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(54) **CARTRIDGE-TYPE VANE PUMP**

(57) The cartridge vane pump (100) includes a first connection channel (41a) that connects a first discharge port (7a) and a first discharge channel (93a) and a second connection channel (41b) that connects a second discharge port (7b) and a second discharge channel (93b).

An O-ring (82) is provided on an outer circumference of a circular tube portion (40c), the O-ring (82) blocks communication between the first connection channel (41a) and the second connection channel (41b).

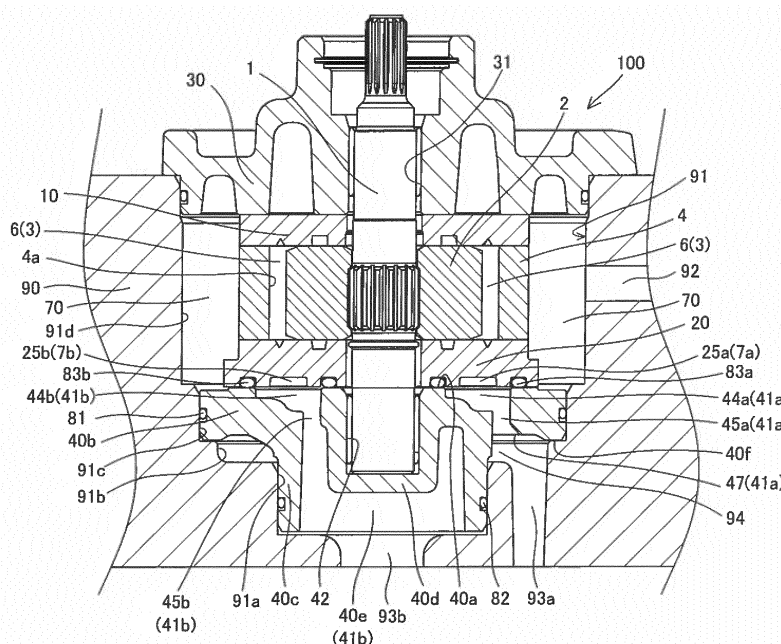


FIG.4

Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] JP2003-301781A discloses a cartridge vane pump that is configured so as to be attachable and detachable to/from a main body portion to be fixed to a base, a frame, and so forth.

[0003] JP2014-74368A discloses a balanced vane pump having two discharge ports.

SUMMARY OF INVENTION

[0004] In a fluid pressure device to which the cartridge vane pump disclosed in JP2003-301781A is installed, there is a request for using pressurized oil separately in two channels. Thus, it is thought to employ, for example, a configuration of the balanced vane pump having two discharge ports disclosed in JP2014-74368A.

[0005] However, with the vane pump disclosed in JP2014-74368A, a seal member is provided between a body-side side plate and a bottom surface of an accommodating concave portion of a pump body. If such a configuration is employed to the cartridge vane pump, there is a risk in that the seal member may fall off when the cartridge vane pump is attached to and detached from a main body portion of the fluid pressure device.

[0006] An object of the present invention is to provide a cartridge vane pump having two discharge ports with superior installability.

[0007] According to one aspect of the present invention, a cartridge vane pump is accommodated in an accommodating concave portion formed in a body of a fluid pressure device in an attachable and detachable manner. The cartridge vane pump includes: a rotor linked to a driving shaft, the rotor being configured to be rotationally driven; a plurality of slits formed in a radiating pattern so as to have opening portions at an outer circumference of the rotor; vanes respectively inserted into the slits in a freely slidable manner; a cam ring configured to have an inner circumference cam face with which tip end portions of the vanes are brought into sliding contact; pump chambers defined between the rotor, the cam ring, and the adjacent vanes; a cover member brought into contact with one end surfaces of the rotor and the cam ring, the cover member being fixed to the body; a side plate brought into contact with other end surfaces of the rotor and the cam ring; first and second discharge ports formed in the side plate, the first and second discharge ports being configured such that working fluid discharged from the pump chambers is guided thereinto; and an adapter formed with connection channels for respectively connecting the first and second discharge ports formed in

the side plate and first and second discharge channels formed in the body. The adapter has a main body portion configured to have a contact surface and an annular surface, the contact surface being brought into contact with the side plate, and the annular surface being configured to face a bottom surface of the accommodating concave portion and a circular tube portion configured to have a diameter smaller than that of the main body portion, the circular tube portion being configured to extend from the main body portion in an axial direction, and the circular tube portion being fitted into the accommodating concave portion. The connection channels have: a first connection channel formed between the contact surface and the annular surface so as to penetrate through the main body portion, the first connection channel being configured to connect the first discharge port and the first discharge channel; and a second connection channel formed so as to penetrate through the main body portion and so as to communicate with an internal space of the circular tube portion, the second connection channel being configured to connect the second discharge port and the second discharge channel, and a seal member is provided on an outer circumference of the circular tube portion, the seal member being configured to block communication between the first connection channel and the second connection channel.

BRIEF DESCRIPTION OF DRAWINGS

[0008]

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

[FIG. 2] FIG. 2 is an exploded perspective view of the cartridge vane pump according to the embodiment of the present invention viewed from the cover member side.

[FIG. 3] FIG. 3 is an exploded perspective view of the cartridge vane pump according to the embodiment of the present invention viewed from the adapter side.

[FIG. 4] FIG. 4 is a sectional view of the cartridge vane pump according to the embodiment of the present invention in the axial direction.

[FIG. 5] FIG. 5 is an enlarged view of a fastening member of the cartridge vane pump according to the embodiment of the present invention.

[FIG. 6] FIG. 6 is a plan view of the adapter of the cartridge vane pump according to the embodiment of the present invention.

[FIG. 7] FIG. 7 is a rear view of the adapter of the cartridge vane pump according to the embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0009] An embodiment of the present invention will be

described below with reference to drawings.

[0010] A cartridge vane pump 100 according to the embodiment of the present invention is used as a fluid pressure source for a fluid pressure device mounted on a vehicle, such as, for example, a power steering apparatus, a transmission, and so forth. Working oil, aqueous alternative fluid of other types, and so forth may be used as a working fluid.

[0011] The cartridge vane pump 100 (hereinafter, simply referred to as "a vane pump 100") is accommodated, in a state in which components are assembled in advance (the state shown in FIG. 1), in an accommodating concave portion 91 formed in a body 90 of the fluid pressure device in an attachable and detachable manner (see FIG. 4). As a motive force from an engine (not shown) is transmitted to an end portion of a driving shaft 1, a rotor 2 linked to the driving shaft 1 is rotated.

[0012] As shown in FIGs. 1 to 4, the vane pump 100 includes the rotor 2 that is rotationally driven by being linked to the driving shaft 1, a plurality of slits 2a that are formed in a radiating pattern so as to open at an outer circumference of the rotor 2, a plurality of vanes 3 that are respectively inserted into the slits 2a in a freely slidable manner so as to be capable of reciprocating in the radial direction of the rotor 2, and a cam ring 4 that accommodates the rotor 2 and that has an inner circumference cam face 4a on which tip end portions of the vanes 3 slide by rotation of the rotor 2.

[0013] At the base-end side of the slits 2a, back pressure chambers 5 into which discharge pressure from a pump is guided are defined. The vanes 3 are pushed by the pressure in the back pressure chambers 5 in the directions in which the vanes 3 are drawn out from the slits 2a, and the tip end portions of the vanes 3 are brought into contact with the inner circumference cam face 4a of the cam ring 4. With such a configuration, a plurality of pump chambers 6 are defined in the cam ring 4 by an outer circumferential surface of the rotor 2, the inner circumference cam face 4a of the cam ring 4, and the adjacent vanes 3.

[0014] The cam ring 4 is an annular member whose inner circumference cam face 4a has a substantially oval shape, and the cam ring 4 has suction regions at which the volumes of the pump chambers 6 are expanded as the rotor 2 is rotated and discharge regions at which the volumes of the pump chambers 6 are contracted as the rotor 2 is rotated. The respective pump chambers 6 are expanded/contracted by the rotation of the rotor 2. The vane pump 100 is a so-called balanced vane pump in which the cam ring 4 has two suction regions and two discharge regions. At the positions of both end surfaces corresponding to the two suction regions, the cam ring 4 is formed with cut-out portions 4e through which an outside and an inside of the cam ring 4 are communicated.

[0015] The vane pump 100 further includes a cover-side side plate 10 that is brought into contact with one end surfaces of the rotor 2 and the cam ring 4 (upper side in FIGs. 1 and 4), a body-side side plate 20 that is

brought into contact with other end surfaces of the rotor 2 and the cam ring 4 (lower side in FIGs. 1 and 4), and a cover 30 that is brought into contact with the cover-side side plate 10 and fixed to the body 90 of the fluid pressure device. A cover member is configured with the cover-side side plate 10 and the cover 30.

[0016] The cover-side side plate 10 and the body-side side plate 20 are arranged so as to sandwich the rotor 2 and the cam ring 4. Both end surfaces of the rotor 2 and the cam ring 4 are sandwiched by the cover-side side plate 10 and the body-side side plate 20, and thereby, the pump chambers 6 are sealed.

[0017] As shown in FIG. 3, the cover-side side plate 10 includes guide suction ports 11 that are formed such that parts of an outer edge portion are cut away so as to guide working oil into the pump chambers 6, discharging concave portions 12 that are respectively formed at positions corresponding to the two discharge regions, and a through hole 13 into which the driving shaft 1 is inserted.

[0018] The suction ports 11 are respectively formed at positions corresponding to two suction regions. The respective suction ports 11 are formed to have an arc shape centered at the through hole 13. The suction ports 11 communicate with a tank through a suction space 70 that is defined and formed to have a ring shape between the cam ring 4 and the body 90 of the fluid pressure device (shown in FIG. 4) and through a suction channel 92 formed in the body 90.

[0019] The discharging concave portions 12 are formed so as to have groove shape at positions corresponding to the two discharge regions. The respective discharging concave portions 12 are formed to have an arc shape centered at the through hole 13. The discharging concave portions 12 are provided so as to face first and second through holes 21a and 21b formed in the body-side side plate 20, which will be described later. The first and second through holes 21a and 21b are formed so as to sandwich the vanes 3. Because the discharging concave portions 12 communicate with the first and second through holes 21a and 21b through the pump chambers 6, the level of the pressure acting on the discharging concave portions 12 is the same as that for the first and second through holes 21a and 21b. Therefore, a force acting on the vanes 3 by the pressure in the first and second through holes 21a and 21b is cancelled out by the pressure in the discharging concave portions 12, and it is possible to prevent the vanes 3 from being pressed against the cover-side side plate 10.

[0020] As shown in FIG. 2, the body-side side plate 20 includes a sliding contact surface 20a with which the other end surface of the rotor 2 comes into sliding contact, the first and second through holes 21a and 21b that are formed in the sliding contact surface 20a so as to respectively correspond to the two discharge regions and that discharge the working oil in the pump chambers 6, a through hole 22 into which the driving shaft 1 is inserted, and suction concave portions 23 through which the suction space 70 is communicated with the pump chambers

6.

[0021] The first and second through holes 21a and 21b are provided at symmetrical positions centered around the through hole 22. The first and second through holes 21a and 21b are formed to have an arc shape centered at the through hole 22 and formed so as to penetrate through the body-side side plate 20.

[0022] The suction concave portions 23 are formed in the sliding contact surface 20a so as to correspond to the two suction regions. Outer circumference ends of the respective suction concave portions 23 reach an outer circumferential surface of the body-side side plate 20 and are formed to a concaved shape that opens towards the outside in the radial direction.

[0023] The sliding contact surface 20a of the body-side side plate 20 is formed with outer notches 26 and inner notches 27 that are grooves extending from the first and second through holes 21a and 21b in the direction opposite to the rotating direction of the rotor 2. The outer notches 26 are arranged at the outer circumferential side of the inner notches 27, and have longer lengths in the rotating direction of the rotor 2 than those of the inner notches 27.

[0024] The outer notches 26 and the inner notches 27 are both formed so as to have a tapered shape that narrows in the dimension in the radial direction of the rotor 2 towards the direction opposite to the rotating direction of the rotor 2 from the first and second through holes 21a and 21b. In addition, the outer notches 26 and the inner notches 27 are arranged at positions between the outer circumferential side of the outer circumferential surface of the rotor 2 and the inner circumferential side of the inner circumference cam face 4a of the cam ring 4.

[0025] In the sliding contact surface 20a of the body-side side plate 20, a pair of first back pressure grooves 24a are formed at symmetrical positions centered around the through hole 22, and a pair of second back pressure grooves 24b are respectively formed at the positions offset from the pair of the first back pressure grooves 24a by 90° with respect to the through hole 22 as the center.

[0026] The first back pressure grooves 24a are formed to have an arc shape centered at the through hole 22 and communicate with the back pressure chambers 5. The plurality of back pressure chambers 5 that open to the first back pressure grooves 24a communicate to each other through the first back pressure grooves 24a.

[0027] The second back pressure grooves 24b are formed to have an arc shape centered at the through hole 22 and communicate with the back pressure chambers 5. The plurality of back pressure chambers 5 that open to the second back pressure grooves 24b communicate to each other through the second back pressure grooves 24b.

[0028] As shown in FIG. 3, the body-side side plate 20 further includes first and second arc-shaped grooves 25a and 25b that open to the end surface on the other side of the sliding contact surface 20a and that communicate with the first and second through holes 21a and 21b,

respectively, a communication hole 28 through which the first and second arc-shaped grooves 25a and 25b communicate with the second back pressure grooves 24b and that is formed so as to penetrate through the body-side side plate 20, and O-rings 83a and 83b serving as seal members that respectively surround and seal outer circumferences of the first and second arc-shaped grooves 25a and 25b. The O-rings 83a and 83b are installed in grooves formed in the outer circumferences of the first and second arc-shaped grooves 25a and 25b of the body-side side plate 20 and are provided in a state in which the O-rings 83a and 83b are compressed between the body-side side plate 20 and an adapter 40, which will be described later.

[0029] The first and second arc-shaped grooves 25a and 25b are formed to have an arc shape centered at the through hole 22. The first through hole 21a and the communication hole 28 open to a bottom surface of the first arc-shaped groove 25a, and the second through hole 21b and the communication hole 28 open to a bottom surface of the second arc-shaped groove 25b. With such a configuration, the first through hole 21a communicates with the communication hole 28 through the first arc-shaped groove 25a, and the second through hole 21b communicates with the communication hole 28 through the second arc-shaped groove 25b. In the vane pump 100, the first through hole 21a and the first arc-shaped groove 25a form a first discharge port 7a, and the second through hole 21b and the second arc-shaped groove 25b form a second discharge port 7b.

[0030] The cover 30 is formed with a through hole 31 that supports the end portion of the driving shaft 1 via a sleeve. The cover 30 is fixed to the body 90 by inserting bolts (not shown) into a plurality of through holes 33 formed in an outer circumference portion of the cover 30.

[0031] The vane pump 100 further includes the adapter 40 that is formed with first and second connection channels 41a and 41b that respectively connect the first and second discharge ports 7a and 7b formed in the body-side side plate 20 and two discharge channels (first and second discharge channels 93a and 93b) formed in the body 90 (see FIG. 4).

[0032] As shown in FIG. 4, the adapter 40 includes a main body portion 40b having a contact surface 40a that is brought into contact with the body-side side plate 20 and an annular surface 40f that faces a bottom surface of a third concave portion 91c of the accommodating concave portion 91, which will be described later, a circular tube portion 40c that has a diameter smaller than that of the main body portion 40b and that extends from the main body portion 40b in the axial direction, a boss portion 40d that extends from the main body portion 40b into the circular tube portion 40c and that is formed with a support hole 42 for supporting the end portion of the driving shaft 1, and an annular recessed groove 47 that is formed in the annular surface 40f of the main body portion 40b.

[0033] The main body portion 40b is formed to have a circular plate shape. On an outer circumference of the

main body portion 40b, an ring-shaped O-ring 81 that prevents leakage of the working oil from between the main body portion 40b and the body 90 is provided.

[0034] The circular tube portion 40c is formed coaxial with the main body portion 40b and has an internal space 40e in the inside thereof. On outer circumference of the circular tube portion 40c, a ring-shaped O-ring 82 that blocks communication between the first connection channel 41a and the second connection channel 41b is provided.

[0035] The first connection channel 41a is formed so as to penetrate through the main body portion 40b between the contact surface 40a and the annular surface 40f, thereby connecting the first discharge port 7a and the first discharge channel 93a. Specifically, the first connection channel 41a is formed with an arc-shaped first opening portion 44a that opens to the contact surface 40a, the recessed groove 47 that opens to the annular surface 40f, and a through hole 45a that allows communication between the first opening portion 44a and the recessed groove 47. The first opening portion 44a is formed at a position facing the first arc-shaped groove 25a of the body-side side plate 20. The through hole 45a is formed to have an arc shape that extends along an outer circumferential surface of the circular tube portion 40c (see FIGs. 6 and 7). Because the recessed groove 47 is formed to have a ring shape, even in a case in which the first connection channel 41a of the vane pump 100 and the first discharge channel 93a of the fluid pressure device are not provided at positions facing each other, as long as the first discharge channel 93a opens so as to face the recessed groove 47, the first connection channel 41a is communicated with the first discharge channel 93a through the recessed groove 47.

[0036] As shown in FIG. 4, the second connection channel 41b is formed so as to penetrate through the main body portion 40b and to communicate with the internal space 40e of the circular tube portion 40c, and thereby, the second connection channel 41b connects the second discharge port 7b and the second discharge channel 93b. Specifically, the second connection channel 41b is formed with an arc-shaped second opening portion 44b that opens to the contact surface 40a, the internal space 40e of the circular tube portion 40c, and a through hole 45b that allows communication between the second opening portion 44b and the internal space 40e of the circular tube portion 40c. The second opening portion 44b is formed at a position facing the second arc-shaped groove 25b of the body-side side plate 20. The through hole 45b is formed to have an arc shape that extends along an outer circumferential surface of the boss portion 40d (see FIGs. 6 and 7). The second connection channel 41b communicates with the second discharge channel 93b formed in the body 90.

[0037] Next, a description will be given to a method of assembling the vane pump 100.

[0038] First, dowel pins 60 are press-fitted into insertion holes 34 formed in the cover 30. Next, these dowel

pins 60 are inserted into through holes 15 formed in the cover-side side plate 10, through holes 4c formed in the cam ring 4, and through holes 29b formed in the body-side side plate 20 in this order, and finally, the dowel pins 60 are inserted into insertion holes 46 formed in the adapter 40. With such a configuration, the cover 30, the cover-side side plate 10, the cam ring 4, the body-side side plate 20, and the adapter 40 are assembled in a stacked state. The driving shaft 1, the rotor 2, and the vanes 3 are assembled inside the cam ring 4 when the cam ring 4 is inserted. By doing so, the dowel pins 60 penetrate through the cam ring 4 such that both ends of the dowel pins 60 are supported by the cover 30 and the adapter 40, and thereby, relative rotation between the cover 30, the cover-side side plate 10, the body-side side plate 20, and the adapter 40 with respect to the cam ring 4 is prevented. In other words, the dowel pins 60 achieve a positioning function for these members at the time of assembling and achieve a rotation locking function for preventing the relative rotation of the cover-side side plate 10 and the body-side side plate 20 with respect to the cam ring 4 after assembly.

[0039] The cover 30, the cover-side side plate 10, the cam ring 4, the body-side side plate 20, and the adapter 40 stacked as described above are integrally held by two head pins 50 serving as joining members. A specific description of the head pins 50 will be given below.

[0040] As shown in FIGs. 2 and 3, the head pins 50 have shaft portions 51 tip ends of which are fixed to engaging holes 43 formed in the adapter 40 and restricting portions 52 that have diameters larger than those of the shaft portions 51 and formed on base ends of the head pins 50. The shaft portions 51 penetrate through through holes 32 formed in the cover 30, through holes 14 formed in the cover-side side plate 10, through hole 4b formed in the cam ring 4, and through hole 29a formed in the body-side side plate 20, and the tip ends of the shaft portions 51 are press-fitted to the engaging holes 43. With such a configuration, the cover 30, the cover-side side plate 10, the cam ring 4, and the body-side side plate 20 are held in an integrated state between the restricting portions 52 of the head pins 50 and the adapter 40. Two head pins 50 are provided at symmetrical positions centered around the driving shaft 1. The head pins 50 may be fixed to the adapter 40 by providing male screw portions on the tip end portions of the shaft portions 51, and by screwing the tip end portions into female screw portions formed in the engaging holes 43.

[0041] As described above, the vane pump 100 is held in the integrated state with the head pins 50. With such a configuration, when the vane pump 100 is installed to the body 90, specifically, when the vane pump 100 is transported in order to install it to the body 90 or when the vane pump 100 is mounted to the accommodating concave portion 91 of the body 90, it is possible to prevent the vane pump 100 from being disassembled into separate parts. Therefore, an installability is improved. In addition, also when the vane pump 100 is to be removed

from the body 90, because the vane pump 100 is held in the integrated state, it is easy to remove the vane pump 100.

[0042] In a state in which the vane pump 100 is installed to the body 90 of the fluid pressure device, specifically, in a state in which the vane pump 100 is accommodated in the accommodating concave portion 91 of the body 90 and the cover 30 is fixed to the body 90, as shown in FIG. 5, there is a gap S between the cover 30 and the restricting portions 52 of the head pins 50. When the pressure in the pump chambers 6 has become high as the vane pump 100 is driven, there is a risk in that the cover 30 undergoes a deformation (distortion) such that the vicinity of the central part of the cover 30 is lifted up. With the vane pump 100, because the gap S is formed between the cover 30 and the restricting portions 52 of the head pins 50, it is possible to allow such a deformation of the cover 30. In other words, because a force pulling out the head pins 50 is not applied to the restricting portions 52 of the head pins 50 due to the deformation of the cover 30, it is possible to prevent the head pins 50 from being loosened or damaged. As described above, because the vane pump 100 is held in the integrated state by the head pins 50, the vane pump 100 is not disassembled into separate parts when the vane pump 100 is to be removed. As long as sufficient strength is secured for the cover 30 and the cover-side side plate 10, the gap S may not be provided.

[0043] In the above-mentioned embodiment, although a case in which two head pins 50 are used is described as an example, the configuration is not limited thereto, and the number of the head pins 50 may be more than two (about three to six) as long as an enough space can be secured. As the number of the head pins 50 increases, a holding force holding the integrated state of the vane pump 100 is correspondingly improved. In contrast, as the number of the head pins 50 decreases, the size of the vane pump 100 can be reduced correspondingly. By providing two head pins 50 at symmetrical positions centered around the driving shaft, it is possible to stably hold the integrated state with the minimum number of pins. In addition, by configuring the head pins 50 such that the tip end portions thereof are press-fitted to the engaging holes 43, it is possible to omit threading of the head pins 50 and the engaging holes 43.

[0044] The vane pump 100 thus assembled is mounted in the accommodating concave portion 91 of the body 90 and is fixed to the body 90 by screwing, into the body 90, the bolts inserted into the through holes 33 of the cover 30.

[0045] Next, a description will be given to the accommodating concave portion 91 of the body 90.

[0046] As shown in FIG. 4, the accommodating concave portion 91 of the body 90 has, in this order from the bottom surface side, a first concave portion 91a to which the second discharge channel 93b opens at a bottom surface thereof, a second concave portion 91b that has the diameter larger than that of the first concave portion

91a and to which the first discharge channel 93a opens at the bottom surface thereof, the third concave portion 91c that has the diameter larger than that of the second concave portion 91b and into which the main body portion 40b of the adapter 40 is inserted, and a fourth concave portion 91d that is formed to have the diameter larger than that of the third concave portion 91c and that has the above-described suction space 70 formed between the fourth concave portion 91d and the vane pump 100.

[0047] In a state in which the vane pump 100 is accommodated in the accommodating concave portion 91, the circular tube portion 40c of the adapter 40 is fitted into the first concave portion 91a, and the main body portion 40b of the adapter 40 is fitted into the third concave portion 91c. At this time, the annular surface 40f of the main body portion 40b faces the bottom surface of the third concave portion 91c. With such a configuration, a ring-shaped high-pressure chamber 94 is defined by the second concave portion 91b, the third concave portion 91c, the main body portion 40b of the adapter 40, and the outer circumference of the circular tube portion 40c, in other words, the high-pressure chamber 94 is defined between the main body portion 40b of the adapter 40 and the bottom surfaces of the second concave portion 91b and the third concave portion 91c. Into the high-pressure chamber 94, the high-pressure working oil that has been discharged from the pump chambers 6 is guided through the first through hole 21a, the first arc-shaped groove 25a, the first opening portion 44a, the through hole 45a, and the recessed groove 47. The working oil that has been guided into the high-pressure chamber 94 then flows out to the first discharge channel 93a.

[0048] The body-side side plate 20, the cam ring 4, and the cover-side side plate 10 are accommodated in the fourth concave portion 91d, and the fourth concave portion 91d is closed by attaching the cover 30 to the body 90. The ring-shaped suction space 70 that is in communication with the above-described suction channel 92 is formed between the fourth concave portion 91d and the vane pump 100 (the body-side side plate 20, the cam ring 4, and the cover-side side plate 10).

[0049] Next, a description will be given to an operation of the vane pump 100.

[0050] As the driving shaft 1 is rotationally driven by a motive force generated by a driving device, such as an engine (not shown), the rotor 2 is rotated. As the rotor 2 is rotated, the pump chambers 6 positioned at the two suction regions are expanded. With such a configuration, the working oil in the tank is sucked into the pump chambers 6 through the suction channel 92, the suction space 70, the cut-out portions 4e, the suction ports 11, and the suction concave portions 23. In addition, the pump chambers 6 positioned at the two discharge regions are contracted as the rotor 2 is rotated. With such a configuration, the working oil in the pump chambers 6 in the one of the discharge regions is supplied to a hydraulic apparatus (not shown) through the first discharge port 7a (the first through hole 21a and the first arc-shaped groove 25a),

the first connection channel 41a (the first opening portion 44a, the through hole 45a, and the recessed groove 47), the high-pressure chamber 94, and the first discharge channel 93a, and the working oil in the pump chambers 6 in the other of the discharge regions is supplied to the hydraulic apparatus (not shown) through the second discharge port 7b (the second through hole 21b and the second arc-shaped groove 25b), the second connection channel 41b (the second opening portion 44b, the through hole 45b, and the internal space 40e), and the second discharge channel 93b. With the vane pump 100, as the rotor 2 completes a full rotation, the respective pump chambers 6 repeat the suction and discharge of the working oil twice.

[0051] A part of the working oil that has been discharged to the first and second discharge ports 7a and 7b (the first and second arc-shaped grooves 25a and 25b) is respectively supplied to the back pressure chambers 5 through the communication hole 28 and the second back pressure grooves 24b, and base-end portions 3b of the vanes 3 are pushed towards the inner circumference cam face 4a. Therefore, the vanes 3 are biased in the directions in which the vanes 3 project out from the slits 2a by a fluid pressure in the back pressure chambers 5 that pushes the base-end portions 3b and by the centrifugal force that is caused by the rotation of the rotor 2. With such a configuration, because the rotor 2 rotated while the tip end portions 3a of the vanes 3 are brought into sliding contact with the inner circumference cam face 4a of the cam ring 4, the working oil in the pump chambers 6 is discharged from the pump chambers 6 without leaking out from between the tip end portions 3a of the vanes 3 and the inner circumference cam face 4a of the cam ring 4.

[0052] In the state in which the vane pump 100 is accommodated in the accommodating concave portion 91 of the body 90, the main body portion 40b of the adapter 40 is brought into contact with the bottom surface of the third concave portion 91c of the accommodating concave portion 91. Furthermore, the O-rings 83a and 83b are provided between the adapter 40 and the body-side side plate 20 in a compressed state. With such a configuration, because the body-side side plate 20 is constantly pushed against the end surface of the rotor 2 by an elastic force exerted by the O-rings 83a and 83b, it is possible to prevent a leakage of the working oil from between the body-side side plate 20 and the rotor 2. Therefore, the discharge efficiency of the vane pump 100 is improved. As described above, in addition to a function as seal members that surround and seal the outer circumference of the first and second arc-shaped grooves 25a and 25b, the O-rings 83a and 83b also has a function of biasing members that constantly bias the body-side side plate 20 against the end surface of the rotor 2.

[0053] As the high-pressure working oil is discharged from the pump chambers 6, the pressure of the working oil in the first and second arc-shaped grooves 25a and 25b is also increased. With such a configuration, the

body-side side plate 20 is pushed against the end surface of the rotor 2. Furthermore, the high-pressure working oil is guided from the pump chambers 6 also into the high-pressure chamber 94 through the first discharge port 7a and the first connection channel 41a. With such a configuration, by the pressure of the working oil in the high-pressure chamber 94, the adapter 40 is separated away from the bottom surface of the third concave portion 91c and is pushed against the body-side side plate 20. With such a configuration, the adapter 40 biases the body-side side plate 20 towards the rotor 2 by the high-pressure working oil that has been guided into the high-pressure chamber 94 and pushes the body-side side plate 20 against the end surface of the rotor 2.

[0054] As the pressure in the pump chambers 6 is increased, the body-side side plate 20 is no longer pushed towards the rotor 2 sufficiently with only the elastic force exerted by the O-rings 83a and 83b. However, as the pressure in the pump chambers 6 is increased, in addition to the biasing force exerted by the elasticity of the O-rings 83a and 83b, the body-side side plate 20 is pushed against the rotor 2 also by the pressure of the working oil in the first and second arc-shaped grooves 25a and 25b and by the pressure of the working oil acting on the adapter 40. Therefore, even when the pressure in the pump chambers 6 is high, it is possible to prevent the leakage of the working oil from between the body-side side plate 20 and the rotor 2.

[0055] In addition, in a state in which the high-pressure working oil has been guided into the internal space 40e and the high-pressure chamber 94, because the adapter 40 is pushed against the body-side side plate 20, the O-rings 83a and 83b are strongly compressed between the adapter 40 and the body-side side plate 20. With such a configuration, even if the pressure of the working oil in the first and second arc-shaped grooves 25a and 25b is increased, it is possible to prevent the O-rings 83a and 83b from being squeezed out from the grooves.

[0056] According to the embodiment mentioned above, the advantages described below are afforded.

[0057] In the vane pump 100, the O-ring 82 that blocks the communication between the first connection channel 41a and the second connection channel 41b is provided on the outer circumference of the circular tube portion 40c. In addition, the O-ring 81 is provided on the outer circumference of the main body portion 40b. With such a configuration, it is possible to prevent the O-ring 81 and the O-ring 82 from falling off during its installation to the body 90 of the vane pump 100, for example. Therefore, the vane pump 100 has a superior installability.

[0058] In addition, there is no need to perform sealing by bringing the circular tube portion 40c into contact with the bottom surface of the first concave portion 91a of the body 90, and thereby, the processing accuracy is not required in the axial direction of the adapter 40. With such a configuration, it is possible to reduce the processing time.

[0059] The main body portion 40b of the adapter 40 is

formed to have a circular plate shape, and the circular tube portion 40c is formed to have circular tube shape. With such a configuration, the O-rings 81 and 82 that are provided in the main body portion 40b and the circular tube portion 40c can be formed to have a ring shape. Therefore, the O-rings 81 and 82 can have a simple shape, and the O-rings 81 and 82 can be manufactured easily. Furthermore, by forming the main body portion 40b and the circular tube portion 40c coaxially, it is possible to make the processing of the adapter 40 easier and to improve a processing accuracy.

[0060] The vane pump 100 includes the body-side side plate 20 that is brought into contact with the other end surfaces of the rotor 2 and the cam ring 4, and the adapter 40 that is formed with the first and second connection channels 41a and 41b for connecting the first and second discharge ports 7a and 7b formed in the body-side side plate 20 to the first and second discharge channels 93a and 93b formed in the body 90. By appropriately altering the configuration of the adapter 40, regardless of positional deviations and differences in the shape of the first and second discharge ports 7a and 7b formed in the body-side side plate 20 and the first and second discharge channels 93a and 93b formed in the body 90, it is possible to connect the first and second discharge ports 7a and 7b and the first and second discharge channels 93a and 93b, respectively. Furthermore, because there is no need to form the first and second discharge channels 93a and 93b of the body 90 in accordance with the shapes and the positions of the first and second arc-shaped grooves 25a and 25b, a degree of freedom for designing is improved.

[0061] The cartridge vane pump is mounted on various fluid pressure devices. Therefore, arrangement of the first and second discharge channels 93a and 93b may be different depending on the fluid pressure device. In addition, because the body-side side plate 20 slides on the rotor 2, the body-side side plate 20 is formed of an iron-type sintered metal having superior durability. A processability of such an iron-type sintered metal is poor, and a cost of the material itself is high, and therefore, if the body-side side plate 20 is formed so as to be adapted to the positions of the first and second discharge channels 93a and 93b, increase in the cost will be incurred. Thus, with the vane pump 100, a member for connecting the first and second discharge ports 7a and 7b formed in the body-side side plate 20 and the first and second discharge channels 93a and 93b formed in the body 90 is formed as the adapter 40 that is separate from the body-side side plate 20, and the adapter 40 is further formed of an aluminum alloy having superior processability. With such a configuration, even if arrangements and shapes of the first and second discharge channels 93a and 93b of the fluid pressure device are different, it is possible to use common body-side side plate 20. Furthermore, because the processing time can be reduced by using the aluminum alloy, the adapter 40 can be manufactured easily, and at the same time, because the ma-

terial cost can be reduced, it is possible to suppress the increase in the cost. In addition, by using the aluminum alloy having less relative density than an iron, it is possible to achieve weight reduction of the vane pump 100. In addition, because the body-side side plate 20 is formed of the iron-type sintered metal, the durability is improved and seizing with the rotor 2 is prevented.

[0062] Because the pressure on the discharge side is low at a starting time of the vane pump 100, the body-side side plate 20 cannot be pushed against the end surface of the rotor 2 depending on the discharge-side pressure. Therefore, the leakage of the working oil in the pump chambers 6 is caused from between the body-side side plate 20 and the rotor 2, and the discharge efficiency of the pump is deteriorated. Thus, with the vane pump 100, the O-rings 83a and 83b are provided between the adapter 40 and the body-side side plate 20 so as to be compressed. With such a configuration, because the body-side side plate 20 is pushed against the end surface of the rotor 2 by the elastic force exerted by the O-rings 83a and 83b, it is possible to prevent the leakage from between the body-side side plate 20 and the rotor 2 even when the pressure of the vane pump 100 is low. Furthermore, because the O-rings 83a and 83b also function as the seal members for the first and second arc-shaped grooves 25a and 25b, it is possible to reduce a number of components.

[0063] In addition, because the body-side side plate 20 is constantly pushed against the end surface of the rotor 2 by the elastic force exerted by the O-rings 83a and 83b, a force pushing the body-side side plate 20 against the rotor 2 need not be generated by the head pins 50. Therefore, it is possible to make the head pins 50 thinner or to reduce a number thereof.

[0064] With the vane pump 100, by providing the O-rings 83a and 83b, it is possible to allow dimension errors of the respective members constituting the vane pump 100. Specifically, even if the total dimension of the main body portion 40b of the adapter 40, the body-side side plate 20, the cam ring 4, the cover-side side plate 10, and a part of the cover 30 that is inserted into the accommodating concave portion 91 in the axial direction of the driving shaft 1 is less than a depth dimension of the third concave portion 91c to the bottom surface thereof, it is possible to allow the dimension error by the possible compressed amount of the O-rings 83a and 83b.

[0065] Instead of using the O-rings 83a and 83b, a biasing member may be provided between, for example, the main body portion 40b of the adapter 40 and the bottom surface of the third concave portion 91c of the body 90. In this case, the biasing member is not limited to the O-ring, and a member such as a disc spring etc. may also be employed.

[0066] With the vane pump 100, the ring-shaped high-pressure chamber 94 into which the high-pressure working oil that has been discharged from the pump chambers 6 is guided is defined between the adapter 40 and the bottom surface of the body 90. Because the high pressure

discharged from the pump chambers 6 acts on the entire annular surface 40f of the main body portion 40b, it is possible to strongly push the body-side side plate 20 against the end surface of the rotor 2.

[0067] The configurations, operations, and effects of the embodiment of the present invention configured as described above will be collectively described.

[0068] The cartridge vane pump 100 includes: the rotor 2 that is rotationally driven by being linked to the driving shaft 1; the plurality of slits 2a that are formed in a radiating pattern so as to open at the outer circumference of the rotor 2; the vanes 3 that are respectively inserted into the slits 2a in a freely slidable manner; the cam ring 4 that has the inner circumference cam face 4a with which the tip end portions of the vanes 3 are brought into sliding contact; the pump chambers 6 that are defined by the rotor 2, the cam ring 4, and the adjacent vanes 3; the cover members (the cover 30 and the cover-side side plate 10) that are brought into contact with the one end surfaces of the rotor 2 and the cam ring 4 and that are fixed to the body 90; the body-side side plate 20 that is brought into contact with the other end surfaces of the rotor 2 and the cam ring 4; the first and second discharge ports 7a and 7b that are formed in the body-side side plate 20 and into which the working fluid discharged from the pump chambers 6 is guided; and the adapter 40 that is formed with the connection channels (the first connection channel 41a and the second connection channel 41b) for respectively connecting the first and second discharge ports 7a and 7b formed in the body-side side plate 20 and the first and second discharge channels 93a and 93b formed in the body 90. In this configuration, the adapter 40 has: the main body portion 40b having the contact surface 40a that is brought into contact with the body-side side plate 20 and the annular surface 40f that faces the bottom surface of the accommodating concave portion 91; and the circular tube portion 40c that has a diameter smaller than that of the main body portion 40b, that extends from the main body portion 40b in the axial direction, and that is fit into the accommodating concave portion 91. The connection channels (the first connection channel 41a and the second connection channel 41b) are the first connection channel 41a and the second connection channel 41b. The first connection channel 41a is formed between the contact surface 40a and the annular surface 40f so as to penetrate through the main body portion 40b and connects the first discharge port 7a and the first discharge channel 93a. The second connection channel 41b that is formed so as to penetrate through the main body portion 40b and so as to be in communication with the internal space 40e of the circular tube portion 40c and that connects the second discharge port 7b and the second discharge channel 93b. The outer circumference of the circular tube portion 40c is provided with the seal member (the O-ring 82) that blocks communication between the first connection channel 41a and the second connection channel 41b.

[0069] According to this configuration, because the

seal member (the O-ring 82) is provided on the outer circumference of the circular tube portion 40c, it is possible to prevent the seal member (the O-ring 82) from falling off during attachment and detachment of the cartridge vane pump 100. Therefore, the cartridge vane pump 100 has a superior installability.

[0070] In addition, in the cartridge vane pump 100, the main body portion 40b is formed to have a circular plate shape, and the main body portion 40b and the circular tube portion 40c are formed coaxially.

[0071] According to this configuration, because the main body portion 40b and the circular tube portion 40c are formed coaxially, it is possible to make the processing of the adapter 40 easier and to improve a processing accuracy.

[0072] 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.

[0073] In addition, the cover 30 may be formed integrally with the cover-side side plate 10. As long as the high-pressure chamber 94 is formed, the recessed groove 47 may not be formed.

[0074] This application claims priority based on Japanese Patent Application No.2015-185588 filed with the Japan Patent Office on September 18, 2015, the entire contents of which are incorporated into this specification.

Claims

1. A cartridge vane pump accommodated in an accommodating concave portion formed in a body of a fluid pressure device in an attachable and detachable manner, the cartridge vane pump comprising:

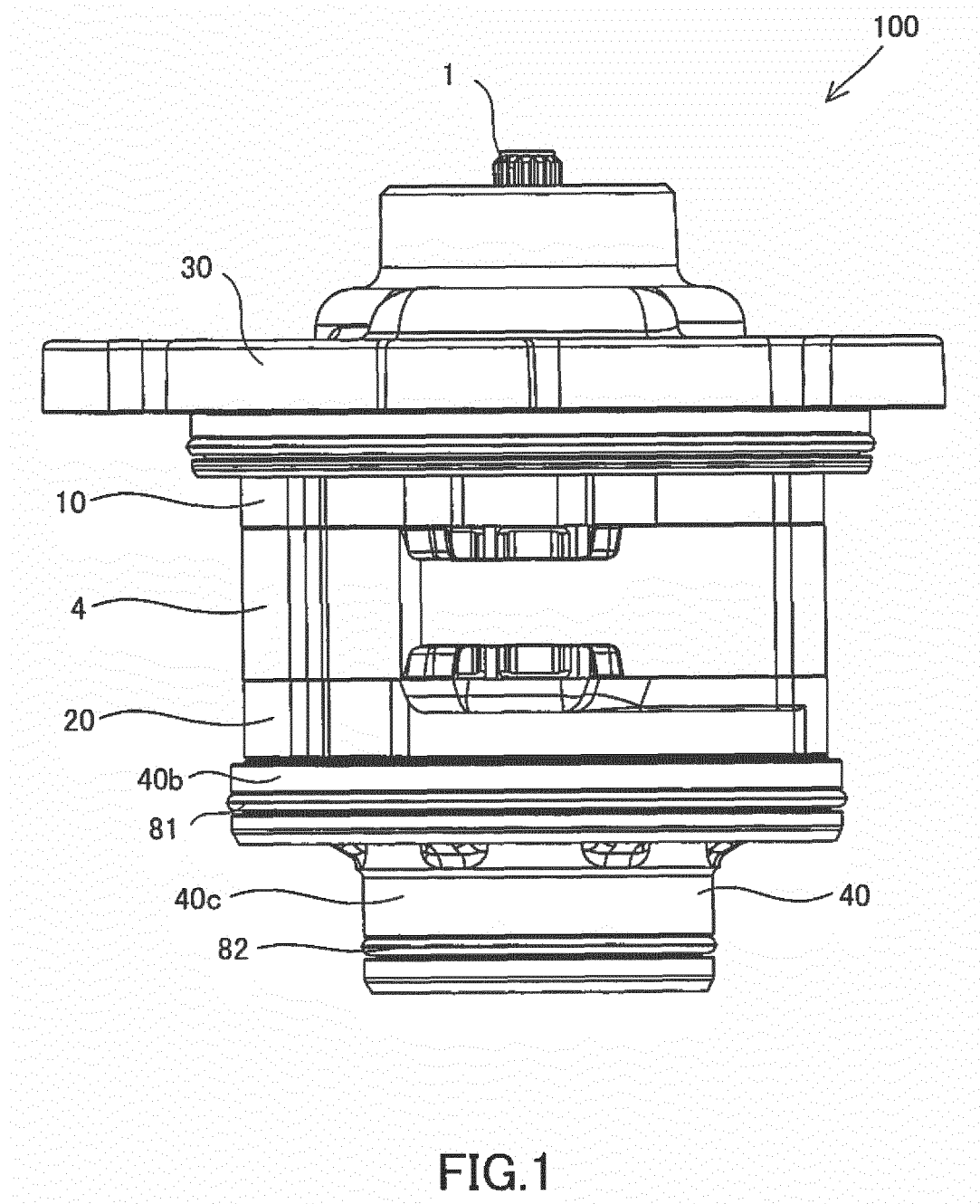
a rotor linked to a driving shaft, the rotor being configured to be rotation ally driven;
a plurality of slits formed in a radiating pattern so as to have opening portions at an outer circumference of the rotor;
vanes respectively inserted into the slits in a freely slidable manner;
a cam ring configured to have an inner circumference cam face with which tip end portions of the vanes are brought into sliding contact;
pump chambers defined between the rotor, the cam ring, and the adjacent vanes;
a cover member brought into contact with one end surfaces of the rotor and the cam ring, the cover member being fixed to the body;
a side plate brought into contact with other end surfaces of the rotor and the cam ring;
first and second discharge ports formed in the side plate, the first and second discharge ports being configured such that working fluid discharged from the pump chambers is guided

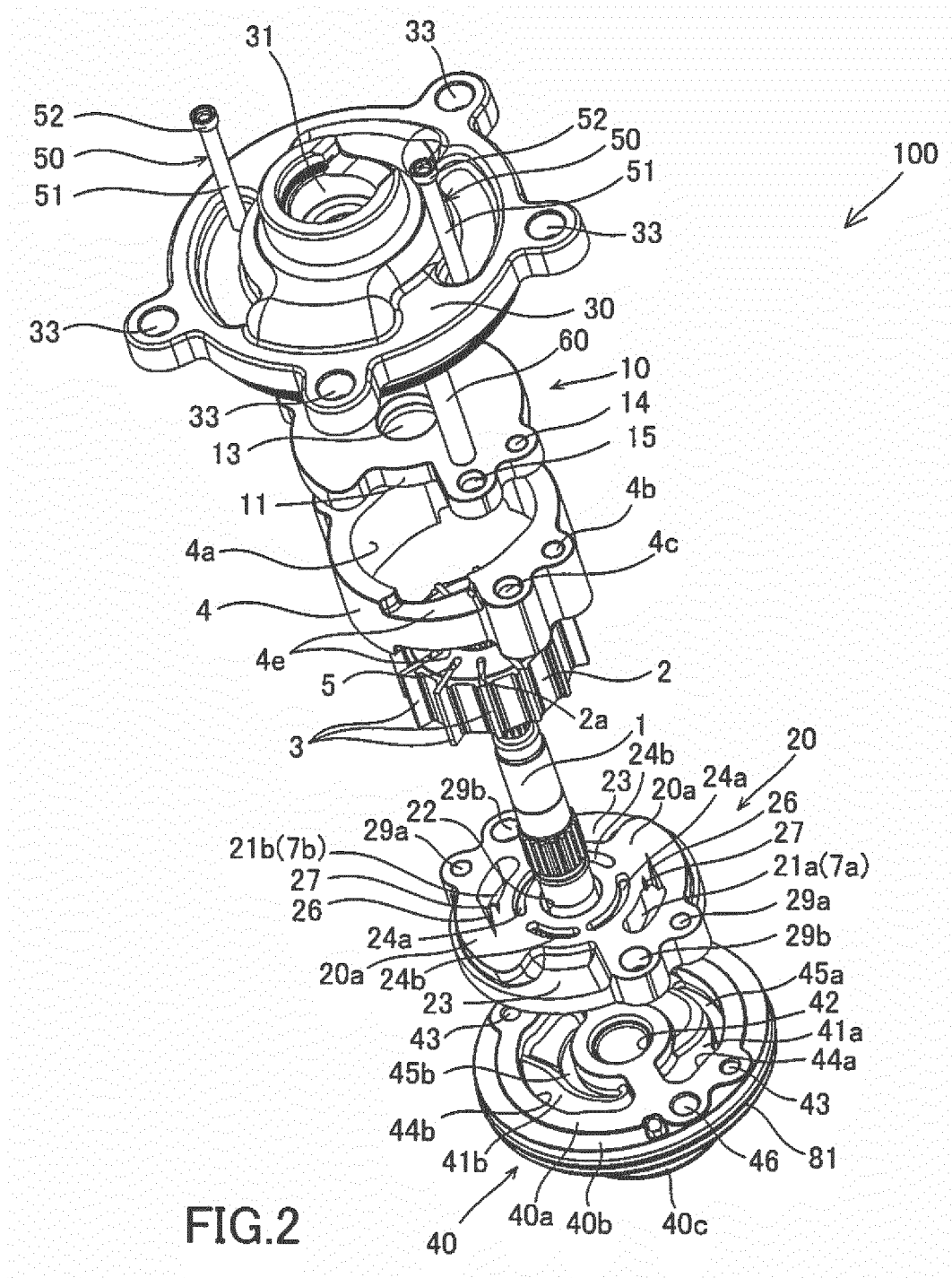
thereinto; and
 an adapter formed with connection channels for
 respectively connecting the first and second dis-
 charge ports formed in the side plate and first
 and second discharge channels formed in the 5
 body, wherein
 the adapter has
 a main body portion configured to have a contact
 surface and an annular surface, the contact sur-
 face being brought into contact with the side 10
 plate, and the annular surface being configured
 to face a bottom surface of the accommodating
 concave portion and
 a circular tube portion configured to have a di- 15
 ameter smaller than that of the main body por-
 tion, the circular tube portion being configured
 to extend from the main body portion in an axial
 direction, and the circular tube portion being fit-
 ted into the accommodating concave portion,
 the connection channels have 20
 a first connection channel formed between the
 contact surface and the annular surface so as
 to penetrate through the main body portion, the
 first connection channel being configured to
 connect the first discharge port and the first dis- 25
 charge channel and
 a second connection channel formed so as to
 penetrate through the main body portion and so
 as to communicate with an internal space of the
 circular tube portion, the second connection 30
 channel being configured to connect the second
 discharge port and the second discharge chan-
 nel, and
 a seal member is provided on an outer circum- 35
 ference of the circular tube portion, the seal
 member being configured to block communica-
 tion between the first connection channel and
 the second connection channel.

2. The cartridge vane pump according to claim 1, 40
 wherein
 the main body portion is formed to have a circular
 plate shape, and
 the main body portion and the circular tube portion
 are formed coaxially. 45

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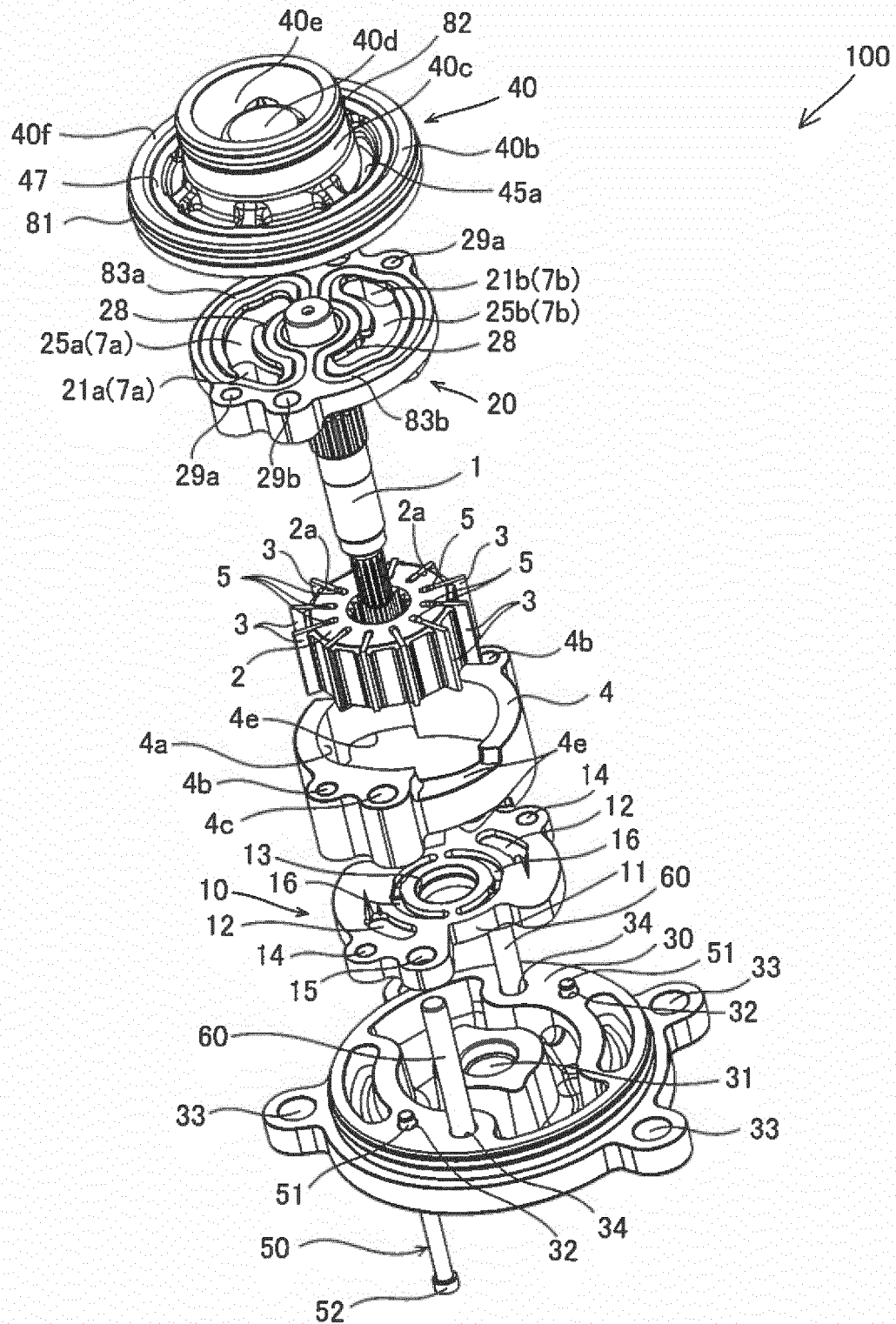


FIG.3

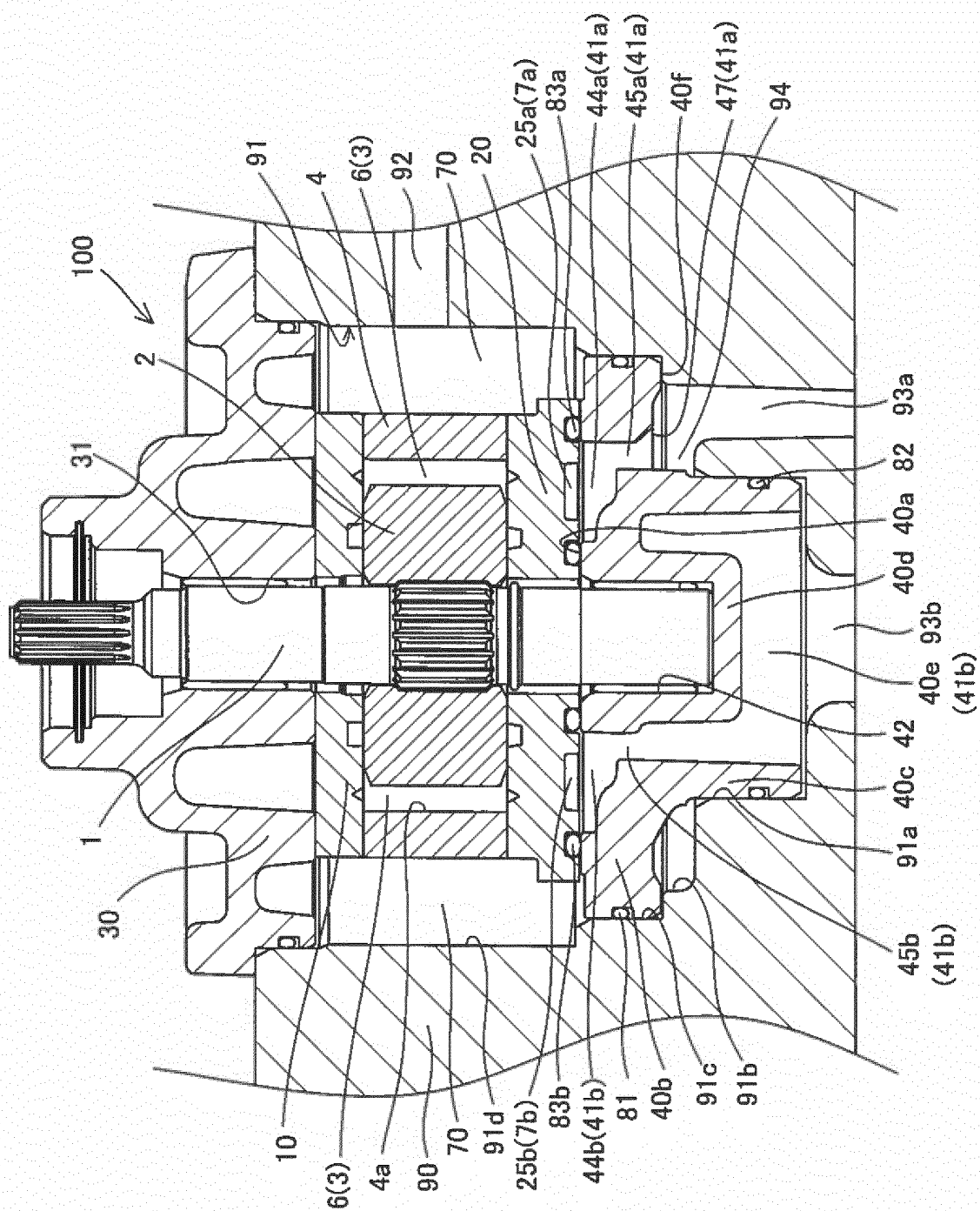
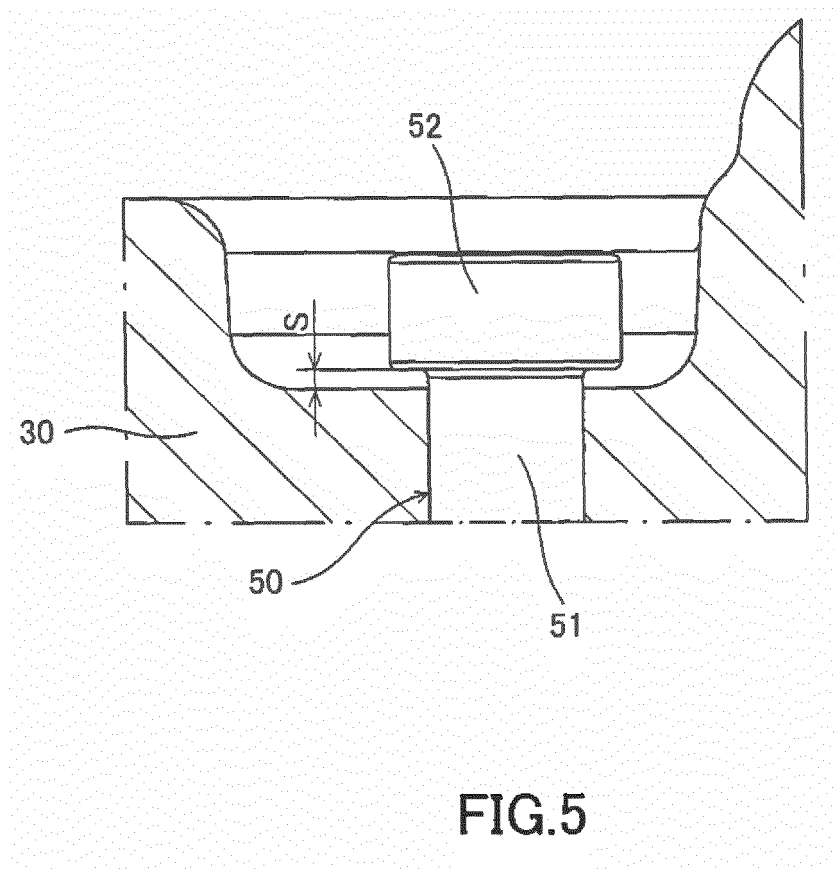


Fig. 4



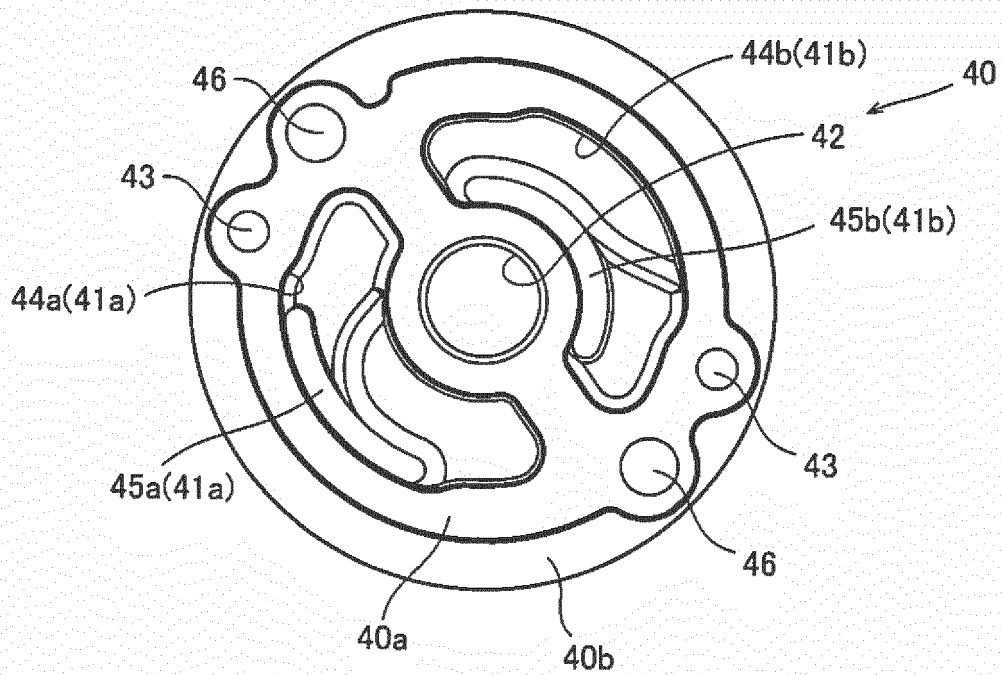


FIG. 6

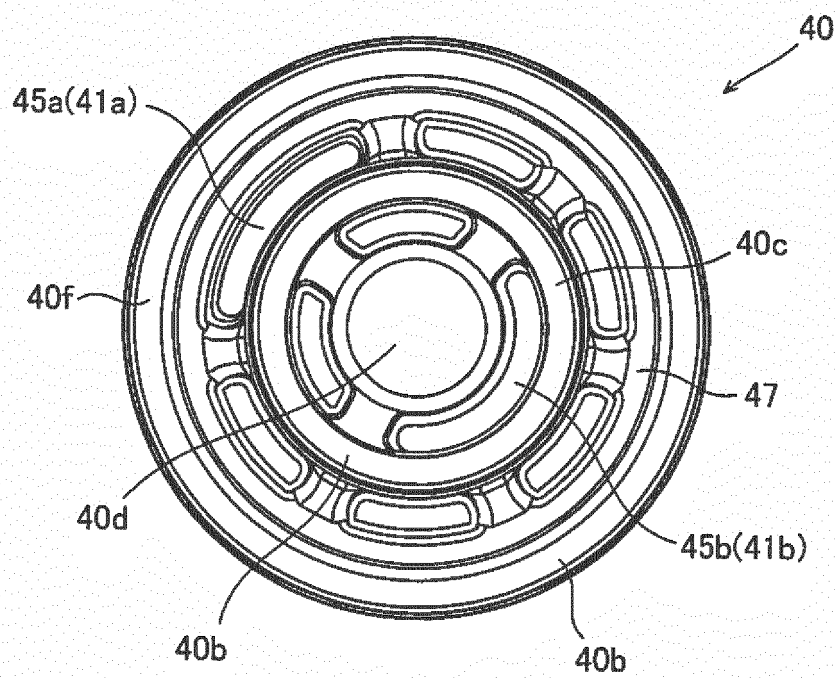


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/076380

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.
X	JP 3-115790 A (Vickers, Inc.), 16 May 1991 (16.05.1991), page 4, lower right column, line 1 to page 7, lower right column, line 6; fig. 1 to 9 & US 5017098 A column 3, line 36 to column 6, line 4; fig. 1 to 9	1-2
A	JP 1-195985 A (Toyoda Machine Works, Ltd.), 07 August 1989 (07.08.1989), entire text; all drawings (Family: none)	1-2

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

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"&" document member of the same patent family

Date of the actual completion of the international search
25 November 2016 (25.11.16)Date of mailing of the international search report
06 December 2016 (06.12.16)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/076380

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 6-159258 A (Vickers, Inc.), 07 June 1994 (07.06.1994), entire text; all drawings & US 5266018 A entire text; all drawings	1-2
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 171135/1987 (Laid-open No. 76582/1989) (Kayaba Industry Co., Ltd.), 24 May 1989 (24.05.1989), entire text; all drawings (Family: none)	1-2

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

REFERENCES CITED IN THE DESCRIPTION

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- JP 2014074368 A [0003] [0004] [0005]
- JP 2015185588 A [0074]