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(54) **VANE PUMP**

(57) A vane pump 100 includes a pump cartridge 10 that is accommodated in an accommodating space defined by the concave portion 30a and the pump cover 31. The pump cartridge 10 includes a first side plate 5 that is provided between the bottom portion of the concave portion 30a in the pump body 30 and a cam ring 4; first pins 11 that are provided so as to extend from the cam ring 4 to the first side plate 5; and second pins 12 that are provided so as to extend from the first side plate 5 to the pump body 30.

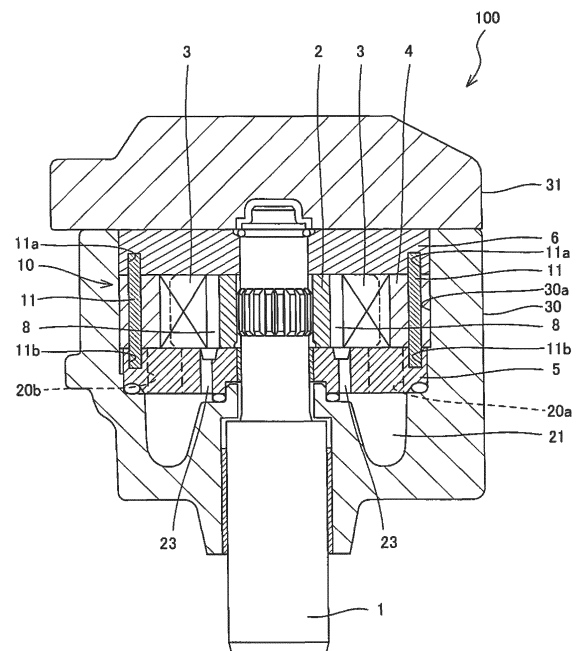


FIG. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to a vane pump.

BACKGROUND ART

[0002] JP2002-21742A discloses a vane pump that includes a pump unit, a body, and a cover having a concave portion for accommodating the pump unit. In this vane pump, a pump housing is formed by the body and the cover.

[0003] In the vane pump disclosed in JP2002-21742A, the pump unit has a cam ring, a rotor, vanes, a first side plate that covers a side surface of each of the cam ring and the rotor on the body side, a second side plate that covers a side surface of each of the cam ring and the rotor on the cover side, and alignment pins for aligning positions of the cam ring and the both side plates in the circumferential direction by penetrating through insertion holes of the cam ring and by being press-fitted into first press-fitting holes of the first side plate and second press-fitting holes of the second side plate. In the vane pump, tip-end portions of the alignment pins serve as projected portions projected from the first side plate, and the pump unit is aligned with respect to the cover by press-fitting the projected portions into the press-fitting holes of the cover.

SUMMARY OF INVENTION

[0004] With the vane pump disclosed in JP2002-21742A, the pump unit is aligned by press-fitting the alignment pins penetrating through the cam ring into the press-fitting holes of the pump cover. However, because the press-fitting holes need to be formed by avoiding the inner side of the cam ring in which the rotor is arranged, there is a restriction on the positions of the press-fitting holes. As the positions of the press-fitting holes are restricted as described above, there is also a restriction on a shape of a passage of working fluid formed in the pump cover.

[0005] An object of the present invention is to improve a degree of freedom for designing a passage of working fluid in a vane pump.

[0006] According to one aspect of the present invention, a vane pump includes: a pump body having a concave portion; a pump cover attached to the pump body, the pump cover being configured to seal the concave portion; and a pump cartridge accommodated in an accommodating space defined by the concave portion and the pump cover. The pump cartridge includes: a rotor linked to a driving shaft; a plurality of slits formed in the rotor in a radiating pattern to open in an outer circumference of the rotor; a plurality of vanes respectively inserted into the plurality of slits in a slidable manner; a cam ring having an inner circumferential surface on which tip-ends

of the vanes slide by rotation of the rotor; a side plate provided between a bottom portion of the concave portion in the pump body and the cam ring; a first pin provided so as to extend from the cam ring to the side plate; and a second pin provided so as to extend from the side plate to the pump body.

BRIEF DESCRIPTION OF DRAWINGS

[0007]

[FIG. 1] FIG. 1 is a sectional view of a vane pump according to an embodiment of the present invention.

[FIG. 2] FIG. 2 is a plan view showing a pump cartridge of the vane pump according to the embodiment of the present invention.

[FIG. 3] FIG. 3 is a plan view showing a bottom portion of a pump body of the vane pump according to the embodiment of the present invention.

[FIG. 4] FIG. 4 is a sectional view taken along a line A-A in FIG. 3.

[FIG. 5] FIG. 5 is a plan view showing a first modification of the vane pump according to the embodiment of the present invention.

[FIG. 6] FIG. 6 is a plan view showing a second modification of the vane pump according to the embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0008] A configuration of a vane pump 100 according to an embodiment of the present invention will be described below with reference to FIGs. 1 to 4.

[0009] The vane pump 100 is used as a fluid pressure source for a fluid pressure apparatus mounted on a vehicle, such as, for example, a power steering apparatus, a continuously variable transmission, or the like. In this embodiment, the fixed displacement vane pump 100 using working oil as working fluid will be described. The vane pump 100 may also be a variable displacement vane pump.

[0010] As shown in FIG. 1, the vane pump 100 has a pump body 30 that has a concave portion 30a, a pump cover 31 that is attached to the pump body 30 and seals the concave portion 30a, and a pump cartridge 10 that is accommodated in an accommodating space defined by the concave portion 30a and the pump cover 31 and discharges the working oil.

[0011] In the vane pump 100, motive force from an engine (not shown) is transmitted to an end portion of a driving shaft 1, and a rotor 2 linked to the driving shaft 1 is rotated. The rotor 2 is rotated in the clockwise direction in FIG. 2.

[0012] As shown in FIGs. 1 and 2, the pump cartridge 10 includes a plurality of vanes 3 that are provided so as to be able to reciprocate in the radial direction relative to the rotor 2, a cam ring 4 that accommodates the rotor 2

and has a cam face 4a serving as an inner circumferential surface on which tip-ends of the vanes 3 slide by rotation of the rotor 2, a first side plate 5 serving as a side plate that is arranged between the cam ring 4 and the bottom portion of the concave portion 30a of the pump body 30 so as to be in contact with the one side surface of the cam ring 4 (lower side surface in FIG. 1), and a second side plate 6 that is arranged between the cam ring 4 and the pump cover 31 so as to be in contact with the other side surface of the cam ring 4 (upper side surface in FIG. 1). Here, FIG. 2 is a plan view showing the pump cartridge 10 in a state in which the second side plate is removed.

[0013] As shown in FIG. 2, in the rotor 2, slits 7 having openings in an outer circumferential surface of the rotor 2 are formed in a radiating pattern with predetermined gaps. The vanes 3 are respectively inserted into the slits 7 in a reciprocable manner. In the slits 7, back pressure chambers 8 into which discharge pressure is guided are defined by base-end portions of the vanes 3.

[0014] The vanes 3 are pushed by the pressure of the working oil guided to the back pressure chambers 8 in the directions in which the vanes 3 are drawn out from the slits 7, and tip-end portions of the vanes 3 are brought into contact with the cam face 4a of the cam ring 4. With such a configuration, a plurality of pump chambers 9 are defined in the cam ring 4 by the outer circumferential surface of the rotor 2, the cam face 4a of the cam ring 4, and the adjacent vanes 3.

[0015] The cam ring 4 is an annular member in which the cam face 4a on the inner circumference has a substantially oval shape. The cam ring 4 has suction regions 4b in which volume of each pump chamber 9, which is defined between respective vanes 3 that slide on the cam face 4a by the rotation of the rotor 2, is increased and discharge regions 4c in which volume of each pump chamber 9 is decreased. As described above, respective pump chambers 9 are expanded/contracted by the rotation of the rotor 2. In this embodiment, the cam ring 4 has two suction regions 4b and two discharge regions 4c.

[0016] As shown in FIG. 1, the first side plate 5 and the second side plate 6 are arranged in such a manner that both side surfaces of each of the rotor 2 and the cam ring 4 are sandwiched, and thereby, the pump chambers 9 are sealed.

[0017] As shown in FIG. 2, in the first side plate 5, two arc-shaped discharge ports 20a and 20b, which open correspondingly to the discharge regions 4c of the cam ring 4, are formed so as to penetrate through the first side plate 5. The two discharge ports 20a and 20b are provided so as to face each other with the angular intervals of 180°.

[0018] As shown in FIG. 3, an arc-shaped high-pressure chamber 21 is formed in the bottom portion of the concave portion 30a of the pump body 30. The working oil that has been discharged from the pump chambers 9 in the discharge regions 4c is guided into the high-pressure chamber 21 through the discharge ports 20a and 20b of the first side plate 5.

[0019] The pump body 30 is formed with a discharge passage 22 that is in communication with the high-pressure chamber 21 through a high-pressure port 22a opening to the high-pressure chamber 21 and that supplies the working oil in the high-pressure chamber 21 to an external hydraulic apparatus. The high-pressure port 22a opens to the high-pressure chamber 21 at the position deviated from that of each of the two discharge ports 20a and 20b in the circumferential direction. In FIG. 1, illustrations of the high-pressure port 22a and the discharge passage 22 are omitted.

[0020] The high-pressure chamber 21 is formed to have an arc-shaped such that both ends of the high-pressure chamber 21 are separated by a raised portion 35 that is raised from the pump body 30 towards the first side plate 5 so as to become higher than the bottom portion of the high-pressure chamber 21. Of two circumferential direction regions R1 and R2 between the two discharge ports 20a and 20b, the raised portion 35 is provided in the circumferential direction region R2 that differs from the circumferential direction region R1 where the high-pressure port 22a is provided. As the raised portion 35 is provided, flows of the working oil flowing in the directions (the directions approaching the raised portion 35) opposite from the directions approaching the high-pressure port 22a from respective discharge ports 20a and 20b (the directions of arrows in FIG. 3) are prevented. Therefore, each of the flows of the working oil guided from the discharge ports 20a and 20b to the high-pressure chamber 21 tends to flow in one direction (the directions of the arrows in FIG. 3) towards the high-pressure port 22a directly without being directed towards the raised portion 35.

[0021] The raised portion 35 may be brought into contact with the first side plate 5, or as shown in FIG. 4, the raised portion 35 may be provided such that a communication gap 36 is formed between the raised portion 35 and the first side plate 5. In other words, the high-pressure chamber 21 may not be completely divided by the raised portion 35, and the raised portion 35 may connect the both ends of the high-pressure chamber 21 through the communication gap 36 formed between the raised portion 35 and the first side plate 5. Even in this case, because the communication gap 36 having the cross-sectional area that is smaller than that of the high-pressure chamber 21 imparts resistance to the flow of the working oil, the working oil guided from the discharge ports 20a and 20b to the high-pressure chamber 21 is less likely to flow towards the raised portion 35 and tends to directly flow into the high-pressure chamber 21 towards the high-pressure port 22a. As described above, as used herein, the phrase "the raised portion 35 that separates the both ends of the high-pressure chamber 21" is not restricted to that completely divides the high-pressure chamber 21, and the phrase also includes the raised portion 35 that allows communication between the both ends of the high-pressure chamber 21 but makes the working oil to flow in one direction towards the high-

pressure port 22a more easily.

[0022] In addition, in the first side plate 5, two arc-shaped back pressure ports 23 that are in communication with the high-pressure chamber 21 are formed (see FIG. 1). The back pressure ports 23 respectively communicate with the back pressure chambers 8. With such a configuration, the working oil in the high-pressure chamber 21 is guided into the back pressure chambers 8 through the back pressure ports 23.

[0023] In the second side plate 6, two arc-shaped suction ports (not shown) that correspondingly open to the two suction regions 4b of the cam ring 4 (see FIG. 2) and that guide the working oil to the pump chambers 9 are formed. In addition, in the pump cover 31, a suction passage (not shown) through which the tank (not shown) is communicated with the suction ports and that guides the working oil in the tank to the pump chambers 9 through the suction ports is formed.

[0024] In the vane pump 100, by the rotation of the rotor 2, the working oil is sucked from the tank through the suction ports and the suction passage to the respective pump chambers 9 in the suction regions 4b of the cam ring 4, and the working oil is discharged to the outside from the respective pump chambers 9 in the discharge regions 4c of the cam ring 4 through the discharge ports 20a and 20b and the discharge passage 22. As described above, in the vane pump 100, the working oil is supplied/discharged by expansion/contraction of the respective pump chambers 9 caused by the rotation of the rotor 2.

[0025] The pump cartridge 10 further has two first pins 11 that are provided so as to extend from the first side plate 5 to the second side plate 6 through the cam ring 4 (see FIG. 1) and two second pins 12 that are provided so as to extend from the first side plate 5 to the pump body 30 (see FIG. 4).

[0026] As shown in FIG. 1, the first pins 11 penetrate through the cam ring 4, and both ends thereof are respectively press-fitted into upper-side first press-fitting holes 11a formed in the second side plate 6 and lower-side first press-fitting holes 11b formed in the first side plate 5. Thereby, integration of the pump cartridge 10 is achieved. The two first pins 11 are symmetrically arranged with respect to the center of the cam ring 4 (see FIG. 2). The two first pins 11 do not respectively penetrate through the first and second side plates 5 and 6. In other words, the both ends of the first pins 11 do not project out from end surfaces of the first and second side plates 5 and 6.

[0027] As shown in FIG. 4, both ends of the second pins 12 are respectively press-fitted into upper-side second press-fitting holes 12a formed in the first side plate 5 and lower-side second press-fitting holes 12b formed in the raised portion 35. As shown in FIG. 3, the second pins 12 are provided so as to avoid and so as not to penetrate a part of the high-pressure chamber 21 formed between the two discharge ports 20a and 20b and the high-pressure port 22a. By providing the second pins 12,

the pump cartridge 10 is aligned with respect to the pump body 30.

[0028] Because the raised portion 35 is provided, the working oil guided from the discharge ports 20a and 20b scarcely flows towards the raised portion 35 and mainly flows directly towards the high-pressure port 22a through a part of the high-pressure chamber 21 formed between the discharge ports 20a and 20b and the high-pressure port 22a. Therefore, if the second pins 12 are provided so as to penetrate through a part of the high-pressure chamber 21 formed between the discharge ports 20a and 20b and the high-pressure port 22a, the flow-passage cross-sectional area is reduced and the flow of the working oil discharged from the pump chambers 9 is disturbed.

[0029] In contrast, in the vane pump 100, as shown in FIG. 3, because the second pins 12 are provided in the raised portion 35, the flow of the working oil is disturbed by the second pins 12. Thus, by providing the second pins 12 in the raised portion 35, it is possible to align the pump cartridge 10 with respect to the pump body 30 without affecting the flow of the working oil discharged from the pump chambers 9. In addition, because there is no need to form an alignment hole of the pump cartridge 10 in the pump cover 31, the passage shape of the suction passage formed in the pump cover 31 is not restricted by the alignment hole. Thus, the degree of freedom for designing the passage formed in the pump cover 31 is improved. With such a configuration, because it is possible to optimize layout of the suction passage and increase the cross-sectional area, and thereby, the sucking property thereof can be improved, it is possible to suppress occurrence of vibration and cavitation of the vane pump 100.

[0030] In addition, in a case in which a single second pin 12 is provided, the pump cartridge 10 may be rotated about the second pins 12 by an angle corresponding to a gap formed between the pump cartridge 10 and the concave portion 30a of the pump body 30 in the radial direction. In contrast, in the vane pump 100, because two second pins 12 are provided, the rotation of the pump cartridge 10 about the second pins 12 is reliably prevented. In cases such as there is no risk of rotation of the pump cartridge 10 about the second pins 12, the single second pin 12 may be provided. In addition, three or more second pins 12 may be provided.

[0031] Next, a modification of the above-mentioned embodiment will be described with reference to FIGs. 5 and 6.

[0032] In the above-mentioned embodiment, the pump cartridge 10 has the second side plate 6 that is provided between the pump cover 31 and the cam ring 4. Instead of this configuration, the pump cartridge 10 may not have the second side plate 6, and the pump cover 31 may be brought into direct contact with the cam ring 4. In this case, the first pins 11 are provided so as to extend from the cam ring 4 to the first side plate 5, and the both ends thereof are respectively press-fitted into the cam ring 4 and the first side plate 5. In other words, the first pins 11

may be provided such that one end of the first pins 11, which is press-fitted into the cam ring 4, does not penetrate through the cam ring 4 and does not project out from the cam ring 4 towards the pump cover 31.

[0033] In addition, in the above-mentioned embodiment, the high-pressure port 22a opens to the high-pressure chamber 21 at the position deviated from that of each of the two discharge ports 20a and 20b in the circumferential direction. Instead of this configuration, as shown in FIG. 5, the high-pressure port 22a may open to the high-pressure chamber 21 at the position facing against the one discharge port 20a. Even in this case, the working oil guided from the other discharge port 20b passes through the high-pressure chamber 21 extending between the discharge port 20b and the high-pressure port 22a in the circumferential direction region R1. Therefore, even when the second pins 12 are provided at the positions where the raised portion 35 is formed in the circumferential direction region R2 at the opposite side of the circumferential direction region R1, the flow of the working oil is not disturbed. Thus, the similar effects as those of the above-mentioned embodiment are afforded.

[0034] In addition, in the above-mentioned embodiment, the second pins 12 are provided at the positions where the raised portion 35 is formed. Instead of this configuration, the second pins 12 may be provided at any positions as long as the flow of the working oil flowing from the discharge ports 20a and 20b to the high-pressure port 22a is not disturbed. Specifically, as shown in FIG. 5, the second pins 12 may be provided at the positions where the second pins 12 do not penetrate through the high-pressure chamber 21 extending between each of the two discharge ports 20a and 20b and the high-pressure port 22a. In other words, the second pins 12 may be provided at any positions in the circumferential direction region R2, where the raised portion 35 is provided, at the opposite side of the circumferential direction region R1, where the high-pressure port 22a is provided. Even in this case, because the flows of the working oil flowing from the discharge ports 20a and 20b to the high-pressure port 22a are not disturbed by the second pins 12, the similar effects as those of the above-mentioned embodiment are afforded.

[0035] In addition, in the above-mentioned embodiment, the vane pump is the so-called balanced vane pump 100 in which the cam ring has the two discharge regions and the two suction regions. Instead, the vane pump may be a so-called unbalanced vane pump 200 in which the cam ring has one discharge region and one suction region.

[0036] More specifically, in the vane pump 200, the first side plate is formed with a single suction port (not shown) that opens correspondingly to the suction region. In addition, the second side plate is formed with a single discharge port 20c that opens correspondingly to the discharge region.

[0037] In the pump body 30, as shown in FIG. 6, an arc-shaped high-pressure chamber 121 is formed at the

position corresponding to the discharge port 20c.

[0038] The second pins 12 are provided at positions where the second pins 12 avoid and do not penetrate through a part of the high-pressure chamber 121 extending in the circumferential direction between the discharge port 20c and the high-pressure port 22a. With such a configuration, even with an unbalanced vane pump, similarly to the above-mentioned embodiment, it is possible to align the pump cartridge 10 without disturbing the flow of the working oil flowing from the discharge port 20c to the high-pressure port 22a by the second pins 12.

[0039] According to the embodiment mentioned above, the advantages described below are afforded.

[0040] In the vane pump 100, the pump cartridge 10 integration of which is achieved with the first pins 11 is aligned with respect to the pump body 30 by the second pins 12 that are provided so as to extend from the first side plate 5 to the pump body 30. Thus, because there is no need to form the alignment hole for the pump cartridge 10 in the pump cover 31, the shape of the passage of the working oil formed in the pump cover 31 is not restricted by the alignment hole. Therefore, the degree of freedom for designing the passage of the working oil formed in the pump cover 31 is improved.

[0041] In addition, because the degree of freedom for designing the passage is improved, it is possible to optimize layout of the suction passage and to increase the cross-sectional area of the suction passage, and thereby, the sucking property thereof can be improved. Therefore, it is possible to suppress occurrence of vibration and cavitation of the vane pump 100.

[0042] In addition, in the vane pump 100, because the second pins 12 are provided in the raised portion 35, the flow of the working oil discharged from the pump chambers 9 is not disturbed by the second pins 12. Thus, it is possible to align the pump cartridge 10 without affecting the flow of the working oil discharged from the pump chambers 9.

[0043] In addition, in the vane pump 100, because the two second pins 12 are provided, the rotation of the pump cartridge 10 relative to the pump body 30 is also prevented.

[0044] The configurations, operations, and effects of the embodiment of the present invention will be collectively described below.

[0045] The vane pumps 100 and 200 include: the pump body 30 that has the concave portion 30a; the pump cover 31 that is attached to the pump body 30 and seals the concave portion 30a; and the pump cartridge 10 that is accommodated in an accommodating space defined by the concave portion 30a and the pump cover 31. The pump cartridge 10 includes: the rotor 2 that is linked to the driving shaft; the plurality of slits 7 that have opening in the outer circumference of the rotor 2 and are formed in a radiating pattern; the plurality of vanes 3 that are respectively inserted into the plurality of slits 7 in a slidable manner; the cam ring 4 that has the cam face 4a on which the tip-ends of the vanes 3 slide by the rotation of

the rotor 2; the first side plate 5 that is provided between the bottom portion of the concave portion 30a in the pump body 30 and the cam ring 4; the first pins 11 that are provided so as to extend from the cam ring 4 to the first side plate 5; and the second pins 12 that are provided so as to extend from the first side plate 5 to the pump body 30.

[0046] In this configuration, the pump cartridge 10 integration of which is achieved by the first pins 11 is aligned with respect to the pump body 30 by the second pins 12 that are provided so as to extend from the first side plate 5 to the pump body 30. Thus, because there is no need to form the alignment hole for the pump cartridge 10 in the pump cover 31, the shape of the passage of the working oil formed in the pump cover 31 is not restricted by the alignment hole. Therefore, the degree of freedom for designing the passage of the working oil in the vane pumps 100 and 200 is improved.

[0047] In addition, in the vane pumps 100 and 200, the pump cartridge 10 includes two or more second pins 12.

[0048] According to this configuration, the rotation of the pump cartridge 10 relative to the pump body 30 can be prevented.

[0049] In addition, in the vane pumps 100 and 200, the first side plate 5 has the discharge ports 20a, 20b, and 20c that guide the working fluid discharged from the pump chambers 9 in the pump cartridge 10, which are defined by the rotor 2, the cam ring 4, and the adjacent vanes 3; the pump body 30 has the arc-shaped high-pressure chambers 21 and 121 into which the working oil that has been discharged from the pump chambers 9 is guided through the discharge ports 20a, 20b, and 20c and has the discharge passage 22 that is in communication with the high-pressure chamber 21 through the high-pressure port 22a opening to the high-pressure chambers 21 and 121; and the second pins 12 are provided at the positions where the second pins 12 do not penetrate through a part of the high-pressure chamber 21 extending in the circumferential direction between each of the discharge ports 20a and 20b and the high-pressure port 22a.

[0050] In addition, in the vane pumps 100 and 200, the pump body 30 is formed with the raised portion 35 that separates the both ends of the high-pressure chamber 21, and the second pins 12 are provided so as to extend from the first side plate 5 to the raised portion 35.

[0051] According to these configurations, because the second pins 12 do not penetrate through a part of the high-pressure chamber 21 extending in the circumferential direction between the discharge ports 20a, 20b, and 20c and the high-pressure port 22a, the flow of the working oil guided from the discharge ports 20a, 20b, and 20c to the high-pressure port 22a is not disturbed by the second pins 12. Therefore, it is possible to align the pump cartridge 10 without affecting the flow of the working oil.

[0052] Embodiments of this invention were described above, but the above embodiments are merely examples of applications of this invention, and the technical scope of this invention is not limited to the specific constitutions

of the above embodiments.

[0053] This application claims priority based on Japanese Patent Application No.2015-183260 filed with the Japan Patent Office on September 16, 2015, the entire contents of which are incorporated in to this specification.

Claims

1. A vane pump comprising:

a pump body having a concave portion;
a pump cover attached to the pump body, the pump cover being configured to seal the concave portion; and
a pump cartridge accommodated in an accommodating space defined by the concave portion and the pump cover, wherein the pump cartridge comprises:

a rotor linked to a driving shaft;
a plurality of slits formed in the rotor in a radiating pattern to open in an outer circumference of the rotor;
a plurality of vanes respectively inserted into the plurality of slits in a slidable manner;
a cam ring having an inner circumferential surface on which tip-ends of the vanes slide by rotation of the rotor;
a side plate provided between a bottom portion of the concave portion in the pump body and the cam ring;
a first pin provided so as to extend from the cam ring to the side plate; and
a second pin provided so as to extend from the side plate to the pump body.

2. The vane pump according to claim 1, wherein the pump cartridge comprises two or more second pins.

3. The vane pump according to claim 1, wherein the side plate has a discharge port configured to guide working fluid that has been discharged from pump chambers in the pump cartridge, the pump chambers being defined by the rotor, the cam ring, and the adjacent vanes, the pump body has:

an arc-shaped high-pressure chamber into which the working fluid that has been discharged from the pump chambers is guided through the discharge port; and
a discharge passage configured to communicate with the high-pressure chamber through a high-pressure port opening to the high-pressure chamber, and

the second pin is provided at a position where the second pin does not penetrate through a part of the high-pressure chamber extending in a circumferential direction between the discharge port and the high-pressure port.

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4. The vane pump according to claim 3, wherein the pump body is formed with a raised portion, the raised portion being configured to separate both ends of the high-pressure chamber, and the second pin is provided so as to extend from the side plate to the raised portion.

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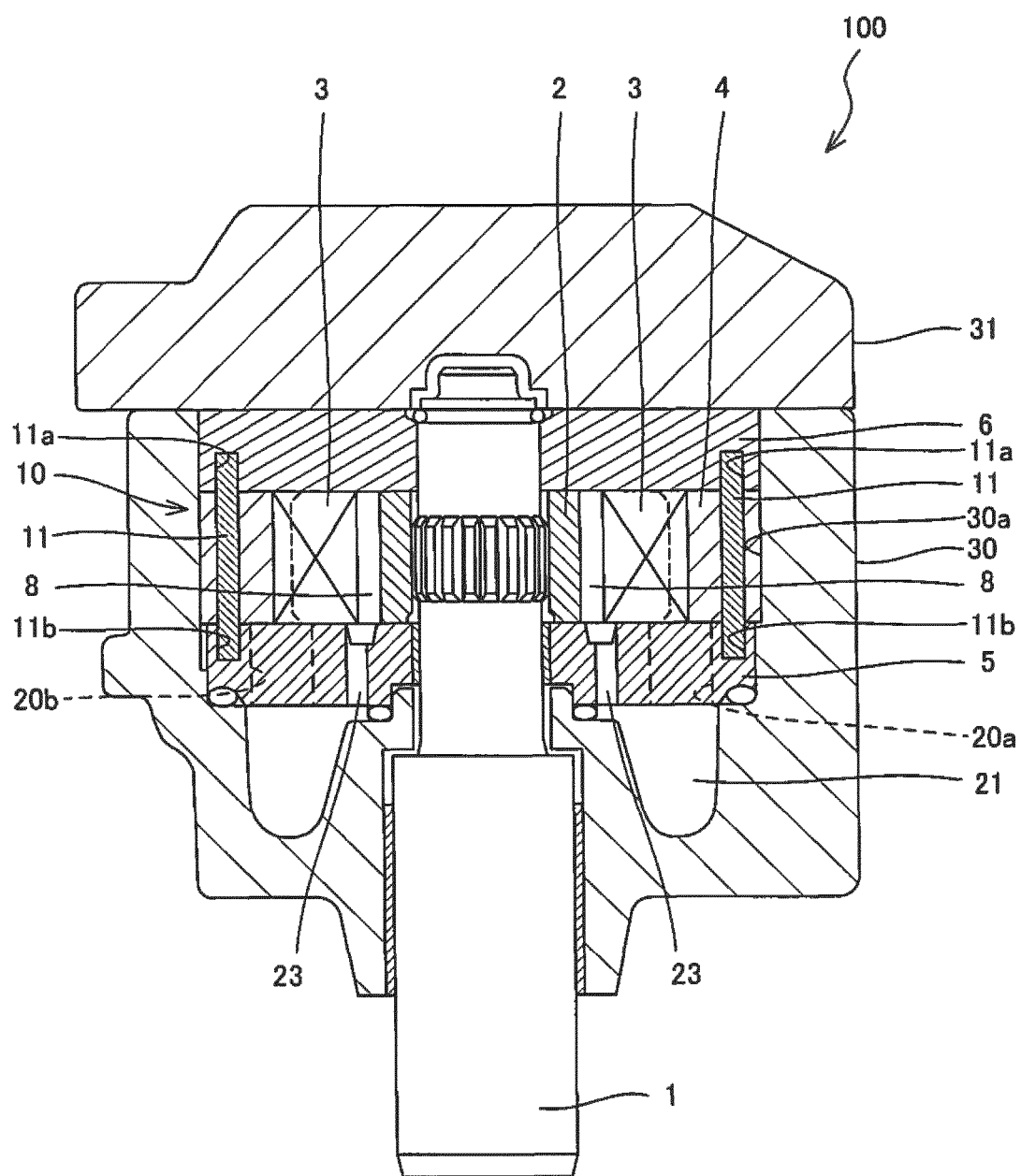


FIG. 1

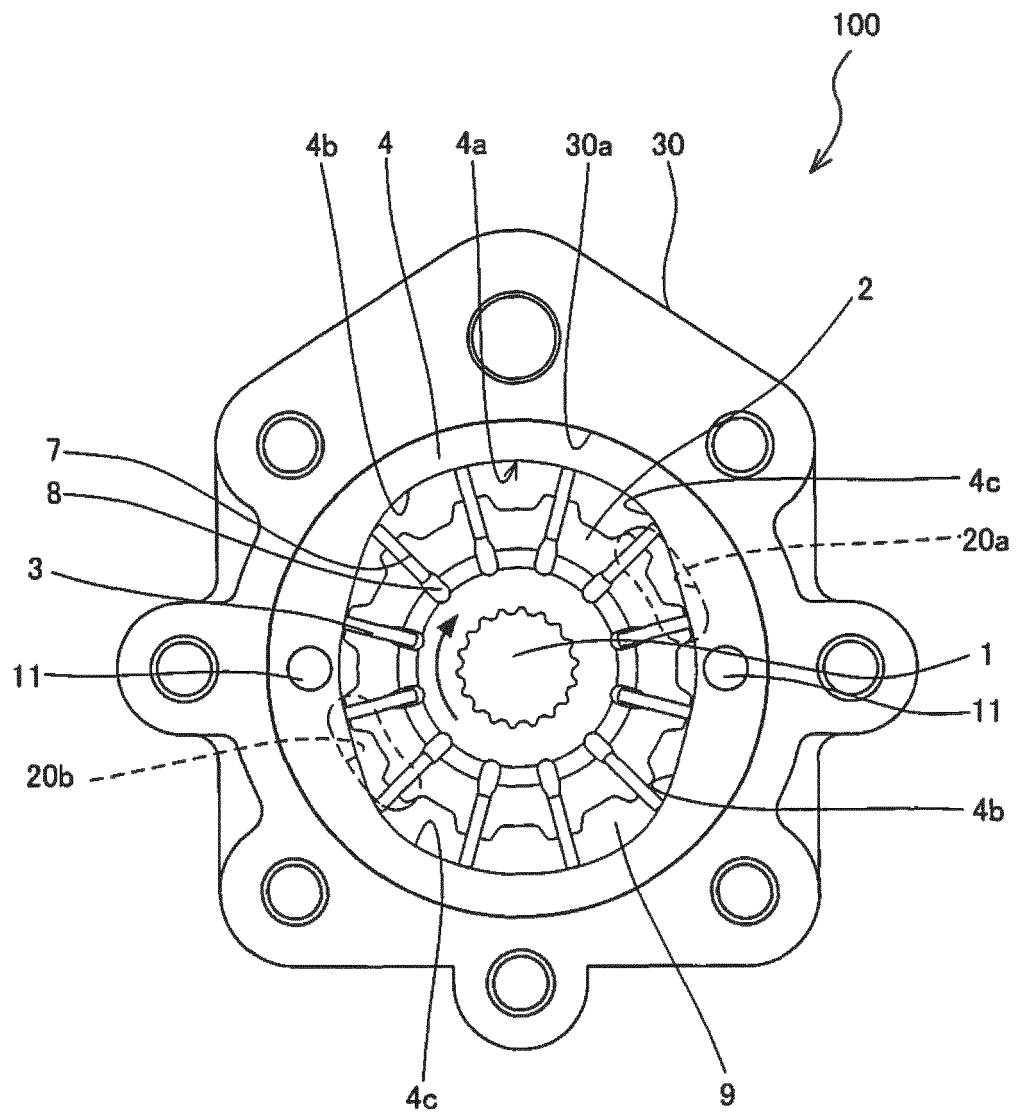


FIG.2

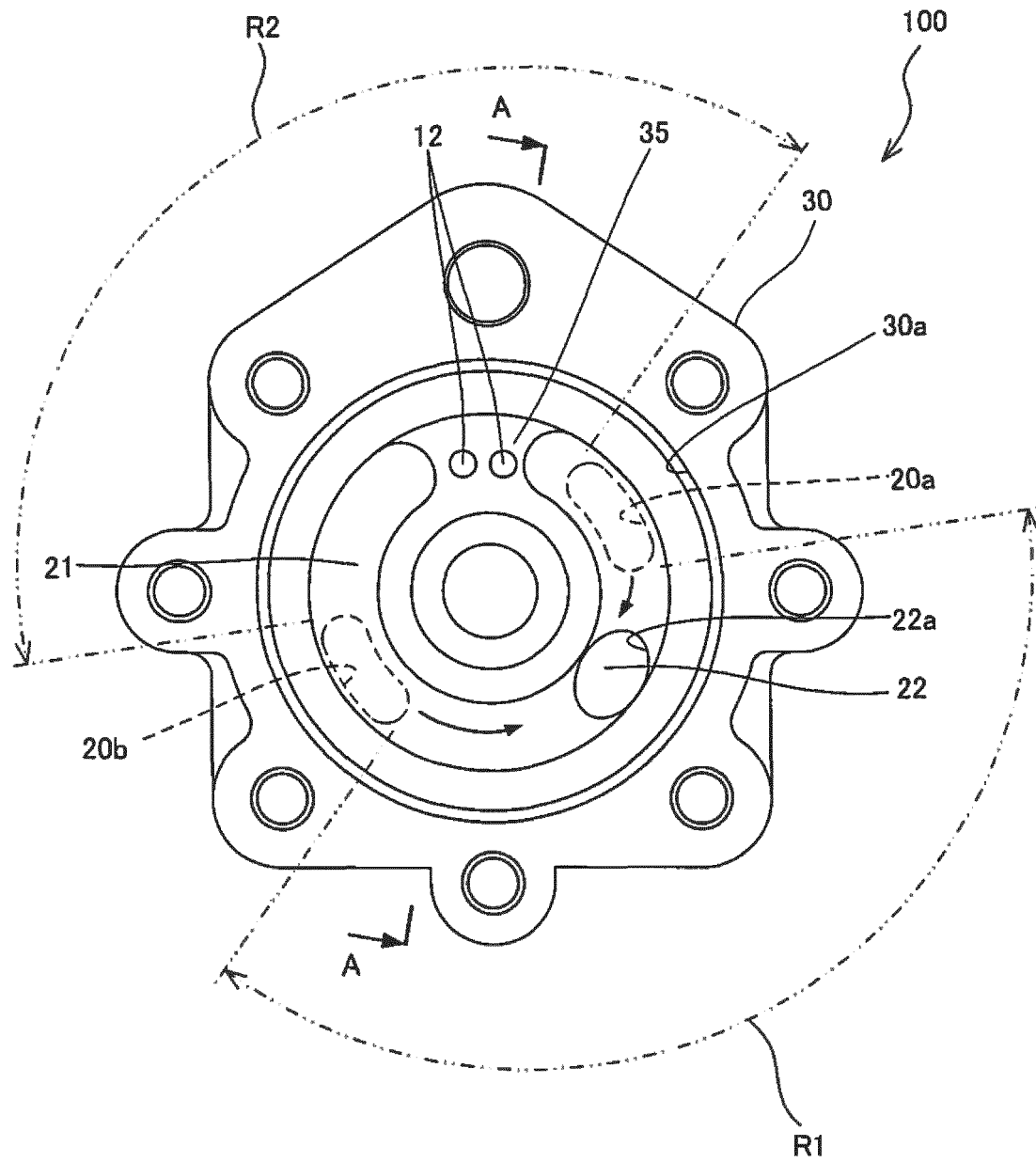


FIG.3

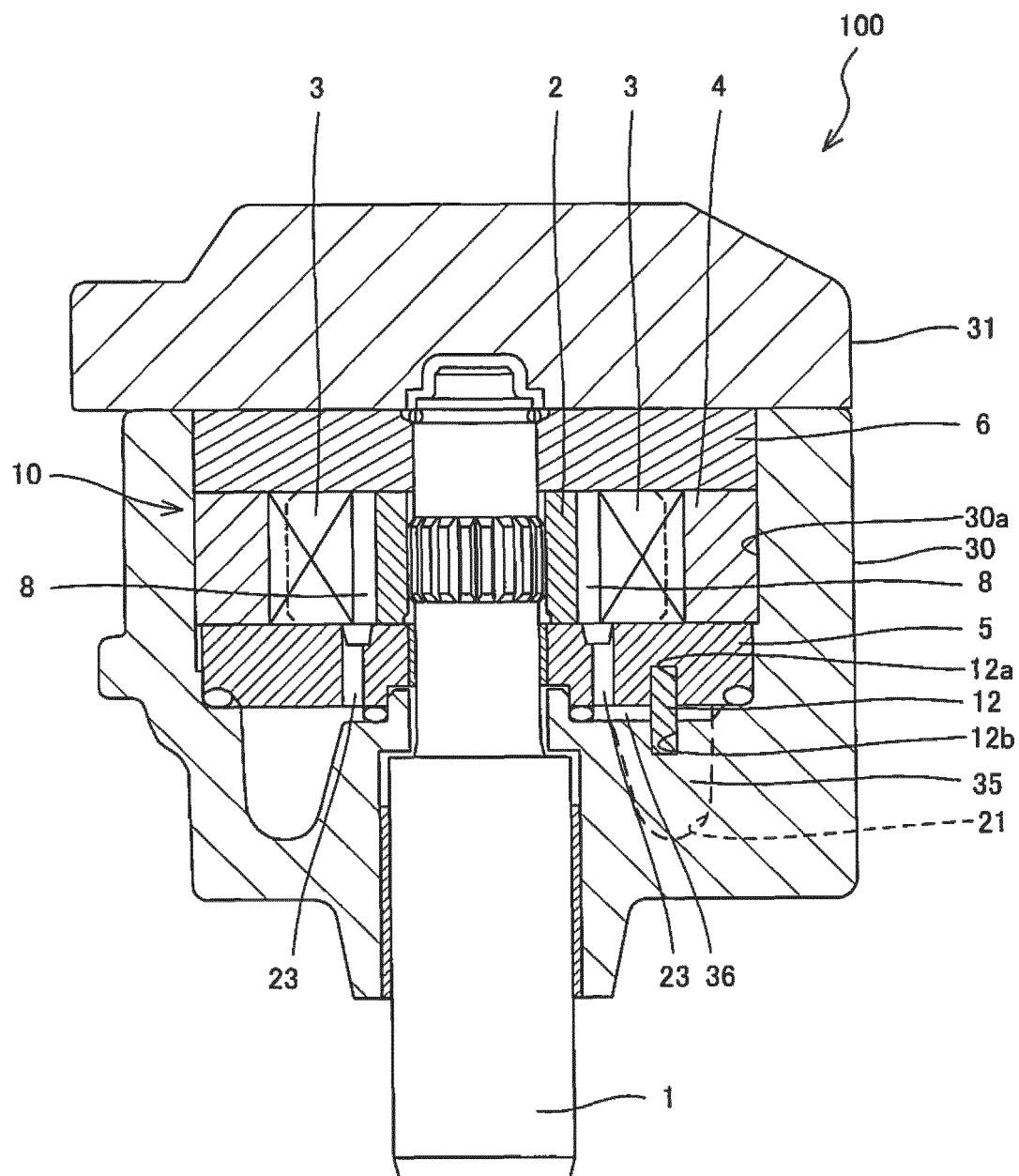


FIG.4

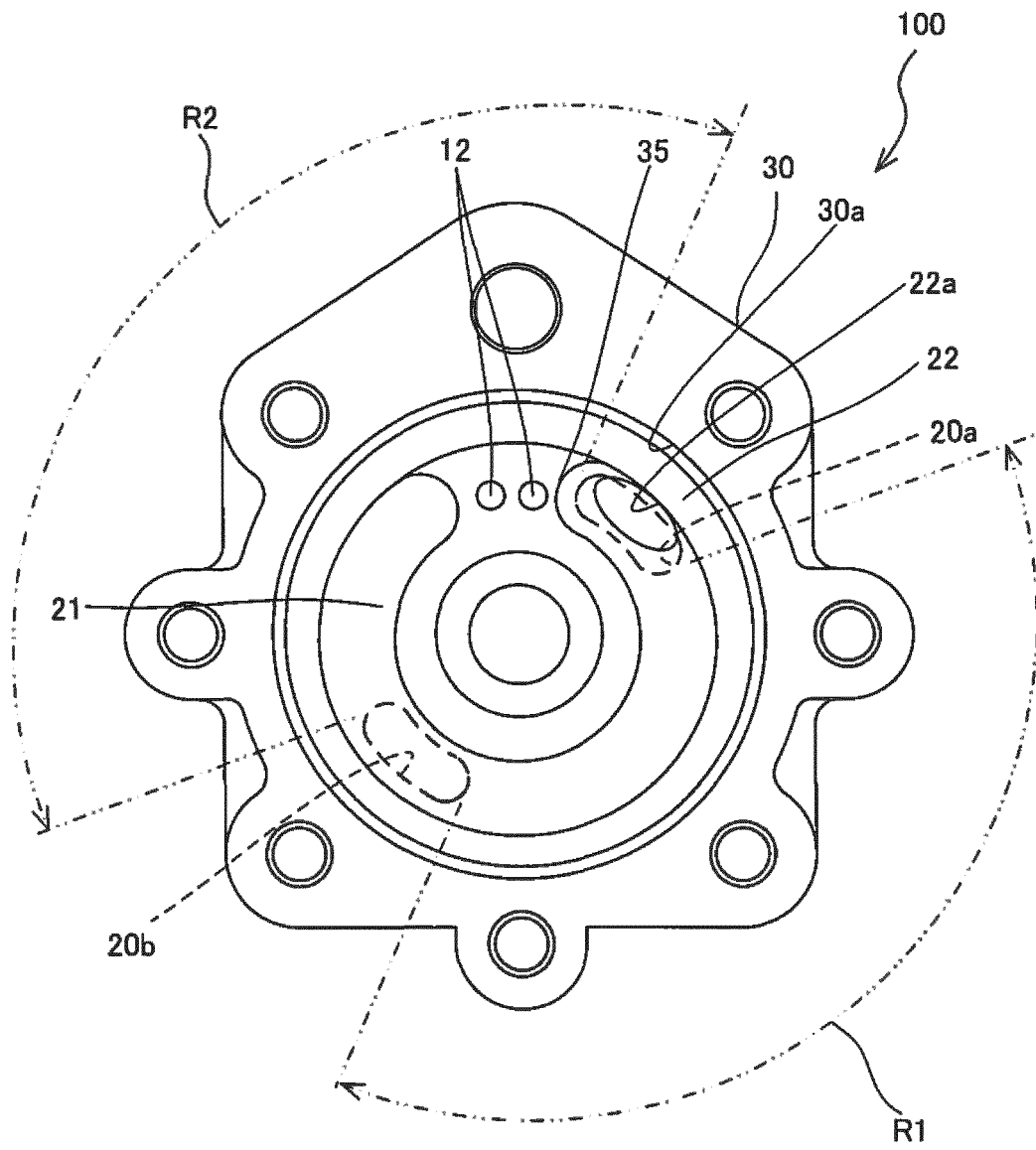


FIG.5

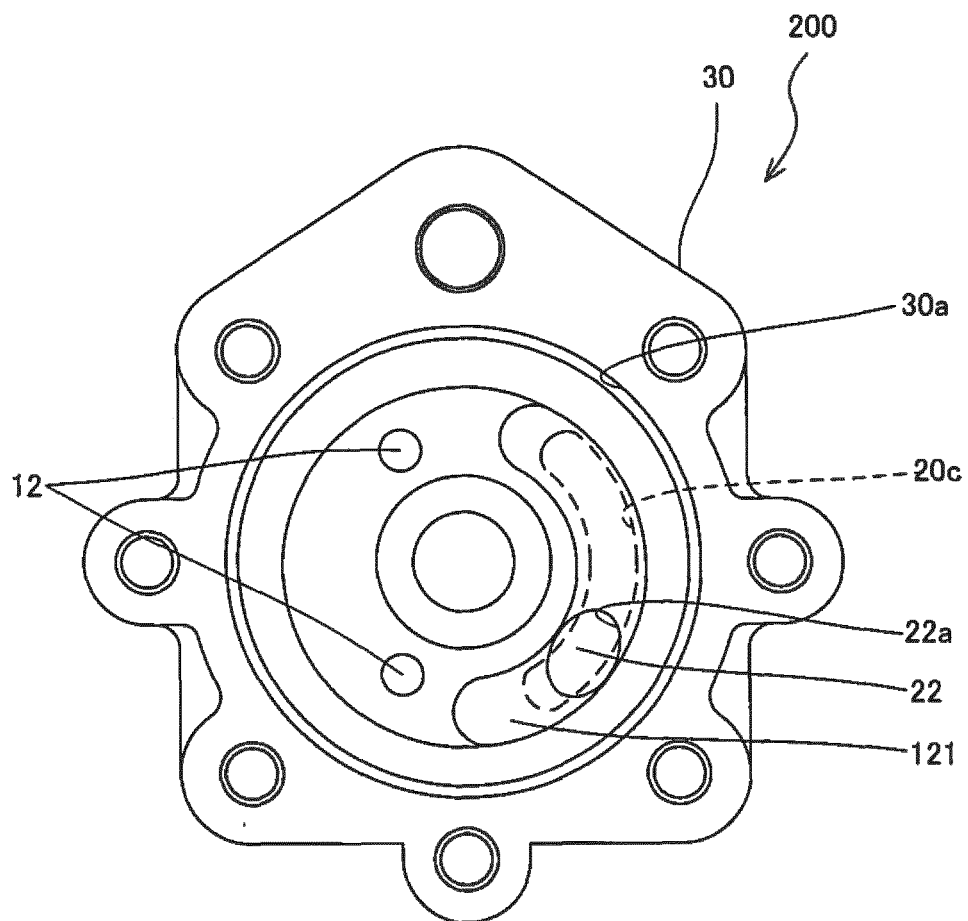


FIG.6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/075170

A. CLASSIFICATION OF SUBJECT MATTER

F04C2/344(2006.01)i, F04C15/00(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)

F04C2/344, F04C15/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2016
Kokai Jitsuyo Shinan Koho	1971-2016	Toroku Jitsuyo Shinan Koho	1994-2016

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2009-52526 A (Kayaba Industry Co., Ltd.), 12 March 2009 (12.03.2009), paragraphs [0011] to [0032]; fig. 1 to 2 (Family: none)	1-3 4
Y A	JP 2008-163787 A (Kayaba Industry Co., Ltd.), 17 July 2008 (17.07.2008), paragraphs [0002] to [0007]; fig. 3 to 4 (Family: none)	1-3 4
Y A	JP 2010-249067 A (Kayaba Industry Co., Ltd.), 04 November 2010 (04.11.2010), paragraphs [0031] to [0036]; fig. 1 to 2 (Family: none)	3 1-2, 4

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

* Special categories of cited documents:

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Date of the actual completion of the international search
15 November 2016 (15.11.16)Date of mailing of the international search report
29 November 2016 (29.11.16)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
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Patent documents cited in the description

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