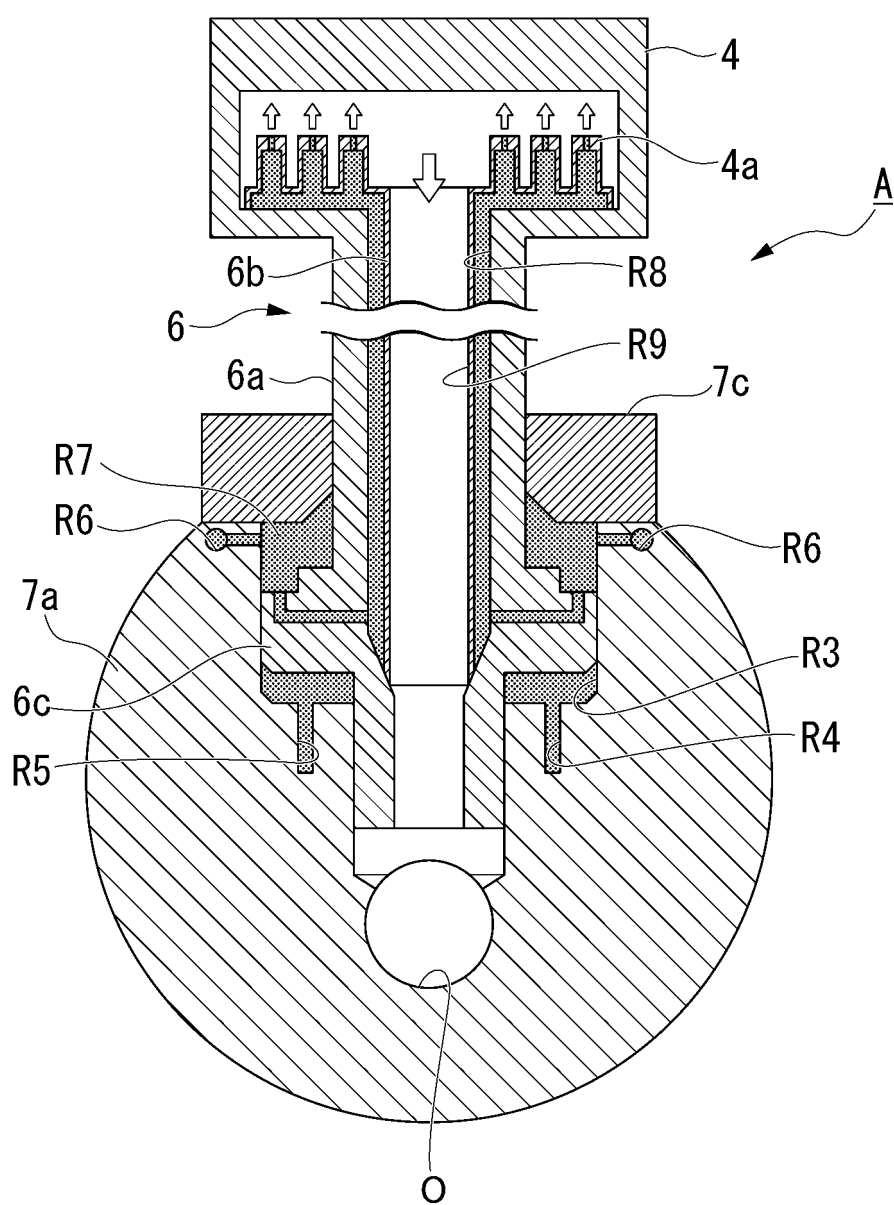


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/043835

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F02B75/04(2006.01) i, F02B23/00(2006.01) i, F02B75/32(2006.01) i,
F02D15/02(2006.01) i, F02F1/18(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)

Int.Cl. F02B75/04, F02B23/00, F02B75/32, F02D15/02, F02F1/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2019

Registered utility model specifications of Japan 1996-2019

Published registered utility model applications of Japan 1994-2019

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	JP 2016-211462 A (IHI CORP.) 15 December 2016, entire text, all drawings & EP 3296539 A1, entire text, all drawings & WO 2016/182004 A1 & KR 10-2017-0083147 A & CN 107532509 A	1-5
A	DE 19835146 A1 (DAIMLERCHRYSLER AG) 10 June 1999, entire text, all drawings (Family: none)	1-5
A	JP 2007-177751 A (HONDA MOTOR CO., LTD.) 12 July 2007, entire text, all drawings (Family: none)	1-5
A	JP 07-197910 A (NABCO LTD.) 01 August 1995, entire text, all drawings (Family: none)	4



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
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Date of mailing of the international search report
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Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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Patent documents cited in the description

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- JP 2014020375 A [0004]