(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 017 476 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.01.2009 Bulletin 2009/04

(51) Int Cl.:
F04B 27/10 *(2006.01)*

(21) Application number: **08012427.4**

(22) Date of filing: **09.07.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: **18.07.2007 JP 2007187365**
18.07.2007 JP 2007187369

(71) Applicant: **Calsonic Kansei Corporation**
Tokyo 164-8602 (JP)

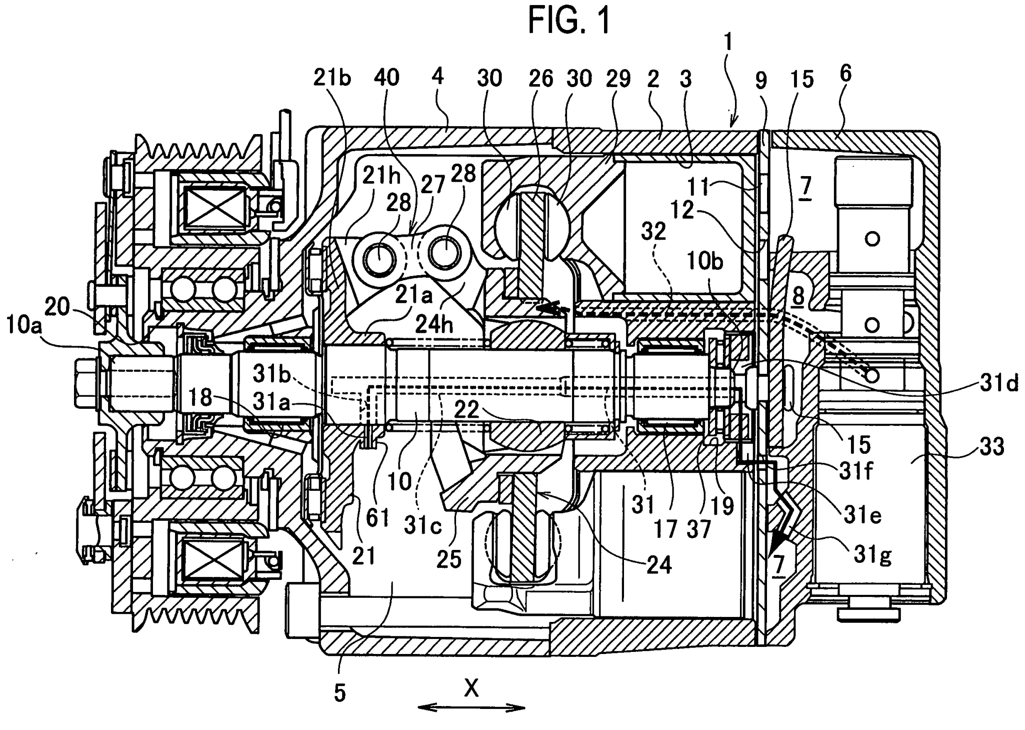
(72) Inventor: **Makishima, Hiroyuki**
Tokyo 164-8602 (JP)

(74) Representative: **Grünecker, Kinkeldey, Stockmair & Schwanhäusser**
Anwaltssozietät
Leopoldstrasse 4
80802 München (DE)

(54) Compressor

(57) An air bleeding passage 31 through which an intake chamber 7 and a crankcase 5 communicate with each other includes at least: a radial passage 31 b which is formed in the driving shaft 10 to be directed in the radial direction, and which indirectly communicates with the intake chamber 7; and a radial passage 31a which is formed in a rotor 21 fixed to the driving shaft 10 by press-fitting to be directed in the radial direction, and through which the radial passage 31b in the driving shaft 10 and the crankcase 5 are communicatively connected to each other. An inlet part 61 of the radial passage 31 a in the rotor 21 is configured as a cylinder-shaped part 61 protruding from the outer peripheral part 63 thereof, and is placed not to overlap a connecting mechanism 40 in the circumferential direction, the connecting mechanism 40 used for connecting the rotor 21 and a swash plate 24 to each other.

FIG. 1



EP 2 017 476 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a compressor for compressing a medium of a compressed object, and particularly to a compressor, installed in a refrigeration cycle for a vehicle air-conditioning system or the like, for compressing a coolant which circulates in the refrigeration cycle.

2. Description of the Related Art

[0002] Compressors of a related technique each include an air bleeding passage through which a crankcase and an intake chamber communicate with each other. In general, lubricant oil is reserved in the crankcase for the purpose of supplying the lubricant oil to the sliding component parts in the crankcase. In the compressor having the air bleeding passage, the lubricant oil reserved in the crankcase flows out to the intake chamber through the air bleeding passage, and accordingly causes two chief problems as follows. First, once the lubricant oil flows out of the crankcase, not enough lubricant oil is supplied to the sliding component parts in the crankcase, and the shortage of the lubricant oil adversely affects the sliding component parts. Second, once the lubricant oil flows out of the crankcase, the lubricant oil circulates from the crankcase, to the heat exchanger (such as the condenser and the evaporator) in the refrigeration cycle through the intake chamber, the cylinder bores, the exhaust chamber, and the outside of the compressor. As a result, the lubricant oil adheres to the condenser tubes in the heat exchanger, and decreases the heat exchange efficiency of the heat exchanger. The above-mentioned related art is disclosed in Japanese Patent Application, Laid-Open No. Sho. 62-203980 (Patent Document 1).

[0003] Thus, a compressor of another related technique has been developed with these problems taken into consideration. In this compressor, an air bleeding passage through which the crankcase and the intake chamber always communicate with each other is provided in the driving shaft with the inlet part of the air bleeding passage being set in the radial direction of the driving shaft. This related technique is disclosed in Japanese Patent Application, Laid-Open No. 2003-343440 (Patent Document 2). Such a structure causes a mist of oil included in the coolant fully contained in the crankcase to collide against, and be captured by, the inner peripheral surface of the inlet part of the air bleeding passage with the rotation of the driving shaft when the mist of oil attempts to flow into the air bleeding chamber, and to be pushed back to the crankcase by centrifugal force generated by the rotation of the driving shaft. Accordingly, this structure is unlikely to allow the mist of oil included in the coolant fully contained in the crankcase to flow out from the crankcase into the intake chamber, and thus reduces the amount of oil flowing out of the crankcase.

SUMMARY OF THE INVENTION

[0004] The present invention has been made with the foregoing problem taken into consideration. An object of the present invention is to provide a compressor capable of reducing the amount of oil flowing out from an air bleeding passage to an intake chamber.

[0005] For the purpose of achieving the object, a first aspect of the present invention is a compressor including: a driving shaft (10); a rotor (21, 121) fixed to the outer periphery of the driving shaft (10) by press fitting; an intake chamber (7); a crankcase (5); and an air bleeding passage (31) through which the intake chamber (7) and the crankcase (5) communicate with each other, the compressor in which the air bleeding passage (31) includes: a radial passage (31b, 131b) which is formed in the driving shaft (10) in a way that the radial passage (31b, 131b) is directed in a radial direction of the driving shaft (10), and which communicates with the intake chamber (7); and a radial passage (31a, 131a) which is formed in the rotor (21, 121) in a way that the radial passage (31a, 131a) is directed in the radial direction of the rotor (21, 121), and through which the radial passage (31b,131b) in the driving shaft (10) and the crankcase (5) communicate with each other, as well as the compressor in which an inlet part (61,161) of the radial passage (31a,131a) in the rotor is configured as a cylinder-shaped part (61,161) protruding from the outer periphery of the rotor.

[0006] The first aspect causes a mist of oil to collide against, and be captured by, the inner peripheral surface of the radial passage in the rotor due to the rotational motion of the driving shaft. In this respect, the mist of oil would otherwise flow into the air bleeding passage from the crankcase along with a medium to be compressed, and the radial passage works as the inlet part of the air bleeding passage. Subsequently, the oil thus attached to the radial passage in the rotor is pushed back to the crankcase by centrifugal force generated by the rotation of the rotor. In this manner, the first aspect offers a structure which unlikely allows the lubricating oil in the crankcase to flow out to the intake chamber through the air bleeding passage. With this simple configuration, the first aspect makes it possible to reduce the amount of oil flowing through the air bleeding passage.

[0007] In addition, because the inlet part of the radial passage in the rotor is formed as the cylinder-shaped part protruding from the outer peripheral surface of the rotor, this shape unlikely allows the oil attached to the outer peripheral surface of the rotor to flow into the air bleeding passage while climbing over steps formed in the cylinder part.

[0008] A second aspect of the present invention, which is dependent on the first aspect, is the compressor according to the first aspect, in which the inlet part (61, 161) of the radial passage (31a, 131a) in the rotor (21, 121) is provided in a location in which the inlet part (61) does not to overlap a connecting mechanism (40) in a circumferential direction of the rotor (21,121). Here, the connecting mechanism (40) connects the rotor (21, 121) with a swash plate (24) which is provided in the crankcase (5).

[0009] The second aspect makes it possible to prevent the cylinder-shaped part and the connecting mechanism from interfering with each other when the rotor is molded, and from obstructing the rotor 121 when the rotor 121 is removed from the mold. That is because the inlet part of the radial passage in the rotor is formed as the cylinder-shaped part, and because the inlet part is provided in the way that the inlet part does not overlap the connecting mechanism in the circumferential direction.

[0010] A third aspect of the present invention, which is dependent on any one of the first and second aspects, is the compressor according to any one of the first and second aspects, in which the outer peripheral surface of the cylinder-shaped part (61) includes an undercut part (61a) which gradually juts out from its base end toward its front end.

[0011] The third aspect makes the oil attached to the outer peripheral surface of the rotor harder to flow into the air bleeding passage while climbing over the steps formed in the cylinder-shaped part. That is because the outer peripheral surface of the cylinder-shaped part includes the undercut part which gradually juts out from its base end toward its front end.

[0012] A fourth aspect of the present invention, which is dependent on any one of the first to third aspects, is the compressor according to any one of the first to third aspects, in which the passage cross-section area of the radial passage (31a, 131a) in the rotor is smaller than that of the radial passage (31 b, 131 b) in the driving shaft.

[0013] The fourth aspect increases the flow rate of the medium to be compressed, which flows into the air bleeding passage, at the inlet of the air bleeding passage. As a result, the fourth aspect facilitates the separation of the mist of oil from the medium to be compressed at the inlet of the air bleeding passage. That is because the passage cross-section area of the radial passage in the rotor is set smaller than that of the radial passage in the driving shaft.

[0014] A fifth aspect of the present invention, which is dependent on any one of the first to fourth aspects, is the compressor according to any one of the first to fourth aspects, which further includes a communicating part (135) through which the radial passage (131a) in the rotor (121) and the radial passage (131b) in the driving shaft (10) communicate with each other, and which is formed in the outer peripheral surface of the driving shaft (10) or the inner peripheral surface of the rotor (121).

[0015] The fifth aspect causes the mist of oil to collide against, and attach to, the inner peripheral surface of the radial passage in the rotor when the mist of oil flows into the air bleeding passage from the crankcase along with the medium to be compressed, as well as thereafter to be pushed back to the crankcase directly by the centrifugal force. In this respect, even if the mist of oil passes the radial passage in the rotor while not captured by the inner peripheral surface of the radial passage in the rotor, the mist of oil thereafter flows through the communicating part (135) so that the mist of oil is further centrifuged in the communicating part, instead of the mist of oil directly flowing into the radial passage in the driving shaft after passing the radial passage in the rotor. For this reason, the mist of oil is eventually pushed back into the crankcase through the radial passages in the rotor. As a result, the fifth aspect enhances the oil separating function better than ever before.

[0016] In other words, the passage cross-section area of the radial passage in the rotor is set smaller that that of the radial passage in the driving shaft. This setting increases the flow rate of the medium to be compressed, which flows into the air bleeding passage, at the inlet of the air bleeding passage. The increased flow rate makes it easy for the mist of oil flowing together with the medium to be compressed to collide directly against the inner peripheral surface of the radial passage or the inner peripheral surface of the communicating part (135) due to its inertial force. This makes it easier for the mist of oil to be separated from the medium to be compressed.

[0017] A sixth aspect of the present invention, which is dependent on any one of the first to fifth aspects, is the compressor according to any one of the first to fifth aspects, in which the radial passage (131a) in the rotor (121) is formed in a location offset from the radial passage (131b) in the driving shaft (10) in the rotational direction (R) of the rotor (121), thereby the radial passage (131a) communicates with the radial passage (131b) through the communicating passage (135).

[0018] A seventh aspect of the present invention, which is dependent on any one of the first to sixth aspects, is the compressor according to any one of the first to sixth aspects, in which the radial passage (131a) in the rotor (121) is provided to be offset from the radial passage (131b) in the driving shaft (10) in a direction reverse to the rotational direction (R) of the rotor.

[0019] Any one of the sixth and seventh aspects causes the mist of oil included in the medium to be compressed flowing through the communicating part to be subject to the centrifugal force for a longer time, and accordingly increases the oil separating function further. This effect is obtained by utilizing a phenomenon in which the medium to be compressed flowing into the communicating part from the radial passage in the rotor is not abreast of the rotation of the rotor, so that the medium to be compressed flows in a direction reverse to the rotational direction of the rotor. Specifically, in the structure according to the invention of the seventh aspect, the radial passage in the rotor is offset from the radial passage in the driving shaft in the direction reverse to the rotational direction of the rotor, and thus the medium to be compressed flowing into the communicating part from the radial passage in the rotor is not abreast of the rotation of the rotor so that the medium to be compressed flows in the direction reverse to the rotational direction of the rotor. As a result, the medium to be compressed does not flow into the radial passage in the driving shaft until the medium to be compressed makes at least approximately one circuit along the communicating part. This causes the mist of oil included in the medium to be compressed flowing through the communicating part to be subject to the centrifugal force for a longer time, and thus further increases the oil separating function.

[0020] An eighth aspect of the present invention, which is dependent on any one of the first to seventh aspects, is the compressor according to any one of the first to seventh aspects, in which the radial passage (131a) in the rotor (121) includes a first radial passage (131a1) and the second radial passage (131a2) which are arranged in the rotational direction (R) of the rotor.

[0021] In the structure according to the eighth aspect, multiple radial passages are formed inside the rotor in the rotational direction of the rotor. The structure having the multiple radial passages which are formed inside the rotor brings about the oil separating function as well as the structure having the single radial passage which is formed inside the rotor.

[0022] A ninth aspect of the present invention, which is dependent on any one of the first to eighth aspects, is the compressor according to any one of the first to eighth aspects, in which the passage cross-section area in the minimum-diameter portion of the second radial passage (131a2) is formed smaller than the passage cross-section area in the minimum-diameter portion of the first radial passage (131a1).

[0023] A tenth aspect of the present invention, which is dependent on any one of the first to ninth aspects, is the compressor according to any one of the first to ninth aspects, in which the first radial passage (131a1) is arranged in a location offset from the radial passage (131b) in the driving shaft (10) in the direction reverse to the rotational direction (R) of the rotor, and in which the second radial passage (131a2) is arranged in a location offset from the first radial passage (131a1) in the rotational direction (R) of the rotor.

[0024] Any one of the ninth and tenth aspects facilitates the medium to be compressed flowing through the first radial passage, and on the contrary unlikely allows the medium to be compressed to flow through the second radial passage. As a result, any one of the ninth and tenth aspects causes the medium to be compressed to flow into the communicating part chiefly through the first radial passage 131a1. In addition, the medium to be compressed which flows into the communicating part through the first radial passage is not abreast of the rotation of the rotor, and thus flows in the direction reverse to the rotational direction of the rotating rotor. Only after making at least approximately one circuit along the communicating part, the medium to be compressed is allowed to flow into the radial passage in the driving shaft. At this time, the mist of oil having flown into the communicating part through the first radial passage together with the medium to be compressed is centrifuged at the communication part. The mist of oil is discharged to the crankcase through the second radial passage, before making approximately one circuit along the communicating part and then entering the radial passage in the driving shaft. For this reason, any one of the ninth and tenth aspects reduces the probability that the oil once centrifuged in the communicating part may be drawn into the radial passage in the driving shaft under the influence of the flow of the medium to be compressed, and accordingly heightens the centrifugal separation function further.

[0025] An eleventh aspect of the present invention, which is dependent on any one of the first to tenth aspects, is the compressor according to any one of the first to tenth aspects, in which the second radial passage (131a2) is tapered in a way that the diameter of the second radial passage (131a2) progressively becomes larger toward its inner opening end on an inner-peripheral side of the rotor from its outer opening end near to an outer-peripheral side of the rotor.

[0026] The eleventh aspect makes it easy for the oil to be discharged to the crankcase through the second radial passage more smoothly. That is because the opening end of the second radial passage in its inner periphery is set larger although the minimum-diameter portion of the second radial passage is structured small, or although the opening end of the second radial passage in its outer periphery is structured small.

[0027] A twelfth aspect of the present invention, which is dependent on any one of the first to eleventh aspects, is the compressor according to any one of the first to eleventh aspects, in which the first radial passage (131a1) is tapered in a way that the diameter of the first radial passage (131a1) progressively becomes smaller toward its inner opening end on the inner-peripheral side of the rotor from its outer opening end near to the outer-peripheral side of the rotor.

[0028] The twelfth aspect makes the medium to be compressed easy to flow through the first radial passage, and on the contrary unlikely allows the medium to be compressed to flow through the second radial passage. As a result, the twelfth aspect causes the medium to be compressed to flow into the communicating part chiefly through the first radial passage (131a1). In addition, the medium to be compressed which flows through the first radial passage is not abreast of the rotation of the rotor, and thus flows in the direction reverse to the rotational direction of the rotating rotor. Only after making at least approximately one circuit along the communicating part, the medium to be compressed is allowed to flow into the radial passage in the driving shaft. At this time, the mist of oil having flown into the communicating part through the first radial passage together with the medium to be compressed is designed to be centrifuged. The mist of oil is discharged to the crankcase through the second radial passage, before making approximately one circuit along the communicating part and then entering the radial passage in the driving shaft. For this reason, the twelfth aspect reduces the probability that the oil once centrifuged in the communicating part may be drawn into the radial passage in the driving shaft under the influence of the flow of the medium to be compressed, and accordingly heightens the centrifugal separation function further. In addition, because the second radial passage is tapered in the way that the opening end in the inner peripheral side of the second radial passage is set larger, the twelfth aspect makes it possible to discharge the oil to the crankcase through the second radial passage more smoothly.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0029]

Fig. 1 is a cross-sectional view of a compressor according to a first embodiment of the present invention.
Fig. 2 is a magnified, cross-sectional view showing an inlet part of an air bleeding passage in the compressor in a magnified manner according to a first embodiment of the present invention.
Fig. 3 is a magnified, cross-sectional view showing an inlet part of an air bleeding passage in a compressor in a magnified manner according to a second embodiment of the present invention.
Fig. 4 is a side view which is viewed in the IV-IV direction indicated by an arrow in Fig. 3.
Fig. 5 is a perspective view schematically showing a rotor in a compressor according to a third embodiment of the present invention.
Fig. 6 is a cross-sectional view of a compressor according to a fourth embodiment of the present invention.
Fig. 7 is a magnified, cross-sectional view of showing an inlet part of an air bleeding passage in the compressor in a magnified manner according to the fourth embodiment of the present invention.
Fig. 8 is a cross-sectional view taken along the VIII-VIII line of Fig. 7.
Fig. 9 is a schematic perspective view showing a modification of a rotor in the compressor according to the fourth embodiment of the present invention.
Fig. 10 is a cross-sectional view of a compressor according to a fifth embodiment of the present invention.
Fig. 11 is a cross-sectional view of a rotor in the compressor according to the fifth embodiment of the present invention, and is the cross-sectional view corresponding to Fig. 8.
Fig. 12 is a cross-sectional view of a rotor in a compressor according to a 6th embodiment of the present invention, and is the cross-sectional view corresponding to Fig. 8.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] Descriptions will be provided hereinbelow for the embodiments of the present invention by referring to the drawings.

(First Embodiment)

[0031] Figs. 1 and 2 each show a compressor according to a first embodiment. Fig. 1 is a cross-sectional view of the compressor, and Fig. 2 is a magnified cross-sectional view showing an inlet side of an air bleeding passage in the compressor shown in Fig. 1.

[0032] As shown in Fig. 1, the compressor according to the present embodiment is a swash plate (a cam plate) variable displacement compressor, and is set in a refrigeration cycle for an air conditioning system for a vehicle, which is mounted on the vehicle such as an automobile.

[0033] This swash plate variable displacement compressor includes: a cylinder block 2 including multiple cylinder bores 3; a front head 4 connected to the front end surface of the cylinder block 2, a crankcase 5 being formed between the front head 4 and the cylinder block 2; a rear head 6 connected to the rear end surface of the cylinder block 2 with a valve plate 9 being interposed in between, an intake chamber 7 and an exhaust chamber 8 being formed in the rear head 6.

[0034] The cylinder block 2, the front head 4 and the rear head 6 are fixedly fastened one to another by use of through-bolts, and thus form a housing 1 for the compressor.

[0035] The valve plate 9 includes: intake holes 11 respectively for causing the cylinder bores 3 to communicate with the intake chambers 7; and exhaust holes 12 respectively for causing the cylinder bores 3 to communicate with the exhaust chambers 8.

[0036] Reed intake valves (not illustrated) for opening and closing the respective intake holes 11 are provided to the cylinder block 2 side of the valve plate 9. On the other hand, reed exhaust valves (not illustrated) and the retainers 15 are provided to the rear head 6 side of the valve plate 9. The reed exhaust valves open and close the exhaust holes 12. The retainers 15 retain the respective exhaust valves, and respectively restrict the opening limits of the exhaust valves.

[0037] A shaft supporting holes 19 and 20 are provided in the center portions of the cylinder block 2 and the front head 4, respectively. The shaft supporting holes 19 and 20 rotatably support a driving shaft 10 with bearings 17, 37, and 18 being interposed in between.

[0038] A rotor 21, a sleeve 22 and a swash plate 24 are provided inside the crankcase 5. The rotor 21 is fixed to the driving shaft 10 by press-fitting from the outer periphery of the driving shaft 10. The driving shaft 10 is slidably fitted into the sleeve 22. The swash plate 24 is tiltably put on the sleeve 22. The swash plate 24 is configured including a journal 25 and a swash plate main body 26. The journal 25 is directly put on the sleeve 22, and is almost shaped like a cylinder. The swash plate main body 26 is fixed to the journal 25, and is shaped like a disc. In addition, the rotor 21 is configured including: a cylinder-shaped hub part 21 a into which the driving shaft 10 is press-fitted; and a disc part 21b protruding from the hub part 21a in an outer diameter direction.

[0039] The rotor 21 and the swash plate 24 are connected to each other by use of a connecting mechanism 40. This connecting mechanism 40 causes the rotor 21 and the swash plate 24 to integrally rotate by transmitting the rotation of the rotor 21 to the swash plate 24 while allowing the swash plate 24 to incline. Incidentally, the connecting mechanism 40 according to the present embodiment is configured including: a hinge arm 21h protruding from the rotor 21 toward the swash plate 24; a hinge arm 24h protruding from the swash plate 24 toward the rotor 21; and a link 27 for connecting the hinge arms 21h and 24h to each other by use of pins 28 and 28.

[0040] Pistons 29 housed in the respective cylinder bores 3 are connected to the swash plate main body 26 with being sandwiched by paired shoes 30. When the swash plate main body 26 rotates, the pistons 29 reciprocate back and forth in the respective cylinder bores 3.

[0041] The basic function of the compressor is as follows. Depending on the reciprocation of these pistons 29, a coolant as a medium to be compressed is aspirated from the intake chamber 7, the intake holes 11 in the valve plate 9 to the inside of cylinder bores 3. The coolant is compressed in the cylinder bores 3. Thereafter, the coolant thus compressed is exhausted from the cylinder bores 3, the exhaust holes 12 in the valve plate 9 to the exhaust chamber 8.

[0042] The compressor 1 according to the present embodiment includes a pressure control system for the purpose of making the exhaust displacement of the compressor variable. The pressure control system is configured including: an air bleeding passage 31 (indicated by an arrow in Fig. 1) through which the crankcase 5 and the intake chamber 7 always communicate with each other; a air supply passage 32 (indicated by an arrow in Fig. 1) through which the crankcase 5 and the exhaust chamber 8 communicate with each other; and a control valve 33 for opening and closing the air supply passage 32. The air bleeding passage 31 makes a coolant gas in the crankcase 5 return to the intake chamber 7 depending on the pressure of the coolant gas in the crankcase 5. Through the air supply passage 32, the coolant gas is forcedly introduced from the exhaust chamber 8 to the crankcase 5. When the air supply passage 32 is opened or closed by the control valve 33, the amount of the coolant gas flowing from the exhaust chamber 8 to the crankcase 5 is controlled, and the pressure in the crankcase 5 is thus controlled. Thereby, the inclination angle of the swash plate 24 is changed, that is to say, the piston strokes are changed. This changes the exhaust displacement of the compressor.

[0043] Next, detailed descriptions will be provided for the structure of the air bleeding passage.

[0044] The air bleeding passage 31 includes: a radial passage 31a; a radial passage 31b; an axial passage 31c; a rear end part 31d; a groove part 31e; a hole part 31f; and a hole part 31g (see Fig. 1). The radial passage 31a is formed penetrating the rotor 21 with its end open to the crankcase 5, and extends in a radial direction of the rotor 21. The radial passage 31b is provided in the driving shaft 10, and is directed in a radial direction of the driving shaft 10 to directly communicate with the radial passage 31 in the rotor 21. The axial passage 31 c is provided in the driving shaft 10 in the axial direction of the driving shaft 10 to directly communicate with the radial passage 31b in the driving shaft 10. The rear end part 31d of the shaft supporting hole 19 communicates with the axial passage 31 c in the driving shaft 10. The groove part 31e is provided in the rear end surface of the cylinder block 2 to communicate with the rear end part 31d of the shaft supporting hole 19. The hole part 31f is formed penetrating the valve plate 9 to communicate with the groove part 31e in the cylinder block 2. The hole part 31g is provided to the rear head 6 to allow the hole part 31f in the valve plate 9 and the intake chamber 7 to communicate with each other therethrough.

[0045] An inlet part 61 of the radial passage 31a in the rotor 21 is formed as a cylinder-shape part 61 protruding from the outer peripheral surface of the rotor 21.

[0046] Next, descriptions will be provided for how the compressor according to the present embodiment operates.

[0047] Once the driving shaft 10 rotates, the rotor 21 rotates integrally with the driving shaft 10. This rotation of the rotor 21 is transmitted to the swash plate 24 through the connecting mechanism 40. The rotation of the swash plate 24 is converted to the reciprocations of the respective pistons 29 through the paired piston shoes 30 and 30. Thereby, the pistons 29 reciprocate back and forth in the respective cylinder bores 3. Depending on the reciprocations of the respective pistons 29, the coolant in the intake chamber 7 is aspirated into the cylinder bores 3 through the intake holes 11 in the valve plate 9. Thereafter, the coolant is compressed in each of the cylinder bores 3. The coolant thus compressed is exhausted to the exhaust chamber 8 through the exhaust holes 12 in the valve plate 9.

[0048] When the volume of exhausted coolant is intended to be changed, the control valve 33 is opened or closed. Thereby, the pressure in the crankcase 5 is controlled, and the balance between pressures respectively in front and rear of each piston is controlled. These controls change the strokes of the respective pistons. More specifically, once the air supply passage 32 is opened by the valve 33, the high-pressure coolant gas flows into the crankcase 5 from the exhaust chamber 8 through the air supply passage 32. Thereby, the pressure in the crankcase 5 rises. Once the pressure in the crankcase 5 rises, the swash plate 24 moves closer to the cylinder block 2 with the inclination angle of the swash plate 24 being decreased. This reduces the strokes of the respective pistons, and accordingly decreases the volume of exhausted coolant. On the other, once the air supply passage 32 is closed by the control valve 33, the difference between the pressure in the intake chamber 7 and the pressure in the crankcase 5 decreases to zero, and the pressure in the intake chamber 7 becomes equal to the pressure in the crankcase 5. That is because the coolant gas in the crankcase 5 is constantly released to the intake chamber 7 through the air bleeding passage 31. In response, the swash plate 24 moves in a direction in which the swash plate 24 goes away from the cylinder block 2 while increasing the inclination angle of the swash plate 24. This movement increases the strokes of the respective pistons, and thus increases the volume of exhausted coolant.

[0049] Lubricant oil is reserved in the crankcase 5 for the purpose of lubricating the sliding component parts in the crankcase 5. The oil is swashed up into a mist by rotary component parts including the rotor 21 and the swash plate 24, and the crankcase 5 is filled with the mist of oil. Thereby, the mist of oil is supplied to the sliding surfaces of the sliding component parts in the crankcase 5. It is likely that this mist of oil may flow out to the intake chamber 7 through the air bleeding passage 31 along with the coolant gas in the crankcase 5. However, the present embodiment decreases the amount of oil flowing out of the crankcase 5 by use of the following scheme.

[0050] In the compressor according to the present embodiment, because the radial passage 31a in the rotor 21 which works as the inlet of the air bleeding passage 31 extends in the radial direction of the rotor 21, the mist of oil which attempts to flow into the air bleeding passage 31 from the crankcase 5 along with the coolant gas collides against, and is captured by, the inner peripheral surface of the radial passage 31a in the rotor 21 due to the rotary motion of the driving shaft 10. Subsequently, the oil thus attached to the radial passage 31a in the rotor 21 is pushed back to the crankcase 5 due to centrifugal force generated by the rotation of the rotor 21. In this manner, the compressor according to the present embodiment has a structure which unlikely allows the lubricating oil to flow out to the intake chamber 7 from the crankcase 5. With this simple configuration, the compressor according to the present embodiment is capable of reducing the amount of oil flowing through the air bleeding passage 31.

[0051] Furthermore, in the present embodiment, because the inlet part 61 of the radial passage 31a in the rotor 21 is formed as the cylinder-shaped part 61 protruding from the outer peripheral surface of the rotor 21, this shape unlikely allows the oil attached to the outer peripheral surface of the rotor 21 to flow into the air bleeding passage 31 while climbing over steps formed in the cylinder-shape part 61.

[0052] The cylinder-shaped part 61 is provided in a location in which the cylinder-shaped part 61 does not overlap the hinge arm 21h of the rotor 21, which constitutes the connecting mechanism 40, in the circumferential direction of the rotor 21. This makes it possible to prevent the cylinder-shaped part 61 and the hinge arm 21h from interfering with each other when the rotor 21 is molded and from obstructing the rotor 121 when the rotor 121 is removed from the mold.

[0053] Hereinbelow, the effects (results) of the present embodiment will be summarized.

(1) The compressor according to the present embodiment includes: the housing 1 including the crankcase 5, the intake chamber 7, the exhaust chamber 8 and the cylinder bores 3 in its inside; the driving shaft 10 which is pivotally supported by the housing 1 rotatably, and which rotationally drives in the crankcase 5; the rotor 21 fixed to the driving shaft 10; the swash plate 24 tiltably put on the driving shaft 10; the connecting mechanism 40 which connects the rotor 21 and the swash plate 24 to each other, and which causes the swash plate 24 to rotate together with the rotor 21 while allowing the inclination angle of the swash plate 24 to be changed; the pistons 29 which reciprocate back and forth in the respective cylinder bores 3 in response to the rotation of the swash plate 24, and which makes the coolant as the medium to be compressed to be aspirated, compressed and exhausted, through their respective reciprocations; and the air bleeding chamber 31 through which the intake chamber 7 and the crankcase 5 communicate with each other. In addition, the air bleeding passage 31 is configured including at least: the radial passage 31b which is formed in the driving shaft 10 in the way that the radial passage 31b is directed in the radial direction of the driving shaft 10, and which communicates with the intake chamber 7; and the radial passage 31a which is formed in the rotor 21 in the way that the radial passage 31a is directed in the radial direction of the rotor 21, and through which the radial passage 31b in the driving shaft 10 and the crankcase 5 are communicatively connected to each other. The inlet part 61 of the radial passage 31a in the rotor 21 is configured as the cylinder-shaped part 61 protruding from a part 63 of the outer periphery (or the outer peripheral surface 63 of the hub part 21a of the rotor 21 in this example), and is provided in the location which causes the inlet part 61 not to overlap the connecting mechanism 40 in the circumferential direction.

[0054] For this reason, in the compressor according to the present embodiment, the mist of oil which attempts to flow from the crankcase 5 into the air bleeding passage 31 together with the coolant gas collides against, and is captured by, the inner peripheral surface of the radial passages 31a and 31b as the inlet part of the air bleeding passage 31 in response to the rotary motion of the driving shaft 10. Subsequently, the oil separated from the gas in the radial passages 31a and 31b is pushed back to the crankcase 5 due to the centrifugal force generated by the rotation of the rotor. This offers the structure in which, although the air bleeding passage 31 let the crankcase 5 and the intake chamber 7 constantly communicate with each other, the air bleeding passage 31 actively makes the oil separate from the gas (or the liquid from the gas) at the its inlet parts 31a and 31b by use of the rotary motion of the driving shaft 10. As a result, with its simple configuration, the present embodiment is capable of reducing the amount of oil flowing out of the crankcase.

[0055] Furthermore, the present embodiment has an effect of enabling the sliding component parts in the crankcase 5 to be supplied with oil which is scattered in the crankcase 5, through an end of the inlet of the radial passage 31a.

[0056] Moreover, the present embodiment unlikely allows the oil attached to the outer peripheral surface of the rotor 21 to flow into the air bleeding passage 31 while climbing over the steps formed in the cylinder-shaped part 61. That is because the inlet part 61 of the radial passage 31a in the rotor 21 is formed as the cylinder-shaped part 61 protruding from the outer peripheral surface of the rotor 21. In addition, the present embodiment heightens the centrifugal separation effect further. That is because the radial passages 31a and 31b working because the inlet part of the air bleeding passage 31 are longer by the protrusion amount d with which the cylinder-shaped part 61 protrudes from the outer peripheral surface of the rotor 21.

[0057] Furthermore, the present embodiment makes it possible to prevent the cylinder-shaped part 61 and the hinge arm 21 from interfering with each other when the rotor 21 is molded, and from obstructing the rotor 121 when the rotor 121 is removed from the mold. That is because the inlet part 61 of the radial passage 31a in the rotor 21 is formed as the cylinder-shaped part 61, and concurrently because the cylinder-shaped part 61 is provided in the location which does not cause the cylinder-shaped part 61 to overlap the hinge arm 21h of the rotor 21 which constitutes the connecting mechanism 40, in the circumferential direction.

[0058] The present embodiment has an effect of enabling the inlet part of the radial passage in the rotor to be formed as the cylinder-shaped part with a smaller number of parts than a structural design in which a cylinder-shaped member discrete from a member constituting the rotor is set in the rotor. Accordingly, the present embodiment has an effect of saving the manufacturing costs.

(2) The present embodiment increases the flow rate of the coolant flowing into the air bleeding passage 31 in the inlet 31a of the air bleeding passage, and accordingly facilitates the separation of the mist of oil from the coolant in the inlet 31a of the air bleeding passage. That is because, in the compressor according to the present embodiment, the passage cross-section area of the radial passage 31a in the rotor is set smaller than the passage cross-section area of the radial passage 31b in the driving shaft.

[0059] Next, descriptions will be provided for the other embodiments. In the following descriptions, components which are the same as those according to the foregoing embodiment will be denoted by the same reference numerals, and duplicated descriptions will be omitted.

(Second Embodiment)

[0060] Figs. 3 and 4 each show a second embodiment of the present invention.

[0061] The shape of outer peripheral surface of the cylinder-shaped part 61 in the compressor according to the second embodiment, which is shown in Figs. 3 and 4, is different from the shape of outer peripheral surface of the cylinder-shaped part 61 in the compressor according to the first embodiment. Specifically, in the compressor according to the second embodiment, the outer peripheral surface of the cylinder-shaped part 61 includes an undercut part 61a which gradually juts out from its base end toward its front end. This configuration makes it harder for the oil attached to the outer peripheral surface 63 of the hub part 21 a in the rotor 21 to climb over the steps formed in the cylinder-shaped part 61. This makes it harder for the oil to flow into the air bleeding passage 31.

(Third Embodiment)

[0062] Fig. 5 shows a third embodiment of the present invention.

[0063] In the compressor according to the third embodiment, which is shown in Fig. 5, the orientation of the cylinder-shaped part 61 is different from the orientation of the hinge arm 21h by 90° in the circumferential direction of the rotor. In the compressors according to the first and second embodiments, the orientation of the cylinder-shaped part 61 is different from the orientation of the hinge arm 21h by 180° in the circumferential direction of the rotor. The third embodiment is different from the first and second embodiments in this manner. However, the third embodiment brings about the same working effect as the first and second embodiments do.

(Modification)

[0064] In the foregoing embodiments, the single radial passage 31 a is provided as the inlet part of the air bleeding passage 31. In the present invention, as the inlet part of the air bleeding passage 31, multiple radial passages 31a may be provided arranged in the axial direction of the driving shaft. Otherwise, multiple radial passages 31 a may be provided arranged in the circumferential direction of the rotor.

[0065] In the foregoing embodiments, the axial passage 31 c in the driving shaft 10 is provided along the center line of the driving shaft 10. In the present invention, however, the axial passage 31 c in the driving shaft 10 may be eccentric to the center line of the driving shaft 10, or may slant to the center line of the driving shaft 10, as long as the centrifugal separation effect is exerted.

[0066] In the foregoing embodiments, the radial passage 31b in the driving shaft 10 and the radial passage 31a in the rotor 21 are orthogonal to the axial passage 31c in the driving shaft 10. In the present invention, however, these radial passages 31b and 31a may slant to the axial passage 31 c in the driving shaft 10 as long as the centrifugal separation effect is exerted.

[0067] The compressors according to the foregoing embodiments are the swash variable displacement compressors in which the swash plate main body 26 is fixed to the journal 25 so that the swash plate main body 26 rotates integrally with the driving shaft 10. However, the present invention is also applicable to a wobble variable displacement compressor in which the swash plate main body 26 is rotatably put on the journal 25 so that the swash plate main body 26 rotates unintegrally with the driving shaft 10. The present invention is also applicable to variable displacement compressors of any other types. It goes without saying that the present invention is applicable to not only variable displacement compressors but also fixed displacement compressors.

(Fourth Embodiment)

[0068] Next, descriptions will be provided for a further modified structure of the air bleeding passage 31 as a fourth embodiment.

[0069] As shown in Fig. 6, an air bleeding passage 31 is configured with a communicative sequence in which a radial passage 131a communicates with a communicating part 135, which communicates with a radial passage 131 b, which communicate with an axial passage 31 c, which communicates with a rear end part 31d, which communicates with a groove part 31e, which communicates with a hole part 31f, which communicates with a hole part 31g. The radial passage 131a is formed in a rotor 121. The communicating part 135 is provided between a press-fitting surface 165 of the rotor 121 and a press-fitting surface 167 of the driving shaft 10 (see Figs. 7 and 8). The radial passage 131b is formed in the driving shaft 10. The axial passage 31c is formed in the driving shaft 10. The rear end part 31d is a part of a shaft supporting hole 19. A groove part 31e is provided in the rear end surface of the cylinder block 2. The hole part 31f is formed penetrating a valve plate 9. The hole part 3 1 g is provided in the rear head 6.

[0070] As shown in Figs. 7 and 8, the radial passage 131a in rotor 121 is formed penetrating a hub part 121a of the rotor 121 in the radial direction of the rotor. The radial passage 131b in the driving shaft 10 is similarly formed penetrating the driving shaft 10 in the radial direction of the driving shaft 10. The radial passage 131 b in the driving shaft 10 and the radial passage 131a in the rotor 121 are provided in the respective locations which are offset (shifted) from each other in the circumferential direction. The radial passage 131b and the radial passage 131a are communicatively connected to each other through the communicating part 135. As an annular groove extending in the circumferential direction, the communicating part 135 is constructed in an inner peripheral surface 165 of the hub part 121a of the rotor 121. A cylinder-shaped part (or an inlet part) 161 of the radial passage 131a in the rotor 121 is formed as a cylinder-shaped part 161 protruding an outer peripheral surface 163 of the hub part 121a of the rotor 121.

[0071] Next, descriptions will be provided for effects of the compressor according to the present embodiment.

[0072] Once the driving shaft 10 rotates, the rotor 121 rotates integrally with the driving shaft 10. This rotation of the rotor 121 is transmitted to the swash plate 24 through the connecting mechanism 40. The rotation of the swash plate 24 is converted to the reciprocation of the pistons 29 through the paired piston shoes 30 and 30. Thereby, the pistons 29 reciprocate back and forth in the respective cylinder bores 3. Depending on the reciprocation of the pistons 29, the coolant in the intake chamber 7 is aspirated into the cylinder bores 3 through the intake holes 11 in the valve plate 9. Thereafter, the coolant thus aspirated is compressed in each cylinder bore 3. Subsequently, the compressed coolant is exhausted to the exhaust chamber 8 through the corresponding exhaust hole 12 in the valve plate 9.

[0073] When the volume of exhausted coolant is intended to be changed, the control valve 33 is opened or closed. Thereby, the pressure in the crankcase 5 is controlled, and the balance between pressures respectively in front and rear of each piston is controlled. These controls change the strokes of the respective pistons. More specifically, once the air supply passage 32 is opened by the valve 33, the high-pressure coolant gas flows into the crankcase 5 from the exhaust chamber 8 through the air supply passage 32. Thereby, the pressure in the crankcase 5 rises. Once the pressure in the crankcase 5 rises, the swash plate 24 moves closer to the cylinder block 2 with the inclination angle of the swash plate 24 being decreased. This reduces the strokes of the respective pistons, and accordingly decreases the volume of exhausted coolant. On the other hand, once the air supply passage 32 is closed by the control valve 33, the difference between the pressure in the intake chamber 7 and the pressure in the crankcase 5 reduces to zero, and the pressure in the intake chamber 7 becomes equal to the pressure in the crankcase 5. That is because the coolant gas in the crankcase 5 is constantly released to the intake chamber 7 through the air bleeding passage 31. In response, the swash plate 24 moves in a direction in which the swash plate 24 goes away from the cylinder block 2 while increasing the inclination angle of the swash plate 24. This movement increases the strokes of the respective pistons, and thus increases the volume of exhausted coolant.

[0074] Lubricant oil is reserved in the crankcase 5 for the purpose of lubricating the sliding component parts in the crankcase 5. The oil is swashed up into a mist by rotary component parts including the rotor 121 and the swash plate 24, and the crankcase 5 is filled with the mist of oil. Thereby, the mist of oil is supplied to the sliding component parts in the crankcase 5.

[0075] It is likely that this mist of oil may flow out to the intake chamber 7 through the air bleeding passage 31 together with the coolant gas in the crankcase 5. However, the present embodiment decreases the amount of oil flowing out of the crankcase 5 by use of the following scheme.

[0076] In the present embodiment, because the radial passage 131a in the rotor 121 which works as the inlet of the air bleeding passage 31 extends in the radial direction of the rotor 21, the mist of oil which attempts to flow into the air bleeding passage 31 from the crankcase 5 together with the coolant gas collides against, and is captured by, the inner peripheral surface of the radial passage 131a in the rotor 121 due to the rotary motion of the driving shaft 10. Subsequently, the oil thus attached to the radial passage 131a in the rotor 121 is pushed back to the crankcase 5 due to centrifugal force generated by the rotation of the rotor 121. In this manner, the compressor according to the present embodiment has a structure which unlikely allows the lubricating oil to flow out to the intake chamber 7 from the crankcase 5 through the air bleeding passage 31. With this configuration, the present embodiment reduces the amount of oil flowing through the air bleeding passage 31.

[0077] In this respect, even if the mist of oil does not collide against, or is not captured by, the inner peripheral surface of the radial passage 131a in the rotor 121 so that the mist of oil passes the radial passage 131a in the rotor 121, the mist of oil subsequently flows in the communicating part 135 instead of directly flowing into the radial passage 131b in the driving shaft 10. For this reason, the mist of oil is centrifuged in this communicating part 135, and the oil thus centrifuged is pushed against the outer peripheral surface of the communicating part 135. Eventually, the oil is pushed out into the crankcase 5 through the radial passage 131a in the rotor 121. Consequently, the present embodiment offers the structure which has the heightened oil separating function, and which unlikely allows the lubricant oil to flow out of the crankcase 5 to the intake chamber 7, through centrifugal separation not only in the radial passage 131a in the rotor 121 but also in the communicating part 135.

[0078] Furthermore, in the present embodiment, the cylinder-shaped part (or the inlet part) 161 of the radial passage 131a in the rotor 121 is formed as the cylinder-shaped part 161 protruding from the outer peripheral surface of the rotor 121. This shape unlikely allows the oil attached to the outer peripheral surface of the rotor 121 to flow into the air bleeding passage 31 while climbing over steps formed in the cylinder-shape part 161.

[0079] The effects (results) of the present embodiment will be summarized as follows.

(1) The compressor according to the present embodiment includes: the housing 101 including the crankcase 5, the intake chamber 7, the exhaust chamber 8 and the cylinder bores 3 in its inside; the driving shaft 10 which is pivotally supported by the housing 101 rotatably, and which rotationally drives in the crankcase 5; the rotor 121 fixed to the driving shaft 10; the swash plate 24 tiltably put on the driving shaft 10; the connecting mechanism 40 which connects the rotor 121 and the swash plate 24 to each other, and which causes the swash plate 24 to rotate together with the rotor 121 while allowing the inclination angle of the swash plate 24 to be changed; the pistons 29 which reciprocate back and forth in the respective cylinder bores 3 in response to the rotation of the swash plate 24, and which aspirate, compress and exhaust the coolant as the medium to be compressed through their respective reciprocations; and the air bleeding chamber 31 through which the intake chamber 7 and the crankcase 5 communicate with each other. In addition, the air bleeding passage 31 is configured including at least: the radial passage 131b which is formed in the driving shaft 10 in the way that the radial passage 131b is directed in the radial direction of the driving shaft 10, and which indirectly communicates with the intake chamber 7; and the radial passage 131a which is formed in the rotor 121 in the way that the radial passage 131a is directed in the radial direction of the rotor 121, and which directly communicates with the crankcase 5. In addition, the radial passage 131 a in the rotor 121 and the radial passage 131b in the driving shaft 10 are arranged to be offset (shifted) from each other so as not to be arranged in a line. Moreover, the communicating part 135 through which the radial passage 131a in the rotor 121 and the radial passage 131 b in the driving shaft 10 communicate with each other is formed in the inner peripheral surface of the rotor 121.

[0080] For this reason, the mist of oil which attempts to flow from the crankcase 5 into the air bleeding passage 31 together with the coolant gas collides against, and attaches to, the inner peripheral surface of the radial passages 131a in the rotor 121. The oil thus attached thereto is pushed out into the crankcase 5 by centrifugal force. In this respect, even if the mist of oil is not captured by the inner peripheral surface of the radial passage 131a in the rotor 121 so that the mist of oil passes the radial passage 131a in the rotor 121, the oil is subsequently further centrifuged in the communicating part 135 instead of directly flowing into the radial passage 131b in the driving shaft 10. Eventually, the oil is pushed out into the crankcase 5 through the radial passage 131a in the rotor 121. For this reason, the present embodiment enhances the oil separating function better than ever.

(2) In the compressor according to the present embodiment, the passage cross-section area of the radial passage 131a in the rotor 121 is set smaller that that of the radial passage 131b in the driving shaft 10. This setting increases the flow rate of the coolant gas, which flows into the air bleeding passage 31, at the inlet of the air bleeding passage 31. The increased flow rate makes it easy for the mist of oil flowing together with the coolant gas to collide directly against the inner peripheral surface of the radial passage 131a or the inner peripheral surface of the communicating part 135 due to its inertial force. This makes it easier for the mist of oil to be separated from the medium of the coolant gas.

(3) The present embodiment unlikely allows the oil attached to the outer peripheral surface of the rotor 121 to

flow into the air bleeding passage 31 while climbing over the steps formed in the cylinder-shaped part 161. That is because the cylinder-shaped part (or the inlet part) 161 of the radial passage 131a in the rotor 121 is formed as the cylinder-shaped part 161 protruding from the part 163 on the outer peripheral surface side of the rotor 121 (the outer-peripheral surface 163 of the hub part 121a of the rotor 121 in this example). In addition, the present embodiment heightens the centrifugal separation effect further. That is because the radial passages 131a and 131b working as the inlet part of the air bleeding passage 31 are longer by the protrusion amount d with which the cylinder-shaped part 161 protrudes from the outer peripheral surface of the rotor 121.

[0081] The present embodiment has an effect of enabling the inlet part (or the cylinder-shaped part) 161 of the radial passage 131a in the rotor 121 to be formed as the cylinder-shaped part 161 with a smaller number of parts than a structural design in which a cylinder-shaped member discrete from a member constituting the rotor is set in the rotor. Accordingly, the present embodiment has an effect of saving the manufacturing costs.

(4) Like in the modification of the fourth embodiment, which is shown in Fig. 9, the cylinder-shaped part 161 may be provided in a location in which the cylinder-shaped part 161 does not overlap the hinge arm 121h of the rotor 121 which constitutes the connecting mechanism 40 in the circumferential direction of the rotor 121. In this case, the present embodiment makes it possible to prevent the cylinder-shaped part 161 and the hinge arm 121h from interfering with each other when the rotor 121 is molded, and from obstructing the rotor 121 when the rotor 121 is removed from a mold.

(Fifth Embodiment)

[0082] Next, descriptions will be provided for the other embodiments. Figs. 10 and 11 each show a compressor according to a fifth embodiment of the present invention. A further modification is introduced to the passage configuration of the air bleeding passage 31 inside a housing 201. The illustration of the cylinder-shaped part 161 shown in Fig. 10 is omitted from Fig. 11.

[0083] The location of the radial passage 131a in the rotor 121 in the compressor according to the fifth embodiment is different from the location the radial passage 131a in the rotor 121 in the compressor according to the fourth direction. Specifically, in the fourth embodiment, the location of the radial passage 131a in the rotor 121 is 180° opposite to the location of the radial passage 131b in the driving shaft 10. In the fifth embodiment, the radial passage 131a in the rotor 121 is placed in a location close to the radial passage 131b in the driving shaft 10 and offset (shifted) from the radial passage 131b in a direction reverse to the rotational direction R of the rotor 121.

[0084] With this configuration, the fifth embodiment causes the mist of oil included in the coolant gas flowing in the communicating part 135 to be subject to the centrifugal force for a longer time, and heightens the oil separating function further.

[0085] This effect is obtained by utilizing a phenomenon in which the coolant gas flowing into the communicating part 135 from the radial passage 131a in the rotor 121 is not abreast with the rotation of the rotor 121 so that the coolant gas flows in a direction reverse to the rotational direction R of the rotating rotor 121. Specifically, in the structure in which the radial passage 131a in the rotor 121 is offset (shifted) from the radial passage 131b in the driving shaft 10 in the direction reverse to the rotational direction R of the rotor 121, the coolant gas having flown into the communicating part 135 from the radial passage 131a in the rotor 121 flows in the direction reverse to the rotational direction R of the rotating rotor. As a result, the coolant gas does not flow into the radial passage 131b in the driving shaft 10 until the coolant gas makes at least approximately one circuit along the communicating part 135. This causes the mist of oil included in the coolant gas to be subject to centrifugal force for a longer time, and thus heightens the oil separating function further. It should be noted that the foregoing effect remains the same, no matter whether the cylinder-shaped part 161 whose illustration is omitted from Fig. 11, and which is shown in Fig. 10, is present or absent.

(Sixth Embodiment)

[0086] Fig. 12 shows a sixth embodiment of the present invention.

[0087] A compressor according to the sixth embodiment is different from the compressors according to the first and fifth embodiments in that multiple radial passages 131a are provided in the rotor 121 in the compressor according to the 6th embodiment. Specifically, the compressor according to the 6th embodiment is configured including a first radial passage 131a1 and a second radial passage 131a2 (see Fig. 12). The first radial passage 131a1 is formed inside the cylinder-shaped part 161 whose external shape is shown in Fig. 10. The second radial passage 131a2 is formed inside a cylinder-shaped part 162 discrete from the cylinder-shaped part 161. The cylinder-shaped part 162 is a part which is provided by fitting a bush member into the hub part 121 a in the rotor 121. The first radial passage 131a1 is tapered in way that the diameter of the first radial passage 131a1 becomes progressively smaller toward its opening end on an inner-peripheral side of the rotor from its opening end on an outer-peripheral side of the rotor. On the other hand, the second radial passage 131a2 is tapered in way that the diameter of the second radial passage 131a2 becomes progressively larger toward its opening end on an inner-peripheral side of the rotor from its opening end on an outer-peripheral side of the rotor. In addition, the passage cross-section area of a minimum-diameter portion of the second radial passage 131a2 is smaller than the passage cross-section area of a minimum-diameter portion of the first radial passage 131a1. In other words, the opening end in the outer peripheral side of the second radial passage 131a2 (that is, the minimum-diameter portion of the second radial passage 131a1) is set smaller than the opening end in the inner peripheral side of the first radial passage 131a1 (that is, the minimum-diameter portion of the first radial passage 131a1).

[0088] This setting makes it easy for the coolant to flow into the communicating part 135 through the first radial passage 131a1, and unlikely allows the coolant to flow into the communicating part 135 through the second radial passage 131a2. As a result, the setting causes the coolant to flow chiefly through the first radial passage 131a1.

[0089] In addition, the first radial passage 131a1 is arranged in a location offset (shifted) from the radial passage 131b in the driving shaft 10 in the direction reverse to the rotational direction R, and the second radial passage 131a2 is arranged not only in a location offset (shifted) from the first radial passage 131a1 in the direction reverse to the rotational direction R, but also in a location offset (shifted) from the radial passage 131b in the driving shaft 10 in the rotational direction R.

[0090] For this reason, the coolant having flown into the communicating part 135 chiefly through the first radial passage 131a1 is caused to flow in the direction reverse to the rotational direction R of the rotating rotor 121 as described above. Only after making at least approximately one circuit along the communicating part 135, the coolant is allowed to flow into the radial passage 131b in the driving shaft 10. At this time, the mist of oil having flown into the communicating part 135 through the first radial passage 131a1 together with the coolant is centrifuged at the communicating part 135. The mist of oil is discharged to the crankcase through the second radial passage, before making approximately one circuit along the communicating part and then entering the radial passage in the driving shaft. This design reduces the probability that the oil once centrifuged in the communicating part 135 may be drawn into the radial passage 131b in the driving shaft 10 under the influence of the flow of the coolant, and accordingly heightens the centrifugal separation function further.

[0091] In addition, the 6th embodiment makes it easy for the oil to be discharged to the crankcase 5 through the second radial passage 131a2 more smoothly. That is because the opening end of the second radial passage 131a2 in its inner periphery is set larger although the minimum-diameter portion of the second radial passage 131a2 is structured small, or although the opening end of the second radial passage 131a2 in its outer periphery is structured small.

(Modification)

[0092] In the foregoing embodiments, the communicating part 135 is formed in the inner peripheral surface 165 (or the press-fitting surface) of the rotor 121. In the present invention, however, the communicating part 135 may be formed in the outer peripheral surface 167 (or the press-fitting surface) of the driving shaft 10. Otherwise, the communicating part 135 may be formed both in the inner peripheral surface 165 of the rotor 121 and in the outer peripheral surface 167 of the driving shaft 10.

[0093] In the foregoing embodiments, the axial passage 31c in the driving shaft 10 is provided along the center line of the driving shaft 10. In the present invention, however, the axial passage 31c in the driving shaft 10 may be eccentric to the center line of the driving shaft 10, or may slant to the center line of the driving shaft 10, as long as the centrifugal separation effect is exerted.

[0094] In the foregoing embodiments, the radial passages 131b in the driving shaft 10 and the radial passage 131a in the rotor 121 are orthogonal to the axial passage 31c in the driving shaft 10. In the present invention, however, these radial passages 131b and 131a may slant to the axial passage 31c in the driving shaft 10 as long as the centrifugal separation effect is exerted.

[0095] The compressors according to the foregoing embodiments are the swash variable displacement compressors in which the swash plate main body 26 is fixed to the journal 25 so that the swash plate main body 26 rotates integrally with the driving shaft 10. However, the present invention is also applicable to a wobble variable displacement compressor in which the swash plate main body 26 is rotatably put on the journal 25 so that the swash plate main body 26 rotates unintegrally with the driving shaft 10. The present invention is also applicable to variable displacement compressors of any other types. It goes without saying that the present invention is applicable to not only variable displacement compressors but also fixed displacement compressors.

[0096] The present invention is not limited to the embodiments of the present invention which have been described. The present invention can be carried out as other various embodiments by introducing modifications to the present invention depending on the necessity.

[0097] The entire contents of Japanese Patent Application No. 2007-187365 (filed on July 18, 2007) and Japanese Patent Application No. 2007-187369 (filed on July 18, 2007) are incorporated in the description by reference.

Claims

1. A compressor, comprising:

a driving shaft (10);
a rotor (21, 121) fixed to an outer periphery of the driving shaft (10) by press-fitting;
an intake chamber (7);
a crankcase (5); and
an air bleeding passage (31) through which the intake chamber (7) and the crankcase (5) communicate with each other,

wherein the air bleeding passage (31) comprises:

a radial passage (31b, 131b) which is formed in the driving shaft (10) to be directed in a radial direction of the driving shaft (10), and which communicates with the intake chamber (7); and a radial passage (31 a, 131a) which is formed in the rotor (21, 121) to be directed in a radial direction of the rotor (21, 121), and through which the radial passage (31b, 131b) in the driving shaft (10) and the crankcase (5) are communicatively connected to each other, and

wherein an inlet part (61, 161) of the radial passage (31a, 131a) in the rotor (21, 121) is formed as a cylinder-shaped part (61, 161) protruding from an outer peripheral side (63, 163) of the rotor (21, 121).

2. The compressor according to claim 1, wherein the rotor (21, 121) is connected to a swash plate (24) provided in the crankcase (5) by a connecting mechanism (40); and wherein the inlet part (61, 161) of the radial passage (31a, 131a) in the rotor (21, 121) is placed in a location where the inlet part (61, 161) does not overlap the connecting mechanism (40) in a circumferential direction of the rotor (21, 121).

3. The compressor according to claim 1, wherein

an outer peripheral surface of the cylinder-shaped part (61) includes an undercut part (61a) which gradually juts out from its base end toward its front end.

4. The compressor according to claim 1, wherein

a passage cross-section area of the radial passage (31a, 131a) in the rotor (21, 121) is smaller than that of the radial passage (31b, 131b) in the driving shaft (10).

5. The compressor according to claim 1, further comprising:

a communicating part (135) through which the radial passage (131a) in the rotor (121) and the radial passage (131b) in the driving shaft (10) communicate with each other, and the communicating part (135) being formed in any one of an outer peripheral surface of the driving shaft (10) and an inner peripheral surface of the rotor (121).

6. The compressor according to claim 5, wherein the radial passage (131a) in the rotor (121) is formed in a location offset from the radial passage (131b) in the driving shaft (10) in a rotational direction (R) of the rotor (121); thereby the radial passage (131a) communicates with the radial passage (131b) through the communicating part (135).

7. The compressor according to claim 6, wherein

the radial passage (131a) in the rotor (121) is arranged in a location offset from the radial passage (131b) of the driving shaft (10) in a direction reverse to the rotational direction (R) of the rotor (121).

8. The compressor according to claim 6, wherein

the radial passage (131a) in the rotor (121) includes a first radial passage (131a1) and a second radial passage (131a2) which are arranged in the rotational direction (R) of the rotor (121).

9. The compressor according to claim 8, wherein

a passage cross-section area of a minimum-diameter portion of the second radial passage (131a2) is set smaller than a passage cross-section area of a minimum-diameter portion of the first radial passage (131a1).

10. The compressor according to claim 8, wherein

the first radial passage (131a1) is arranged in a location offset from the radial passage (131b) of the driving shaft (10) in a direction reverse to the rotational direction (R) of the rotor (121), and the second radial passage (131a2) is arranged in a location offset from the first radial passage (131a1) in the rotational direction (R) of the rotor (121).

11. The compressor according to claim 8, wherein

the second radial passage (131a2) is tapered in a way that a diameter of the second radial passage (131a2) becomes progressively larger toward its inner opening end on an inner-peripheral side of the rotor (121) from its outer opening end near to an outer-peripheral side of the rotor (121).

12. The compressor according to claim 11, wherein

the first radial passage (131a1) is tapered in a way that a diameter of the first radial passage (131a1) becomes progressively smaller toward its inner opening end on the inner-peripheral side of the rotor (121) from its outer opening end near to the outer peripheral side of the rotor (121).

FIG. 1

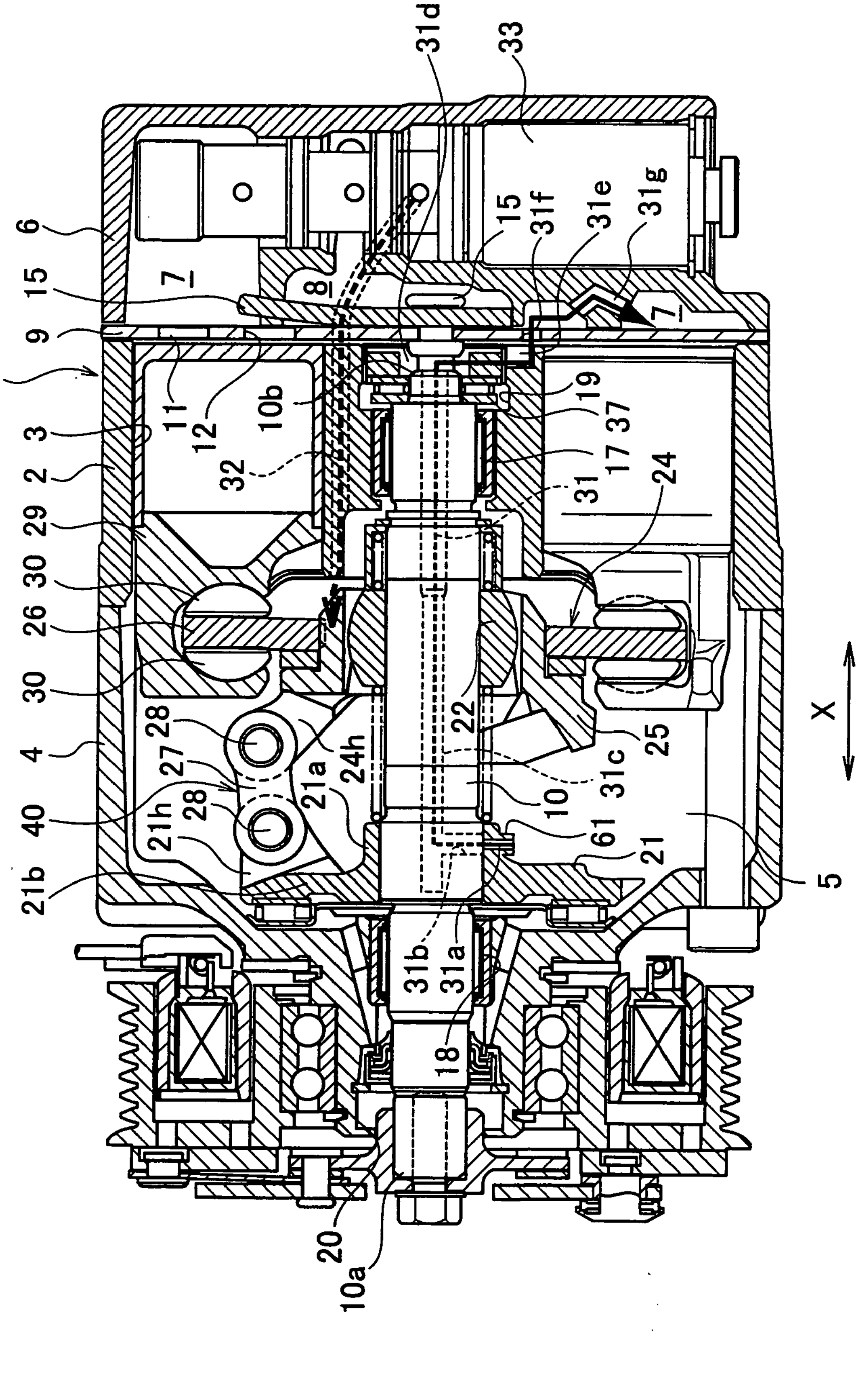

1
2
3
4
5
6
7
8
9
10
10a
10b
11
12
15
17
18
19
20
21
21a
21b
21h
22
24
24h
25
26
27
28
29
30
31
31a
31b
31c
31d
31e
31f
31g
32
33
37
40
61
X

FIG. 2

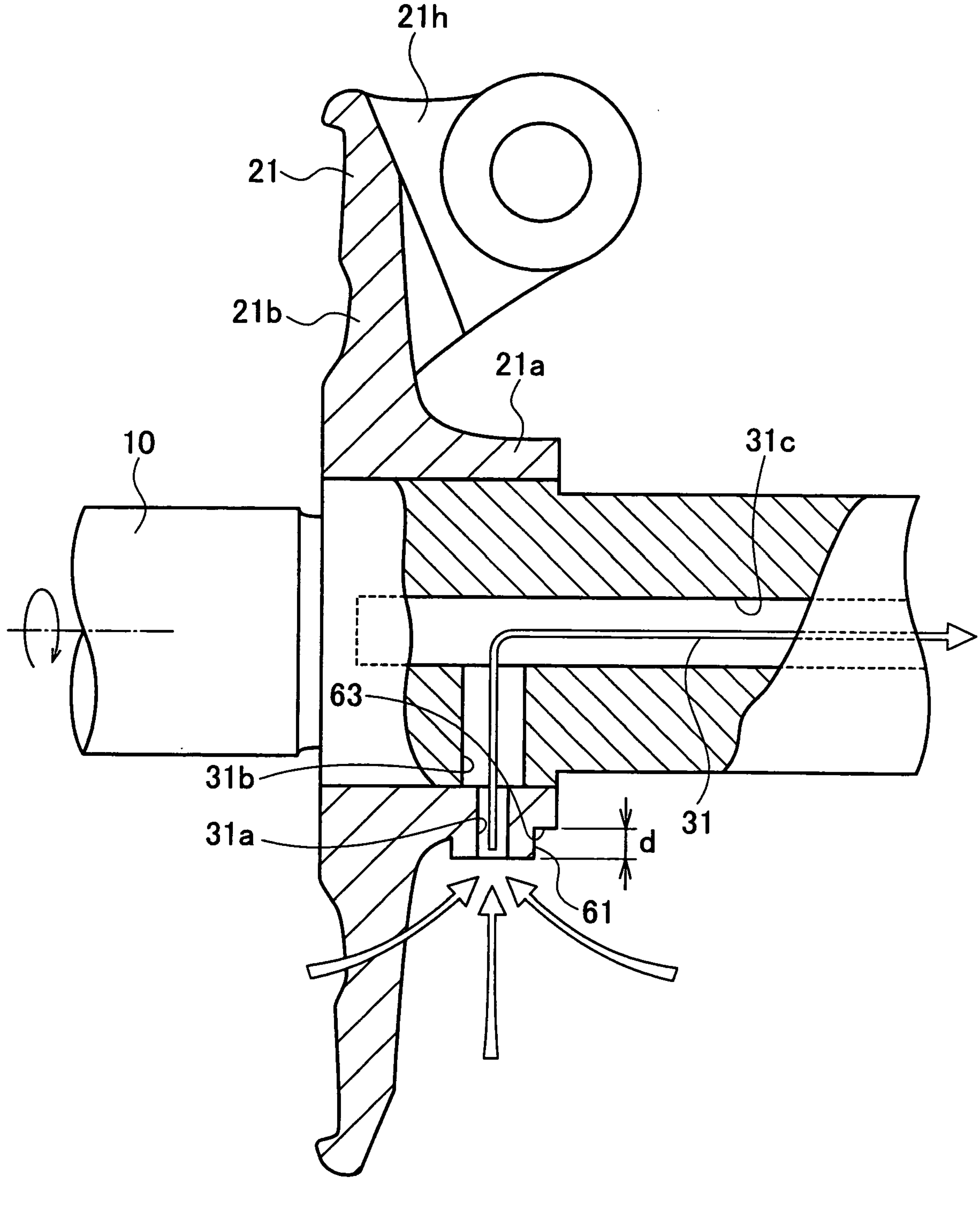


FIG. 3

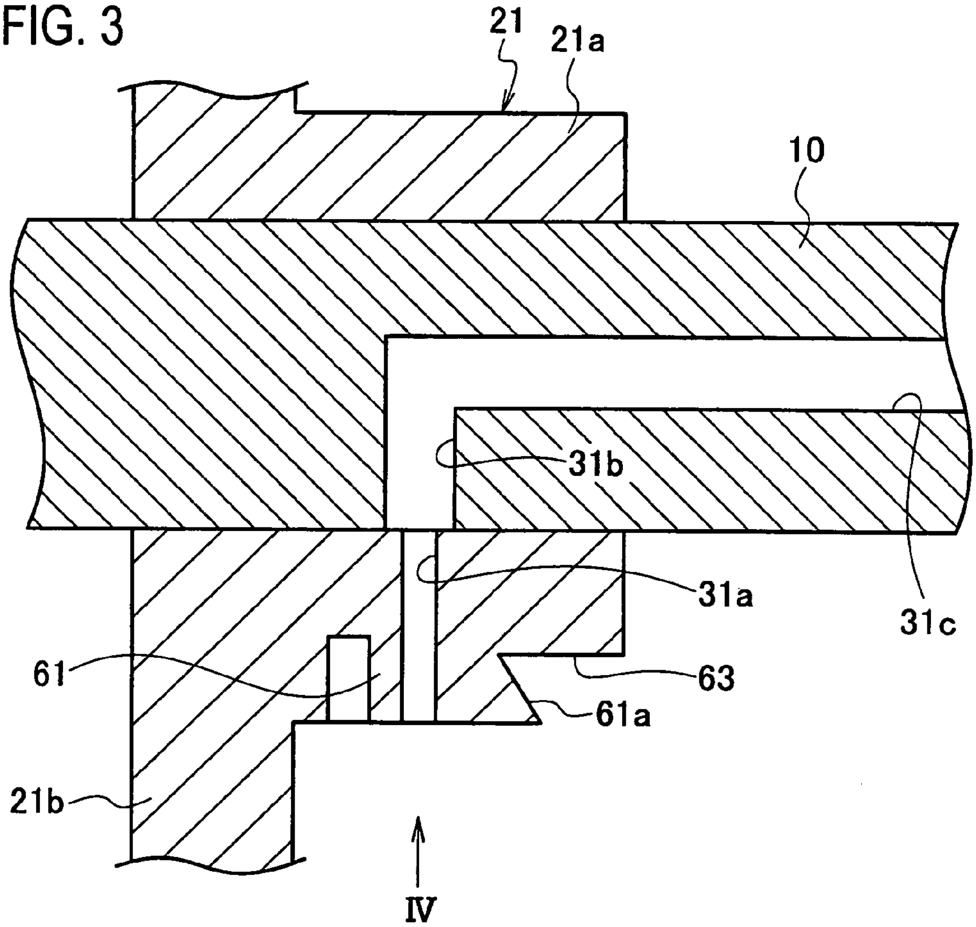


FIG. 4

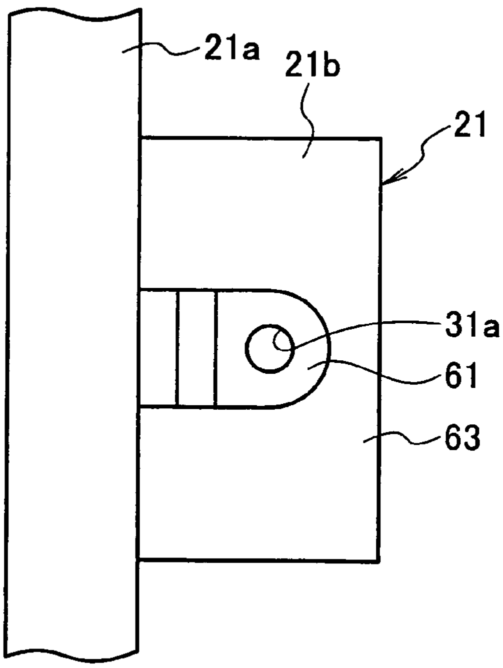


FIG. 5

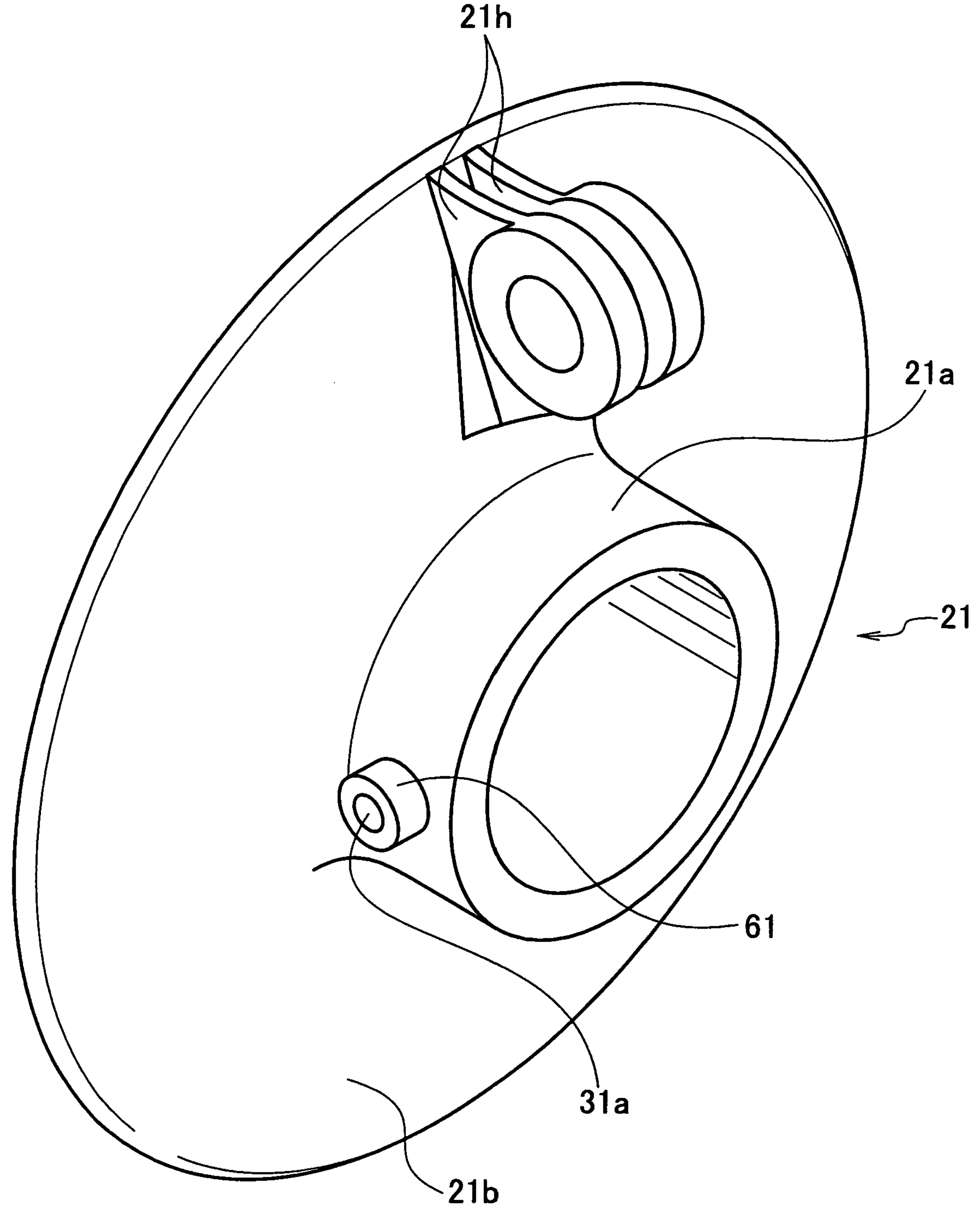


FIG. 6

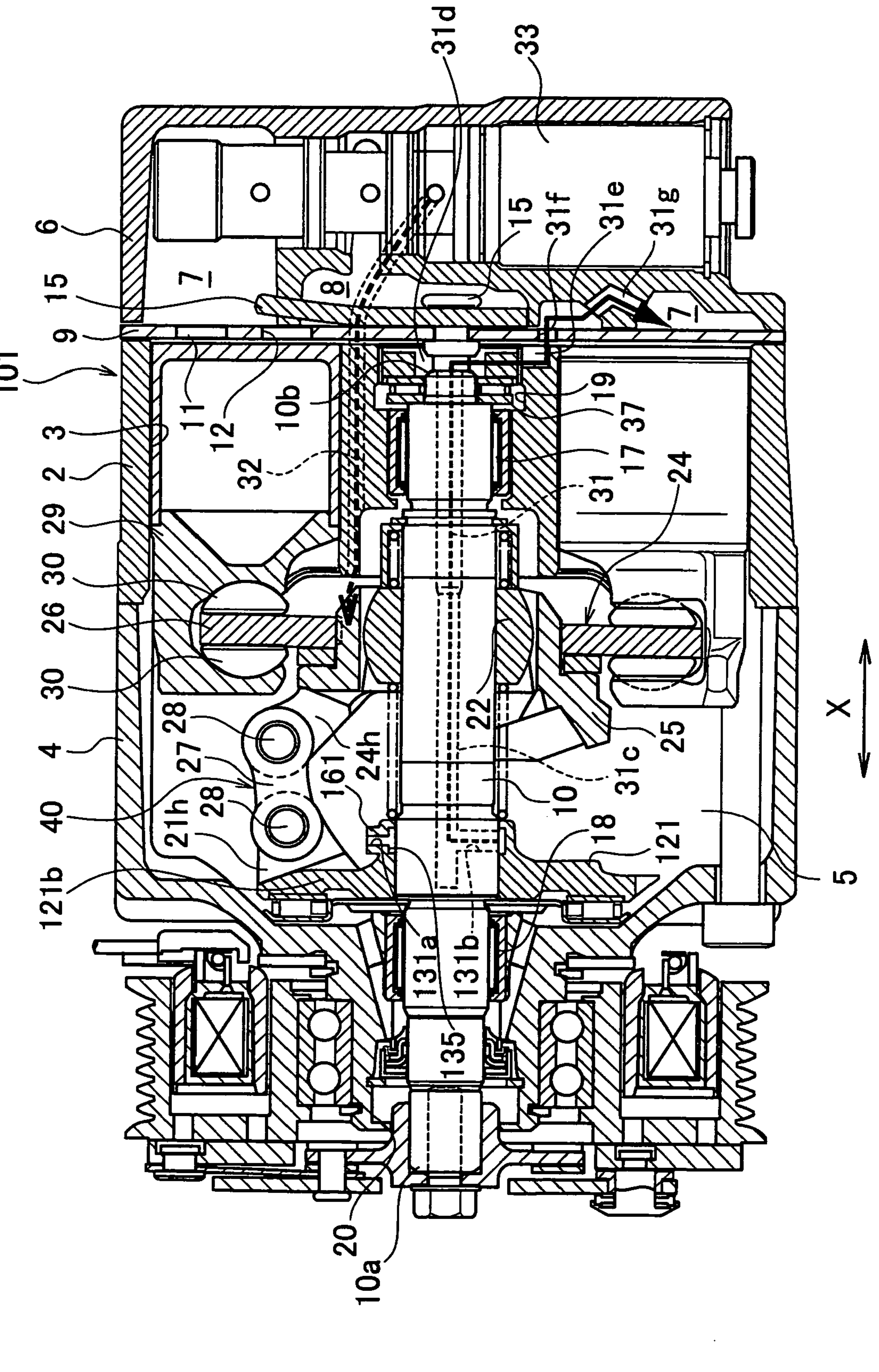

31d
33
6
15
15
9
101
3
2
29
30
26
30
4
28
27
28
40
21h
121b
7
8
11
12
10b
32
31f
31e
31g
7
19
37
17
31
24
22
24h
161
25
31c
10
18
121
5
131a
131b
135
20
10a
X

FIG. 7

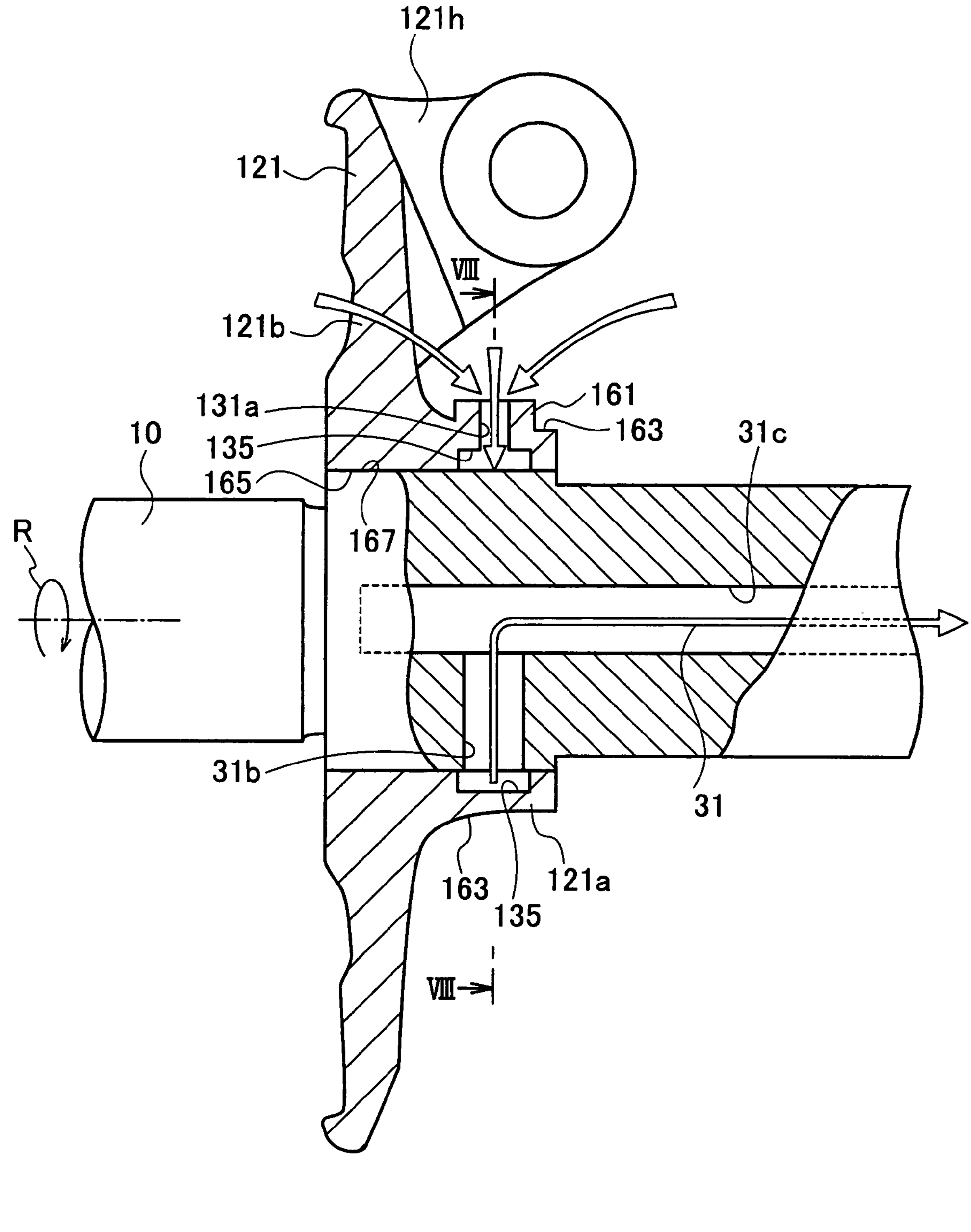

121h
121
VIII
121b
161
131a
163
135
31c
10
165
167
R
31b
31
163
121a
135
VIII

FIG. 8

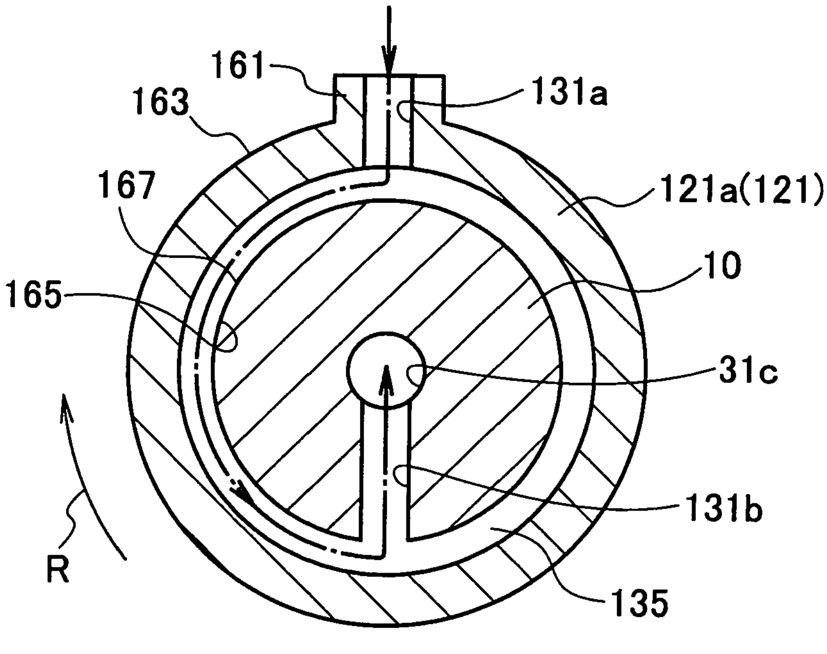


FIG. 9

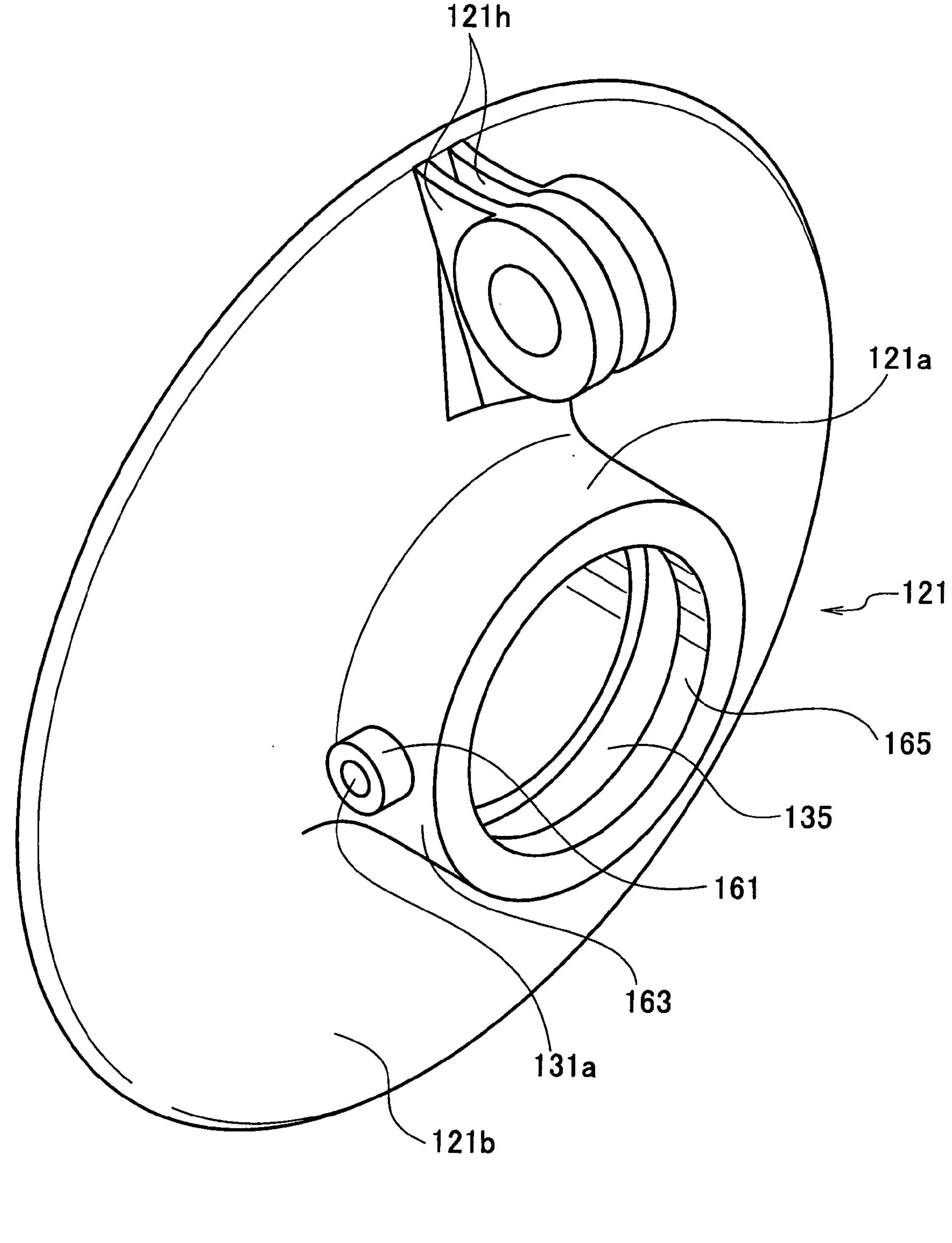


FIG. 10

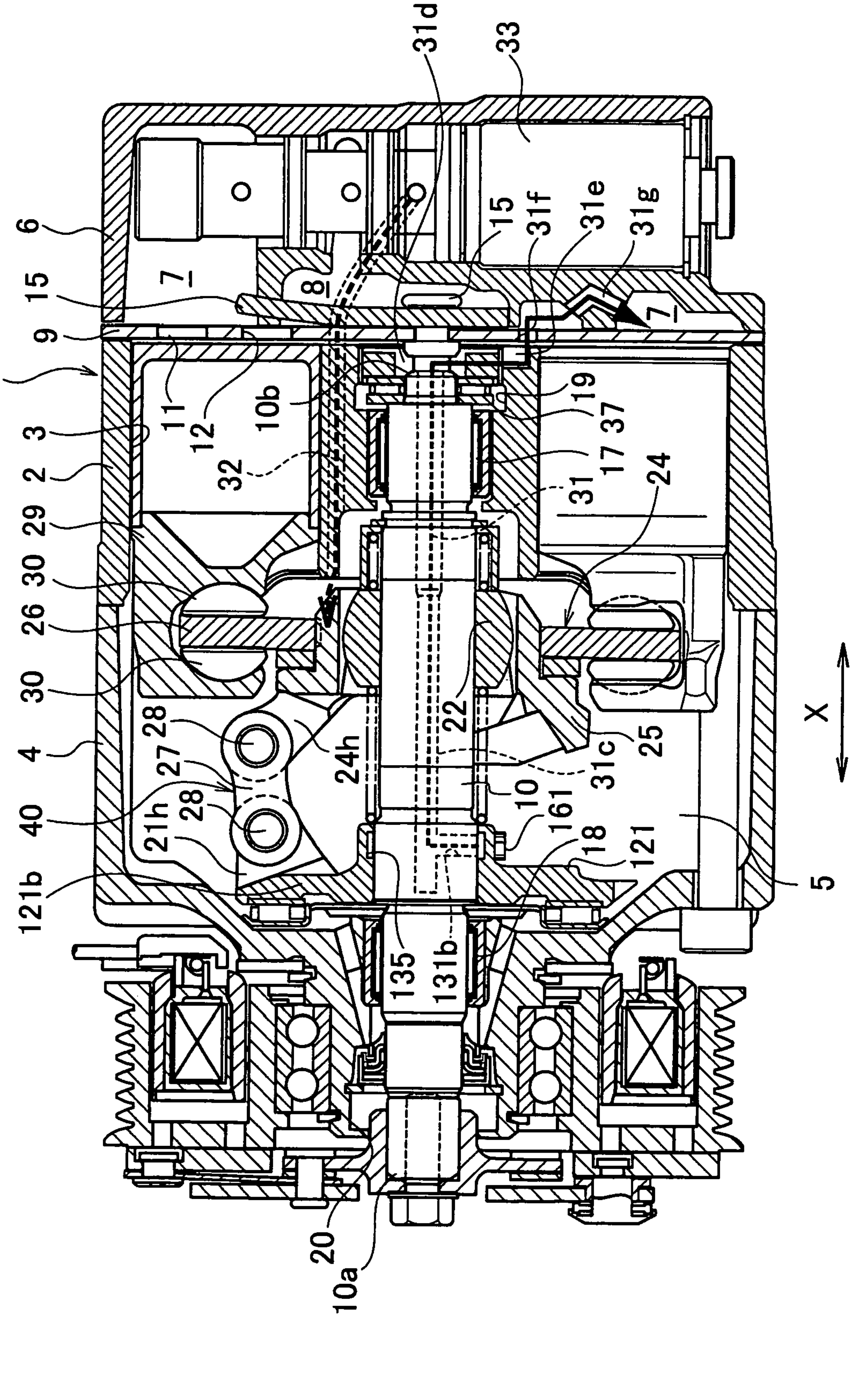

31d
33
6
15
15
31f
31e
31g
7
8
7
9
201
11
12
10b
19
37
17
32
31
24
3
2
29
30
26
30
22
25
28
27
24h
31c
10
161
18
121
4
40
21h
28
121b
5
X
135
131b
20
10a

FIG. 11

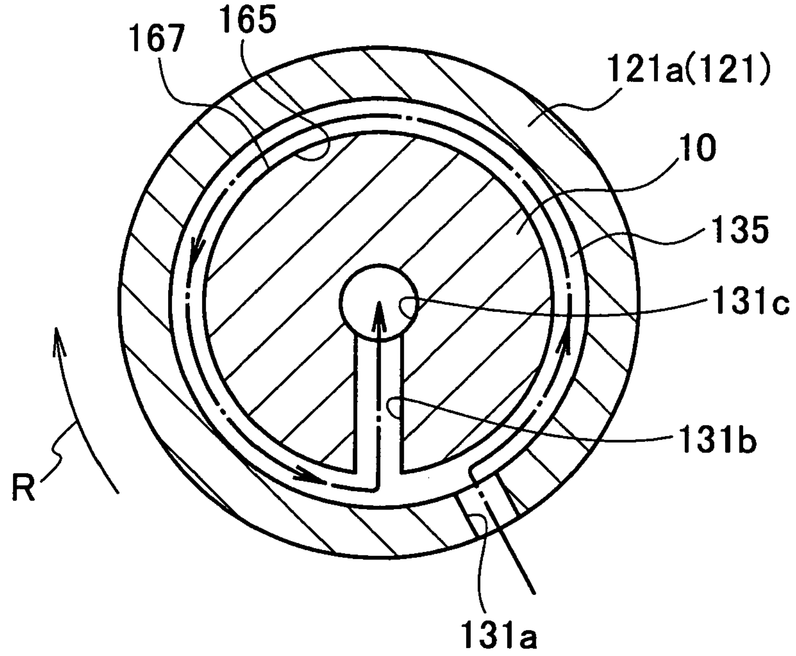
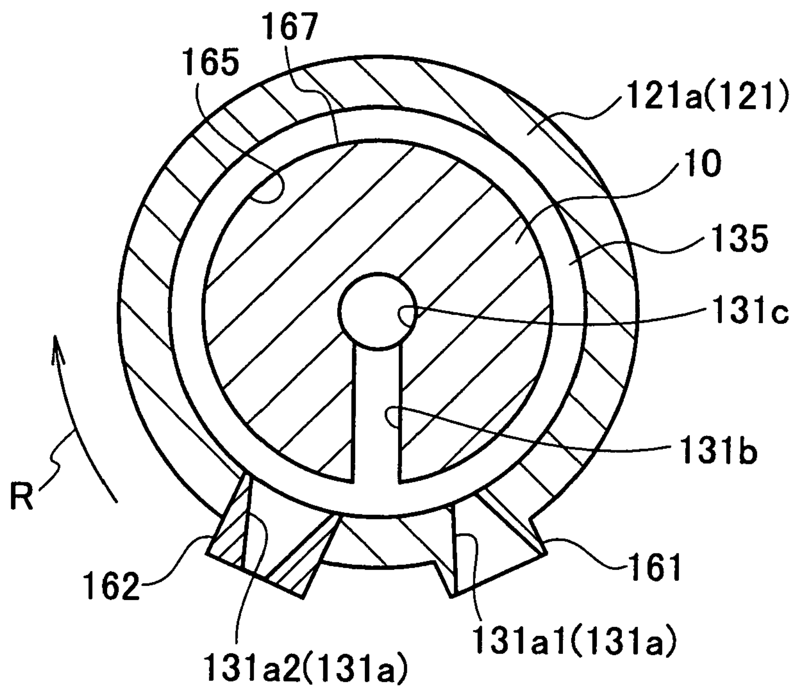

167
165
121a(121)
10
135
131c
131b
R
131a

FIG. 12


167
165
121a(121)
10
135
131c
131b
R
162
161
131a2(131a)
131a1(131a)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP SHO62203980 B **[0002]**
- JP 2003343440 A **[0003]**
- JP 2007187365 A **[0097]**
- JP 2007187369 A **[0097]**