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(54) **HYDRAULIC ROTARY MACHINE, AND VALVE PLATE FOR SAME**

(57) It includes a plurality of cylinders 2b formed on the cylinder block 2; a piston 6 slidably inserted into the cylinder 2b; a case 3 accommodating the cylinder block 2; and a valve plate 20 formed by a core member 21 and a resin layer 22 coating the core member 21, the valve plate 20 being interposed between the cylinder block 2 and an end cover 5 of the case 3. The valve plate 20 has a first land portion 30 formed by the resin layer 22, the first land portion 30 being in sliding contact with the cylinder block 2; and an outer-side non-contact portion 40 provided closer to an outer side in a radial direction than the first land portion 30, the outer-side non-contact portion 40 being separated away from the cylinder block 2. At least a part of the outer-side non-contact portion 40 is an exposed portion 50 where the core member 21 is exposed.

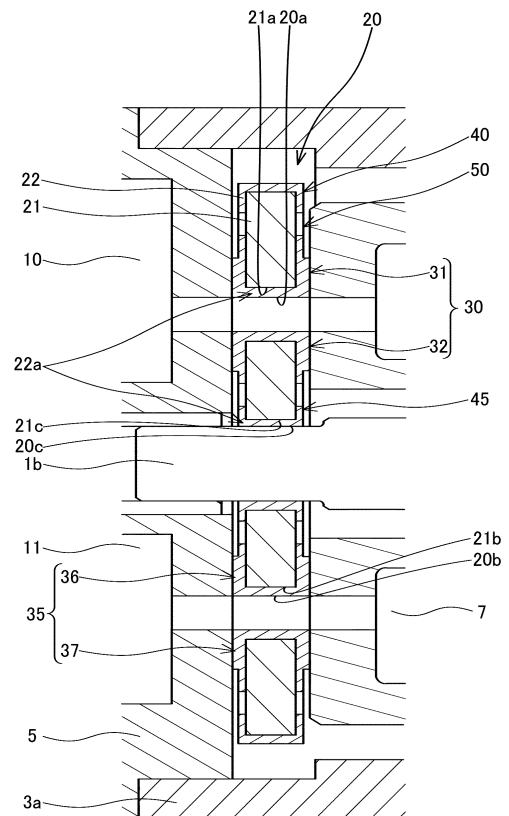


FIG. 2

Description**BRIEF DESCRIPTION OF DRAWINGS****TECHNICAL FIELD****[0008]**

[0001] The present invention relates to a hydraulic rotary machine and a valve plate thereof.

BACKGROUND ART

[0002] JP1995-179616A discloses a swash-plate axial piston type pump including a cylinder block rotated by driving of a shaft through a spline, a piston inserted into a cylinder provided in the cylinder block in a freely reciprocating manner, a slipper provided on a base end of the piston, and a thrust plate having an inclined surface on which the slipper slides.

[0003] In the axial piston pump disclosed in JP1995-179616A, the cylinder block and the valve plate slide, and the piston reciprocates while rotating and thus, an operating liquid is suctioned into the cylinder through a suction port and the valve plate and compressed and is ejected via the valve plate and an ejection port.

SUMMARY OF INVENTION

[0004] In some hydraulic rotary machines, a surface of a sliding member is coated with a resin layer in order to reduce sliding resistance of the member sliding in an operation.

[0005] However, when the surface of the sliding member is coated with the resin layer, a manufacturing cost of the hydraulic rotary machine is increased.

[0006] The present invention has an object to reduce the manufacturing cost of the hydraulic rotary machine.

[0007] According to one aspect of the present invention, a hydraulic rotary machine includes a cylinder block to which a shaft is connected so as to be rotated with the shaft; a plurality of cylinders formed on the cylinder block, the plurality of cylinders being disposed at a predetermined interval in a circumferential direction of the shaft; a piston slidably inserted into the cylinder, the piston defining a volume chamber inside the cylinder; a shoe rotatably connected to a tip end of the piston; a swash plate with which the shoe is in sliding contact; a case accommodating the cylinder block; and a valve plate formed by a core member and a resin layer coating the core member, the valve plate being provided with a supply port through which an operating liquid supplied to the volume chamber passes and a discharge port through which an operating liquid discharged from the volume chamber passes, the valve plate being interposed between the cylinder block and the case. The valve plate has a sliding contact portion formed by the resin layer, the cylinder block being in sliding contact with the sliding contact portion; and a non-contact portion separated away from the cylinder block, and at least a part of the non-contact portion is an exposed portion where the core member is exposed.

FIG. 1 is a sectional view of a hydraulic rotary machine according to a first embodiment of the present invention;

FIG. 2 is an enlarged sectional view of a valve plate of the hydraulic rotary machine according to the first embodiment of the present invention;

FIG. 3 is a plan view of the valve plate of the hydraulic rotary machine according to the first embodiment of the present invention;

FIG. 4 is a plan view of a core member of the hydraulic rotary machine according to the first embodiment of the present invention;

FIG. 5 is a sectional view illustrating a procedure of a manufacturing method of the valve plate according to the first embodiment of the present invention and illustrates a state where the core member is accommodated in a die;

FIG. 6 is a sectional view illustrating a procedure of a manufacturing method of the valve plate and illustrates a state where a resin layer is molded on the core member;

FIG. 7 is a sectional view illustrating a procedure of a manufacturing method of the valve plate and illustrates a state where manufacture of the valve plate is completed;

FIG. 8 is a plan view of a valve plate of a hydraulic rotary machine according to a second embodiment of the present invention;

FIG. 9 is a sectional view of the valve plate of the hydraulic rotary machine according to the second embodiment of the present invention; and

FIG. 10 is a sectional view illustrating a procedure of a manufacturing method of the valve plate according to the second embodiment of the present invention and illustrates a state where a core member is accommodated in a die.

DESCRIPTION OF EMBODIMENTS

[0009] Embodiments of the present invention will be described below by referring to the attached drawings.

(First embodiment)

[0010] First, by referring to Figs. 1 to 7, a hydraulic rotary machine according to a first embodiment of the present invention will be described.

[0011] In the first embodiment, a case where the hydraulic rotary machine is a water-pressure rotary machine 100 using water as an operating liquid will be described. The water-pressure rotary machine 100 functions as a piston pump capable of supplying water as the operating fluid when a shaft 1 is rotated by power from an outside and a piston 6 is reciprocated and also func-

tions as a piston motor capable of outputting a rotary driving force when the piston 6 is reciprocated by a fluid pressure of the water supplied from the outside and the shaft 1 is rotated. The water-pressure rotary machine 100 may function only as a piston pump or may function only as a piston motor.

[0012] In the description below, the case where the water-pressure rotary machine 100 is used as a piston pump is exemplified, and the water-pressure rotary machine 100 is called a "piston pump 100".

[0013] The piston pump 100 includes the shaft 1 rotated by a power source, a cylinder block 2 connected to the shaft 1 and rotated with the shaft 1, and a case 3 accommodating the cylinder block 2 as illustrated in Fig. 1. The case 3 includes a case body 3a whose both ends are open, a front cover 4 sealing one of opening ends of the case body 3a and through which the shaft 1 is inserted, and an end cover 5 sealing the other opening end of the case body 3a and accommodating an end portion of the shaft 1.

[0014] To one end portion 1a of the shaft 1 protruding to the outside through an insertion hole 4a of the front cover 4, the power source is connected. The end portion 1a of the shaft 1 is rotatably supported by the insertion hole 4a of the front cover 4 through a first bush 16. The other end portion 1b of the shaft 1 is accommodated in an accommodating recess portion 5a provided on the end cover 5 and is rotatably supported through a second bush 17.

[0015] The cylinder block 2 has a through hole 2a through which the shaft 1 penetrates and is spline-connected with the shaft 1 through the through hole 2a. As a result, the cylinder block 2 is rotated with rotation of the shaft 1. The cylinder block 2 is rotatably supported by the case 3 through a slide bearing 15.

[0016] On the cylinder block 2, a plurality of cylinders 2b each having an opening portion on one end surface is formed in parallel with the shaft 1. The plurality of cylinders 2b is formed at a predetermined interval in a circumferential direction of the cylinder block 2. Into the cylinder 2b, the columnar piston 6 dividing a volume chamber 7 is inserted to be capable of reciprocating. A tip end side of the piston 6 protrudes from the opening portion of the cylinder 2b, and a spherical surface seat 6a is formed on the tip end portion.

[0017] Into the volume chamber 7, water is led through a supply passage 10 formed in the end cover 5. The water in the volume chamber 7 is discharged through a discharge passage 11 formed in the end cover 5.

[0018] The piston pump 100 further includes a shoe 8 rotatably connected to the spherical surface seat 6a of the piston 6 and in sliding contact with the spherical surface seat 6a, a swash plate 9 with which the shoe 8 is in sliding contact with rotation of the cylinder block 2, and a valve plate 20 interposed between the cylinder block 2 and the end cover 5.

[0019] The shoe 8 has a receiving portion 8a for receiving the spherical surface seat 6a formed on a tip end

of each piston 6 and a circular flat plate portion 8b in sliding contact with the swash plate 9. An inner surface of the receiving portion 8a is formed having a spherical surface shape and is in sliding contact with an outer surface of the received spherical surface seat 6a. As a result, the shoe 8 is capable of angular displacement in any direction with respect to the spherical surface seat 6a.

[0020] The swash plate 9 is fixed to an inner wall of the front cover 4 and has a sliding contact surface 9a inclined from a direction perpendicular to an axis of the shaft 1. The flat plate portion 8b of the shoe 8 is in surface contact with the sliding contact surface 9a.

[0021] The valve plate 20 is a disc member formed by a core member 21 made of metal and a resin layer 22 coating the core member 21.

[0022] The valve plate 20 has, as illustrated in Figs. 2 and 3, a first land portion 30 as a sliding contact portion formed by the resin layer 22 and with which the cylinder block 2 is in sliding contact, a second land portion 35 formed by the resin layer 22 and as a contact portion with which the end cover 5 of the case 3 is in contact, and a non-contact portion separated from the cylinder block 2 and the end cover 5. The non-contact portion has an outer-side non-contact portion 40 provided closer to an outer side in a radial direction than the first land portion 30 and the second land portion 35 and an inner-side non-contact portion 45 provided closer to an inner side in the radial direction than the first land portion 30 and the second land portion 35.

[0023] In the valve plate 20, the first land portion 30 and the second land portion 35 are formed having a similar shape. Thus, Fig. 3 illustrates only the shape of the first land portion 30, and illustration of each constitution of the second land portion 35 is omitted and it is indicated in reference numerals in parentheses.

[0024] In the valve plate 20, a supply port 20a connecting the supply passage 10 and the volume chamber 7 and allowing passage of water to be supplied to the volume chamber 7, a discharge port 20b connecting the discharge passage 11 and the volume chamber 7 and allowing passage of water discharged from the volume chamber 7, and a shaft insertion hole 20c formed at the center of the valve plate 20 and into which the shaft 1 is inserted are provided.

[0025] The first land portion 30 is, as illustrated in Fig. 3, formed annularly by the resin layer 22 coating the surface of the core member 21. Since the first land portion 30 is formed by the resin layer 22, sliding resistance between the valve plate 20 and the cylinder block 2 is reduced.

[0026] The first land portion 30 is divided by the supply port 20a and the discharge port 20b into the first outer-side land portion 31 and a first inner-side land portion 32. The first outer-side land portion 31 and the first inner-side land portion 32 are connected by a first intermediate portion 33 provided between the supply port 20a and the discharge port 20b in the circumferential direction.

[0027] By adjusting a width of the first land portion 30

in the radial direction, sliding resistance between the valve plate 20 and the cylinder block 2 is adjusted, and a surface pressure of the valve plate 20 to the cylinder block 2 is adjusted. By adjusting the surface pressure of the valve plate 20 to the cylinder block 2, sealing performance between the cylinder block 2 and the valve plate 20 is adjusted. Thus, by setting the width of the first land portion 30 in the radial direction appropriately, both the sliding resistance and the sealing performance between the valve plate 20 and the cylinder block 2 are set appropriately.

[0028] The second land portion 35 is formed annularly by the resin layer 22 coating the surface of the core member 21 and is brought into contact with the end cover 5 of the case 3. Similarly to the first land portion 30, the second land portion 35 is divided by the supply port 20a and the discharge port 20b into a second outer-side land portion 36 and a second inner-side land portion 37. Moreover, the second outer-side land portion 36 and the second inner-side land portion 37 are connected by a second intermediate portion 38 provided between the supply port 20a and the discharge port 20b in the circumferential direction. The valve plate 20 is fixed to the end cover 5 in a state where the second land portion 35 is in contact with the end cover 5.

[0029] By setting a width of the second land portion 35 in the radial direction appropriately, the surface pressure of the valve plate 20 to the end cover 5 is adjusted. As a result, sealing performance between the valve plate 20 and the end cover 5 of the case 3 is ensured.

[0030] The outer-side non-contact portion 40 is, as illustrated in Fig. 2, formed having a gap from the cylinder block 2 and is formed having a gap from the end cover 5. Thus, the outer-side non-contact portion 40 is formed away from the cylinder block 2 and the case 3 so as not to be in contact with either of the cylinder block 2 or the case 3.

[0031] The outer-side non-contact portion 40 has, as illustrated in Fig. 3, an exposed portion 50 not coated with the resin layer 22 but exposing the core member 21. In the outer-side non-contact portion 40, eight exposed portions 50 disposed at an equal angular interval in the circumferential direction are provided. The core member 21 exposed in the exposed portion 50 is a support portion supported by support pins 62a and 62b (see Fig. 5) in mold-forming of the resin layer 22 on the core member 21. In the outer-side non-contact portion 40, the other portions excluding the exposed portion 50 are coated with the resin layer 22. The mold-forming of the resin layer 22 will be described later in detail.

[0032] As illustrated in Fig. 2, the inner-side non-contact portion 45 is formed having a gap from the cylinder block 2 and is formed having a gap from the end cover 5 similarly to the outer-side non-contact portion 40. Thus, the inner-side non-contact portion 45 is formed away from the cylinder block 2 and the case 3 so as not to be in contact with either of the cylinder block 2 or the case 3. The inner-side non-contact portion 45 has, as illustrated

in Fig. 3, four exposed portions 50 provided at an equal angular interval in the circumferential direction.

[0033] As described above, the exposed portions 50 are provided on the outer-side non-contact portion 40 and the inner-side non-contact portion 45 not in contact with either of the cylinder block 2 or the case 3. Even if the exposed portion 50 is provided on the outer-side non-contact portion 40 and the inner-side non-contact portion 45, sliding between the cylinder block 2 and the valve plate 20 is not affected. That is, an entire area of the exposed portion 50 can be easily increased without impairing performances of the piston pump 100.

[0034] The supply port 20a and the discharge port 20b are, as illustrated in Fig. 3, formed as arc-shaped grooves, respectively. The supply port 20a and the discharge port 20b are defined by the resin layer coating inner peripheral surface with arc-shaped supply base hole 21a and discharge base hole 21b provided in the core member 21, respectively (hereinafter referred to as a "port resin layer 22a"). That is, the port resin layer 22a is coated so as to cover the inner peripheral surfaces with the supply base hole 21a and the discharge base hole 21b. As a result, entry of the water passing through the supply port 20a and the discharge port 20b between the core member 21 and the resin layer 22 is prevented. Therefore, durability of the valve plate 20 can be improved.

[0035] The port resin layer 22a is, as illustrated in Fig. 2, formed integrally with the first land portion 30 and the second land portion 35 and is provided continuously to each of them. Since the port resin layer 22a is locked by the inner peripheral surfaces of the supply base hole 21a and the discharge base hole 21b of the core member 21, relative rotation of the first land portion 30 and the second land portion 35 with respect to the core member 21 is regulated by sliding resistance between the cylinder block 2 and the valve plate 20. As described above, the port resin layer 22a is provided so as to cover the inner peripheries of the supply base hole 21a and the discharge base hole 21b and functions as a rotation stopper of the resin layer 22.

[0036] The shaft insertion hole 20c is defined by the resin layer coating the inner peripheral surface of a circular base through hole 21c provided in the core member 21 (see Fig. 2).

[0037] Subsequently, an operation of the piston pump 100 will be described.

[0038] When the shaft 1 is rotated/driven by power from an outside, and the cylinder block 2 is rotated, the flat plate portion 8b of each shoe 8 slides with respect to the swash plate 9, and each piston 6 reciprocates in the cylinder 2b with a stroke amount according to an inclination angle of the swash plate 9. By means of reciprocating of each piston 6, the volume of each volume chamber 7 is increased/decreased.

[0039] Into the volume chamber 7 expanding by rotation of the cylinder block 2, water is led through the supply passage 10 of the end cover 5 and the supply port 20a

of the valve plate 20. The water suctioned into the volume chamber 7 has its pressure increased by contraction of the volume chamber 7 by rotation of the cylinder block 2 and is ejected through the discharge port 20b of the valve plate 20 and the discharge passage 11 of the end cover 5. As described above, in the piston pump 100, suction and ejection of the water is continuously performed with rotation of the cylinder block 2.

[0040] Subsequently, a manufacturing method of the valve plate 20 will be described by referring to Figs. 4 to 7.

[0041] First, as illustrated in Fig. 4, the supply base hole 21a, the discharge base hole 21b, and the base through hole 21c (hereinafter they are collectively called a "base hole" as necessary.) are provided in a disc member made of metal so as to form the core member 21. The supply base hole 21a and the discharge base hole 21b are formed as arc grooves disposed on the same circle, respectively.

[0042] Subsequently, as illustrated in Fig. 5, the core member 21 is accommodated in a cavity 63 formed by an upper die 60 and a lower die 61 for mold-forming. The core member 21 in the cavity 63 is supported by being sandwiched by a plurality of support pins 62a provided on the upper die 60 and a plurality of support pins 62b provided on the lower die 61 from a plate thickness direction. The support pins 62a of the upper die 60 and the support pins 62b of the lower die 61 are provided so as to face each other by sandwiching the core member 21. In Fig. 5, only the support pins 62a and 62b on the same section are illustrated, while illustration of the other support pins is omitted.

[0043] In Fig. 4, a hatched portion is a support portion where the core member 21 is supported by the support pins 62a and 62b. Specifically speaking, the core member 21 is supported by the support pins 62a and 62b at eight spots on the outer side in the radial direction of the supply base hole 21a and the discharge base hole 21b at an equal angular interval. Moreover, the core member 21 is supported by the support pins 62a and 62b at four spots between the supply base hole 21a as well as the discharge base hole 21b and the base through hole 21c at an equal angular interval.

[0044] Moreover, the core member 21 is supported by the support pins 62a and 62b on the base intermediate portion 21d provided between the supply base hole 21a and the discharge base hole 21b in the circumferential direction, that is, on the outer side and the inner side in the radial direction of portions corresponding to the first and second intermediate portions 33 and 38 after coating of the resin layer 22.

[0045] Subsequently, a resin material is injected into the cavity 63 from an injection port (not shown) so as to mold-form the resin layer 22 on the core member 21.

[0046] Here, since the core member 21 has the outer side and the inner side with the supply base hole 21a and the discharge base hole 21b supported by the support pins 62a and 62b, even if the resin material at a high pressure and a high temperature is injected, deformation

of the core member 21 caused by an injection pressure and a heat of the resin material is prevented.

[0047] Moreover, the base intermediate portion 21d is located between the supply base hole 21a and the discharge base hole 21b formed as grooves in the circumferential direction, this is a portion with strength smaller than those of the other portions in the core member 21. Since the outer side and the inner side in the radial direction of such base intermediate portion 21 are supported by the support pins 62a and 62b, deformation of the core member 21 in the mold-forming is prevented more reliably.

[0048] After the resin material is mold-formed, when the upper die 60 and the lower die 61 are removed, as illustrated in Fig. 6, the core member 21 is coated with the resin layer 22 along the shape of the cavity 63. Moreover, by removing the upper die 60 and the lower die 61, the support portion having been supported by the support pins 62a and 62b is exposed to the outside, and the exposed portion 50 is formed. As described above, the eight exposed portions 50 are formed on the outer side of the core member 21, and the four exposed portions 50 are formed on the inner side.

[0049] Subsequently, by cutting/machining the resin layer 22 at the outer side portion of the core member 21 including the exposed portion 50 and a center portion of the core member 21 including the exposed portion 50, the outer-side non-contact portion 40 and the inner-side non-contact portion 45 are formed. As a result, as illustrated in Fig. 7, between the outer-side non-contact portion 40 and the inner-side non-contact portion 45, the first land portion 30 and the second land portion 35 protruding closer to the plate thickness direction (axial direction) of the valve plate 20 than the outer-side non-contact portion 40 and the inner-side non-contact portion 45 are formed.

[0050] Subsequently, by cutting/machining a part of the resin layer 22 filled in the base hole, the supply port 20a, the discharge port 20b, and the shaft insertion hole 20c are formed.

[0051] By means of the aforementioned processes, the valve plate 20 is manufactured.

[0052] As described above, by supporting both the outer side and the inner side of the core member 21 in the radial direction by the support pins 62a and 62b, deformation of the core member 21 in the mold-forming can be prevented more reliably, and the exposed portion 50 is formed by removing the support pins 62. Thus, while mold-forming with a small coating amount of the resin material, the valve plate whose deformation is prevented can be obtained.

[0053] Subsequently, a variation of the first embodiment will be described.

[0054] In the aforementioned first embodiment, the water-pressure rotary machine 100 using water as the operating liquid has been described. Instead of this, the operating liquid may be an operating oil or any other things.

[0055] Moreover, in the aforementioned first embodi-

ment, the case where the water-pressure rotary machine 100 is a fixed displacement piston pump in which the inclination angle of the swash plate 9 is fixed has been described. Instead of this, the water-pressure rotary machine 100 may be a variable displacement type capable of changing the inclination angle of the swash plate 9.

[0056] In the aforementioned first embodiment, the eight exposed portions 50 are provided on the outer-side non-contact portion 40 on the outer side of the valve plate 20, and the four exposed portions 50 are provided on the inner-side non-contact portion 45 on the inner side. On the valve plate 20, the number of the exposed portions 50 is not limited to them, but an arbitrary number of the exposed portions 50 can be provided.

[0057] Moreover, in the aforementioned first embodiment, the resin layer 22 is molded in the base hole formed in the core member 21 in advance, and the molded resin layer 22 is machined so as to form the supply port 20a, the discharge port 20b, and the shaft insertion hole 20c. In order to prevent entry of water into a space between the core member 21 and the resin layer 22, the supply port 20a, the discharge port 20b, and the shaft insertion hole 20c are preferably formed as described above. However, instead of this, it may be so configured that the base hole is not machined in advance in the core member 21 but the resin layer 22 is molded on the core member 21 and then, the resin layer 22 is machined together with the core member 21 so as to form the supply port 20a, the discharge port 20b, and the shaft insertion hole 20c.

[0058] Moreover, in the aforementioned first embodiment, the first land portion 30 and the second land portion 35 are formed having a similar shape having the same radial width. Instead of this, the first land portion 30 and the second land portion 35 may have shapes different from each other.

[0059] Moreover, in the aforementioned first embodiment, the valve plate 20 has the second land portion 35, and by setting the radial width of the second land portion 35 appropriately, sealing performance between the valve plate 20 and the end cover 5 of the case 3 is ensured. Instead of this, it may be so configured that the valve plate 20 does not have the second land portion 35 and the land portion is provided on the end cover 5.

[0060] Moreover, the hydraulic rotary machine 100 may be configured such that both the valve plate 20 and the end cover 5 do not have the land portion. In this case, the valve plate 20 is in contact with the end cover 5 on the whole end surface faced with the end cover 5. Even in this case, the exposed portion 50 only needs to be provided on the outer-side non-contact portion 40 with which the cylinder block 2 is not in sliding contact. That is, the exposed portion 50 may be provided on a portion in contact with the end cover 5 as long as it is not provided on the first land portion 30 with which at least the cylinder block 2 is in sliding contact.

[0061] According to the aforementioned first embodiment, the following effects are exerted.

[0062] In the piston pump 100, the exposed portion 50

is provided on the outer-side non-contact portion 40 not in contact with the cylinder block 2 or the case 3. The exposed portion 50 supports the core member 21 by the support pins 62a and 62b in mold-forming of the resin layer 22 and is formed by removing the support pins 62a and 62b after the mold-forming. As described above, by mold-forming the resin layer 22 by supporting the core member 21 of a portion with which the cylinder block 2 is not in sliding contact, the exposed portion 50 thus formed does not affect sliding between the cylinder block 2 and the valve plate 20. Thus, an area of the core member 21 supported in the mold-forming, that is, an area of the core member 21 on which the resin layer 22 is not molded and which is exposed after the mold-forming can be increased. Thus, by increasing the area of the exposed portion 50, deformation in the mold-forming is prevented, and the valve plate 20 with a smaller coating amount of the resin material in the mold-forming can be obtained. Therefore, while the performances of the piston pump 100 are ensured, the manufacturing cost of the piston pump 100 can be reduced.

[0063] Moreover, in the valve plate 20, the exposed portion 50 is provided also on the inner-side non-contact portion 45 not in contact with the cylinder block 2 or the case 3. Thus, an area supported by the support pins 62a and 62b in the mold-forming, that is, the area of the core member 21 exposed after the mold-forming can be further increased. Therefore, the valve plate 20 whose deformation is prevented more reliably and having a smaller coating amount of the resin material can be obtained, and the manufacturing cost of the piston pump 100 can be further reduced.

[0064] Moreover, in the valve plate 20, the outer side and the inner side in the radial direction of the base intermediate portion 20d with relatively lower strength is supported by the support pins 62a and 62b, and the exposed portion 50 is provided on the outer sides and the inner sides in the radial direction of the first and second intermediate portions 33 and 38. Thus, the valve plate 20 with deformation of the core member 21 prevented more reliably can be obtained.

(Second embodiment)

[0065] Subsequently, a piston pump 200 according to a second embodiment of the present invention will be described by referring to Figs. 8 to 10. In the following, points different from the first embodiment will be mainly described, and the same reference numerals are given to the same constitutions as those in the piston pump 100 in the aforementioned first embodiment, and explanation will be omitted.

[0066] In the aforementioned first embodiment, the exposed portion 50 is provided on a part of the outer-side non-contact portion 40 and also provided on a part of the inner-side non-contact portion 45. Instead of this, a valve plate 120 of the piston pump 200 is different from the aforementioned first embodiment in a point that all of an

outer-side non-contact portion 140 is formed as an exposed portion, and all of an inner-side non-contact portion 145 is formed as an exposed portion.

[0067] As illustrated in Figs. 8 and 9, the valve plate 120 of the piston pump 200 has the outer-side non-contact portion 140 formed as the exposed portion and the inner-side non-contact portion 145 formed as the exposed portion.

[0068] A shaft insertion hole 120c is a through hole formed in the core member 21 in advance and its inner periphery is not covered by the resin layer 22 as in the aforementioned first embodiment. The shaft insertion hole 120c has an inner diameter larger than an outer diameter of the shaft 1 and is formed so that the shaft 1 is not brought into contact. Thus, even if the inner periphery of the shaft insertion hole 120c is not covered by the resin layer 22, the shaft 1 and the valve plate 20 are not in contact with each other, and the performances of the piston pump is not lowered.

[0069] In manufacture of the valve plate 120, unlike the manufacturing method in the first embodiment in which the core member 21 is supported by the support pins 62a and 62b, the core member 21 is, as illustrated in Fig. 10, supported on the entire outer peripheral portion by annular clamp members 162a and 162b provided on an upper die 160 and a lower die 161, and the entire center portion is supported by columnar members 163a and 163b provided on the upper die 60 and the lower die 61. As a result, by removing the upper die 160 and the lower die 161 after the resin material is mold-formed on a cavity 164, the valve plate 120 in which all the outer-side non-contact portion 40 on the outer peripheral portion is formed as the exposed portion, and all the outer-side non-contact portion 40 on the center portion is formed as the exposed portion is obtained.

[0070] Here, as in the aforementioned first embodiment, if the outer peripheral surface of the valve plate 20 is coated with the resin layer 22 so as to be covered, friction resistance between the core member 21 and the resin layer 22 becomes larger and thus, the core member 21 and the resin layer 22 do not perform relative rotation easily.

[0071] On the other hand, if the outer peripheral surface is not covered by the resin layer 22 as in the valve plate 120, there is a concern that the core member 21 and the resin layer 22 perform relative rotation. However, in the valve plate 120, similarly to the valve plate 20 according to the aforementioned first embodiment, since the supply port 20a and the discharge port 20b are defined by the port resin layer 22a, and the port resin layer 22a is locked by the supply port 20a and the discharge port 20b, the relative rotation between the core member 21 and the resin layer 22 can be regulated.

[0072] According to the second embodiment as above, the effects similar to those in the aforementioned first embodiment are exerted, and the following effects are also exerted.

[0073] In the valve plate 120, the entire outer-side non-

contact portion 140 is the exposed portion and the entire inner-side non-contact portion 145 at the center is the exposed portion. Thus, the resin amount in the mold-forming of the valve plate 120 can be further reduced.

Moreover, in the valve plate 120, mold-forming is performed while the entire outer periphery corresponding to the outer-side non-contact portion 140 is supported by the clamp members 162a and 162b, and the center portion corresponding to the entire inner-side non-contact portions 45 is supported by the columnar members 163a and 163b. As described above, since the core member 21 is supported by a larger area, deformation of the core member 21 in the mold-forming can be prevented more reliably. Therefore, in the piston pump 200, deformation in the mold-forming of the resin layer 22 can be prevented more reliably, and the valve plate 120 with the smaller coating amount of the resin material can be obtained, and the manufacturing cost of the piston pump can be further reduced.

[0074] The constitutions, the actions, and the effects of the embodiments of the present invention will be described below altogether.

[0075] Each of the piston pumps 100 and 200 include the cylinder block 2 to which the shaft 1 is connected and rotated with the shaft 1, the plurality of cylinders 2b formed on the cylinder block 2 and disposed at a predetermined interval in the circumferential direction of the shaft 1, the piston 6 slidably inserted into the cylinder 2b and dividing the volume chamber 7 inside the cylinder 2b, the shoe 8 rotatably connected to the tip end of the piston 6, the swash plate 9 with which the shoe 8 is in sliding contact, the case 3 accommodating the cylinder block 2, the valve plate 20 or 120 formed by the core member 21 and the resin layer 22 coating the core member 21, provided with the supply port 20a through which the water supplied to the volume chamber 7 passes and the discharge port 20b through which the water discharged from the volume chamber 7 passes, and interposed between the cylinder block 2 and the end cover 5 of the case 3. The valve plate 20 or 120 has the first land portion 30 formed by the resin layer 22 and with which the cylinder block 2 is in sliding contact and the non-contact portion (the outer-side non-contact portion 40 or 140, the inner-side non-contact portion 45 or 145) separated away from the cylinder block 2, and at least a part of the non-contact portion (the outer-side non-contact portion 40 or 140, the inner-side non-contact portion 45 or 145) is the exposed portion 50 where the core member 21 is exposed.

[0076] In this constitution, the exposed portion 50 is provided on the non-contact portion (the outer-side non-contact portion 40 or 140, the inner-side non-contact portion 45 or 145) with which the cylinder block 2 is not in sliding contact in the valve plate 20 or 120. As a result, the coating amount of the resin material is reduced without impairing the performances of the piston pump 100 or 200. Therefore, the manufacturing cost of the piston pump 100 or 200 can be reduced.

[0077] Moreover, in the piston pump 100 or 200, the supply port 20a and the discharge port 20b are defined by the port resin layer 22a coating the inner peripheral surfaces of the supply base hole 21a and the discharge base hole 21b provided in the core member 21, respectively, and the port resin layer 22a is provided continuously to the first land portion 30.

[0078] According to this constitution, entry of the water passing through the supply port 20a and the discharge port 20b into a space between the core member 21 and the resin layer 22 is prevented. Moreover, since the port resin layer 22a is locked by the inner peripheral surfaces of the supply base hole 21a and the discharge base hole 21b of the core member 21, the relative rotation of the first land portion 30 with respect to the core member 21 by sliding resistance between the cylinder block 2 and the valve plate 20, 120 is regulated.

[0079] Moreover, in the piston pump 100 or 200, the non-contact portion has the outer-side non-contact portion 40 or 140 provided closer to the outer side in the radial direction than the first land portion 30, and at least a part of the outer-side non-contact portion 40 or 140 is the exposed portion 50.

[0080] Moreover, in the piston pump 100 or 200, the non-contact portion has the inner-side non-contact portion 45 or 145 provided on the inner side in the radial direction of the first land portion 30, and at least a part of the inner-side non-contact portion 45 or 145 is the exposed portion 50.

[0081] In these constitutions, the exposed portion 50 is provided on the outer-side non-contact portion 40 or 140 and the inner-side non-contact portion 45 or 145 not in contact with the cylinder block 2 or the case 3. Thus, the coating amount of the resin material is reduced without impairing the performances of the piston pump 100.

[0082] Moreover, in the piston pump 100 or 200, at least a part of the core member 21 exposed in the exposed portion 50 is the support portion supported in the mold-forming of the resin layer 22.

[0083] In this constitution, a part of the core member 21 supported in the mold-forming becomes the exposed portion 50 exposed to the outside after the mold-forming. Thus, by increasing the amount of the exposed portion, the area supported in the mold-forming increases, whereby deformation of the core member 21 in the mold-forming is prevented, and the resin amount in the mold-forming is reduced.

[0084] Moreover, in the piston pump 100 or 200, the supply port 20a and the discharge port 20b are formed as arc-shaped grooves, respectively, and the exposed portion 50 which is the support portion is provided on at least one of the outer side in the radial direction and the inner side in the radial direction of the first intermediate portion 33 and the second intermediate portion 38 provided between the supply port 20a and the discharge port 20b in the circumferential direction.

[0085] According to this constitution, since at least one

of the outer side in the radial direction and the inner side in the radial direction of the first intermediate portion 33 and the second intermediate portion 38 with relatively lower strength is made the support portion, deformation in the mold-forming can be prevented more reliably.

[0086] Moreover, in the piston pump 200, the whole non-contact portion (the outer-side non-contact portion 40, 140, the inner-side non-contact portion 45, 145) is formed as the exposed portion.

[0087] According to this constitution, while deformation of the core member 21 in the mold-forming is prevented more reliably, the resin amount in the mold-forming is further reduced.

[0088] Moreover, the valve plate 20, 120 interposed between the cylinder block 2 and the case 3 of the piston pump 100 or 200 and formed by the core member 21 and the resin layer 22 coating the core member 21 has the first land portion 30 formed by the resin layer 22 and with which the cylinder block 2 is in sliding contact and the non-contact portion (the outer-side non-contact portion 40 or 140, the inner-side non-contact portion 45 or 145) separated away from the cylinder block 2, and at least a part of the non-contact portion (the outer-side non-contact portion 40 or 140, the inner-side non-contact portion 45 or 145) is the exposed portion 50 where the core member 21 is exposed.

[0089] In this constitution, the exposed portion 50 is provided on the non-contact portion (the outer-side non-contact portion 40 or 140, the inner-side non-contact portion 45 or 145) with which the cylinder block 2 is not in sliding contact in the valve plate 20 or 120. As a result, the coating amount of the resin material is reduced without impairing the performances of the piston pump 100 or 200. Therefore, the manufacturing cost of the piston pump 100 or 200 can be reduced.

[0090] The embodiments of the present invention described above are merely illustration of some application examples of the present invention and not of the nature to limit the technical scope of the present invention to the specific constructions of the above embodiments.

[0091] The present application claims a priority based on Japanese Patent Application No. 2015-183215 filed with the Japan Patent Office on September 16, 2015, all the contents of which are hereby incorporated by reference.

Claims

1. A hydraulic rotary machine comprising:

- a cylinder block to which a shaft is connected so as to be rotated with the shaft;
- a plurality of cylinders formed on the cylinder block, the plurality of cylinders being disposed at a predetermined interval in a circumferential direction of the shaft;
- a piston slidably inserted into the cylinder, the

- piston defining a volume chamber inside the cylinder;
 a shoe rotatably connected to a tip end of the piston;
 a swash plate with which the shoe is in sliding contact;
 a case accommodating the cylinder block; and
 a valve plate formed by a core member and a resin layer coating the core member, the valve plate being provided with a supply port through which an operating liquid supplied to the volume chamber passes and a discharge port through which an operating liquid discharged from the volume chamber passes, the valve plate being interposed between the cylinder block and the case, wherein
 the valve plate has
- a sliding contact portion formed by the resin layer, the cylinder block being in sliding contact with the sliding contact portion; and
 a non-contact portion separated away from the cylinder block, and
- at least a part of the non-contact portion is an exposed portion where the core member is exposed.
2. The hydraulic rotary machine according to claim 1, wherein
 the supply port and the discharge port are defined by a port resin layer coating an inner peripheral surfaces of a supply base hole and a discharge base hole provided in the core member, respectively; and
 the port resin layer is provided continuously to the sliding contact portion.
3. The hydraulic rotary machine according to claim 1, wherein
 the non-contact portion has an outer-side non-contact portion provided closer to an outer side in a radial direction than the sliding contact portion; and
 at least a part of the outer-side non-contact portion is the exposed portion.
4. The hydraulic rotary machine according to claim 1, wherein
 the non-contact portion has an inner-side non-contact portion provided on an inner side in the radial direction of the sliding contact portion and formed with a gap from the cylinder block; and
 at least a part of the inner-side non-contact portion is the exposed portion.
5. The hydraulic rotary machine according to claim 1, wherein
 at least a part of the core member exposed in the exposed portion is a support portion supported in
- mold-forming of the resin layer.
6. The hydraulic rotary machine according to claim 5, wherein
 the supply port and the discharge port are formed as arc-shaped grooves, respectively; and
 the exposed portion which is the support portion is provided on at least one of an outer side in the radial direction and an inner side in the radial direction of an intermediate portion provided between the supply port and the discharge port in a circumferential direction.
7. The hydraulic rotary machine according to claim 1, wherein
 the whole non-contact portion is formed as the exposed portion.
8. A valve plate interposed between a cylinder block and a case in a hydraulic rotary machine, the valve plate being formed by a core member and a resin layer coating the core member, comprising:
 a sliding contact portion formed by the resin layer, the cylinder block being in sliding contact with the sliding contact portion; and
 a non-contact portion separated away from the cylinder block, wherein
 at least a part of the non-contact portion is the exposed portion where the core member is exposed.

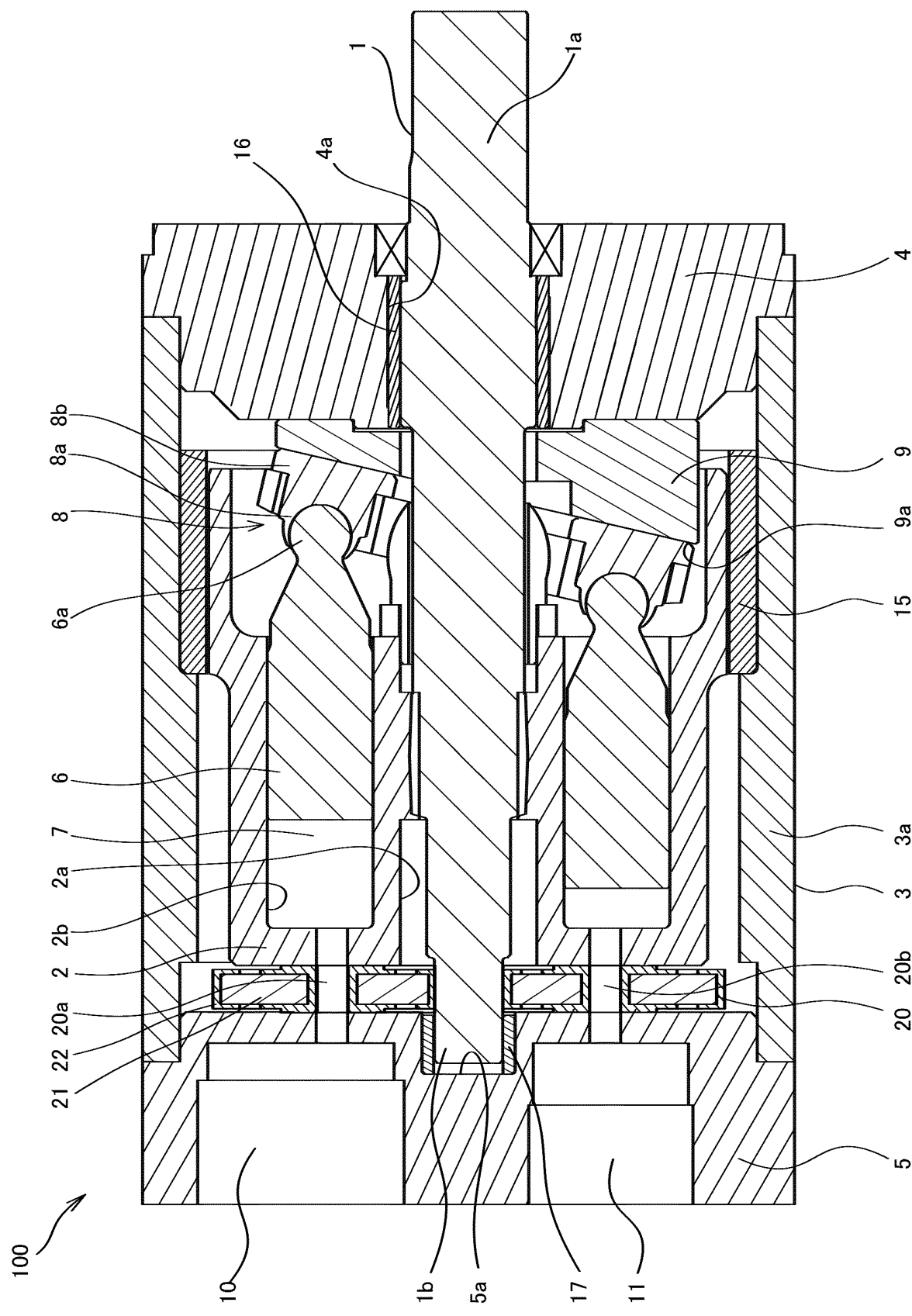


FIG. 1

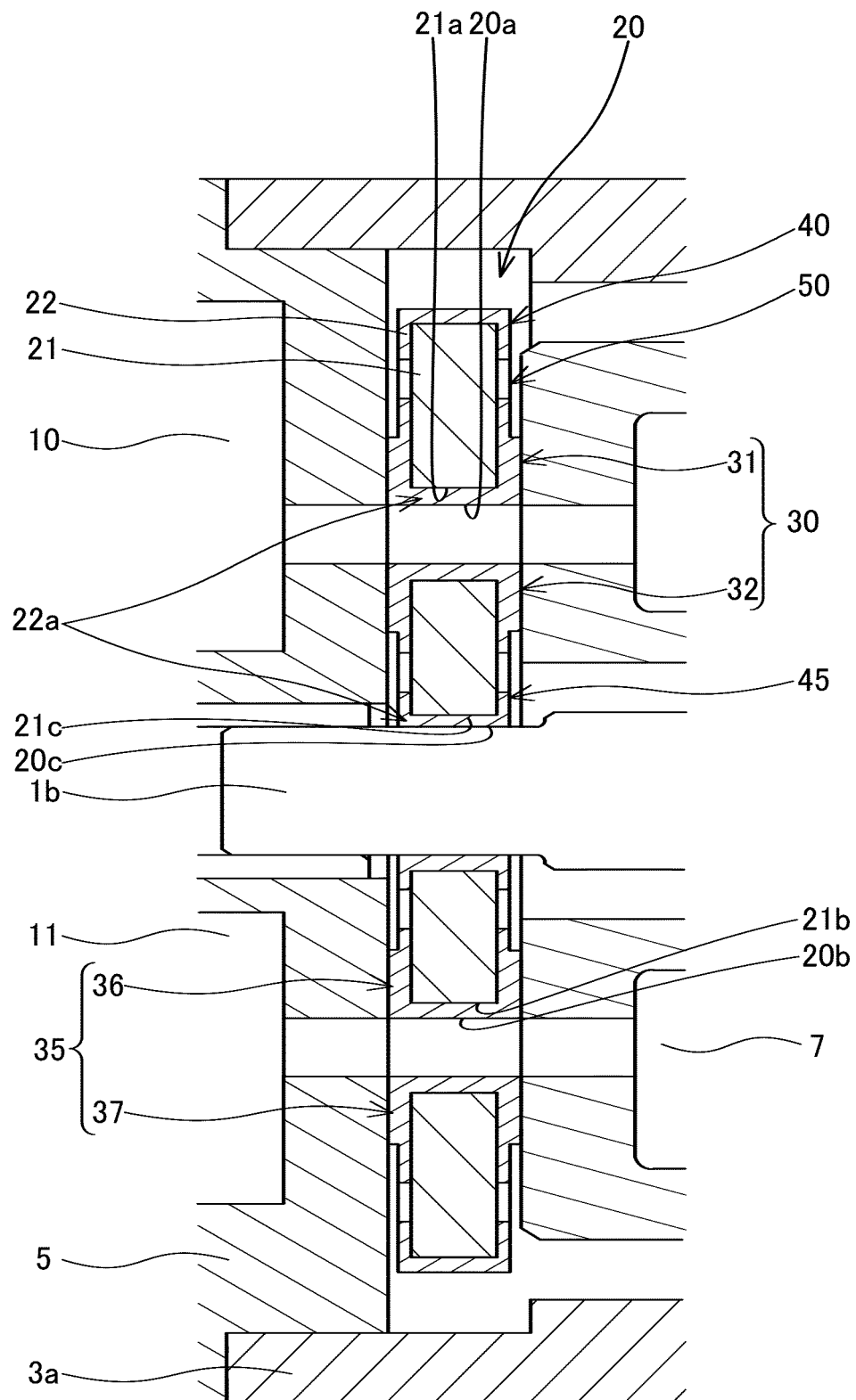


FIG. 2

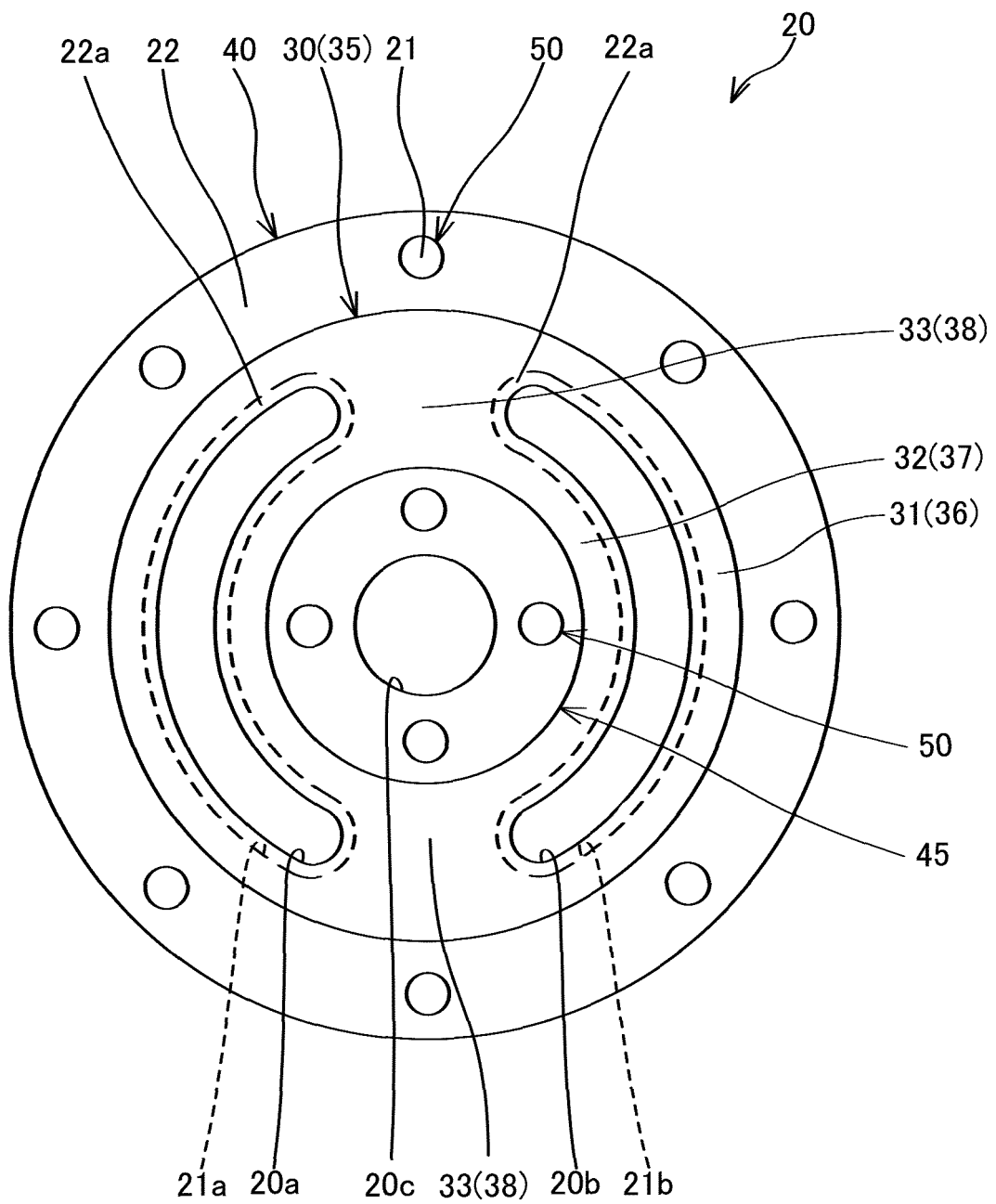


FIG. 3

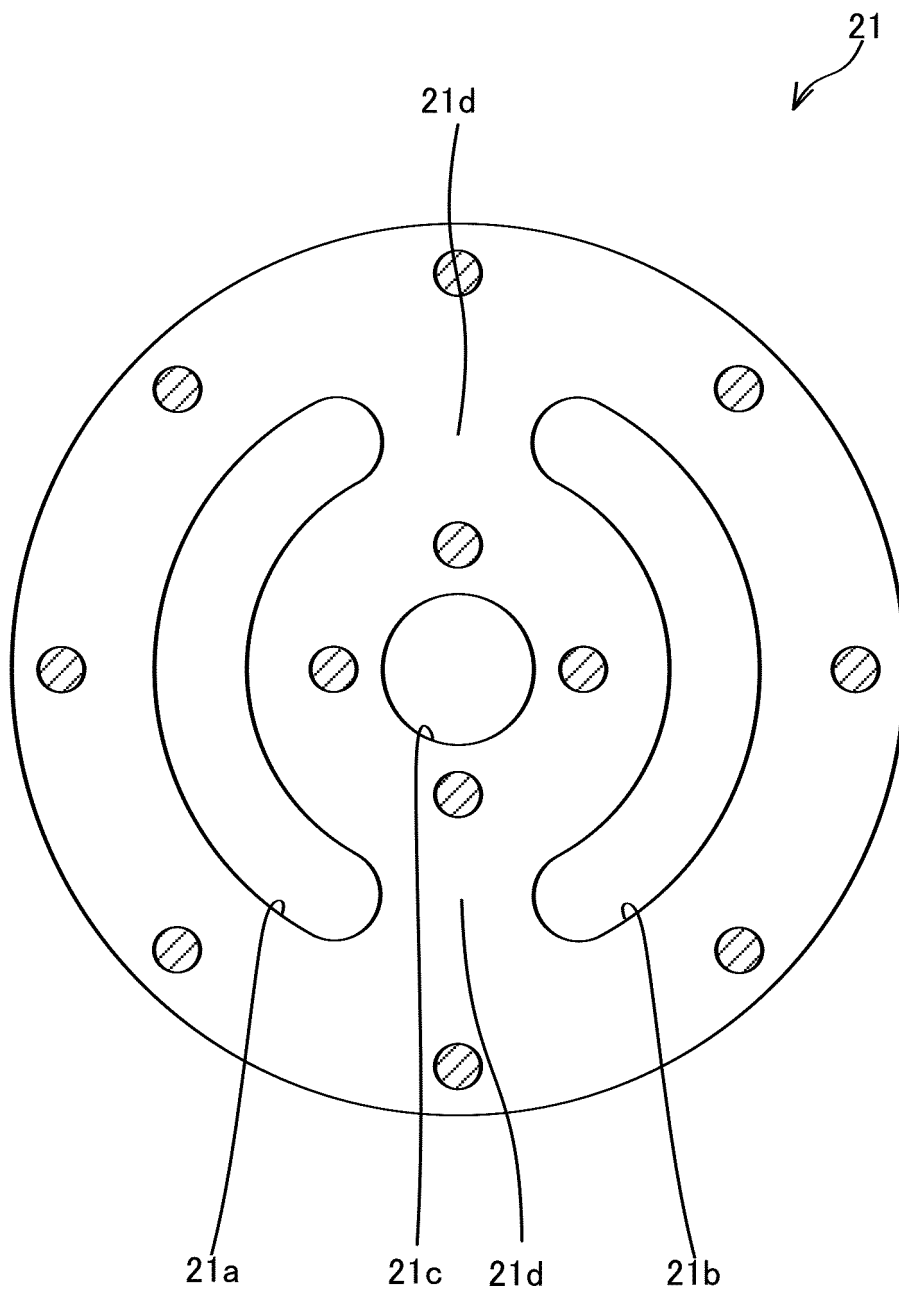


FIG. 4

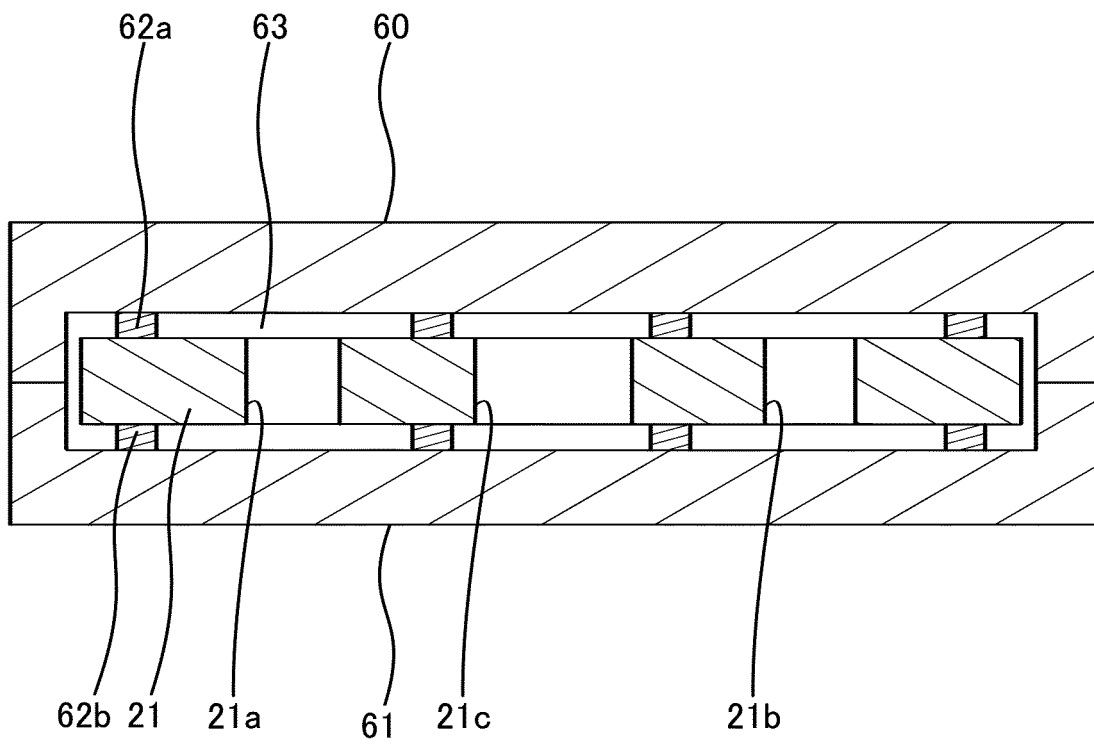


FIG. 5

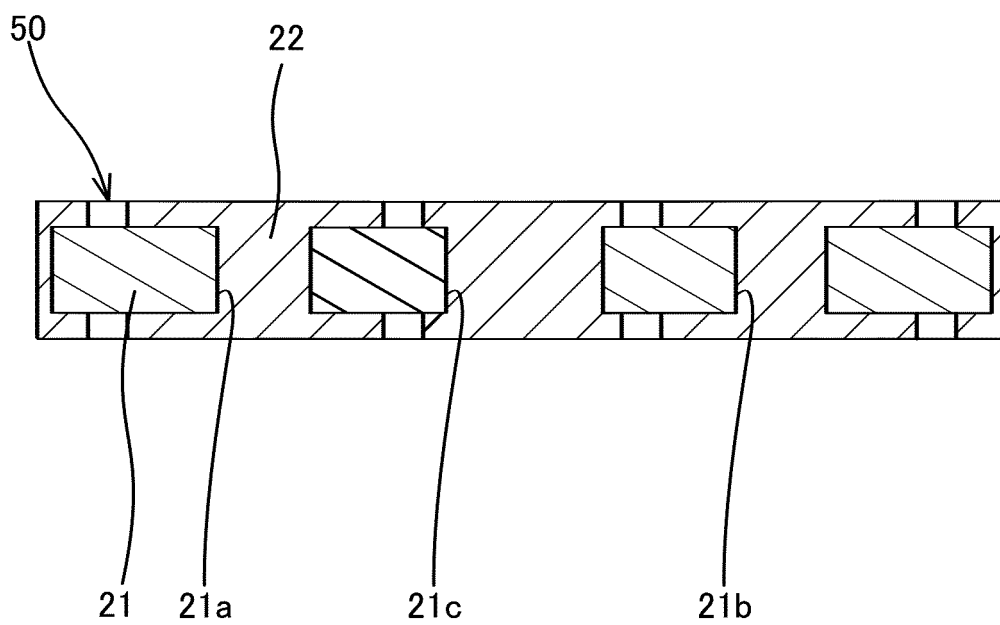


FIG. 6

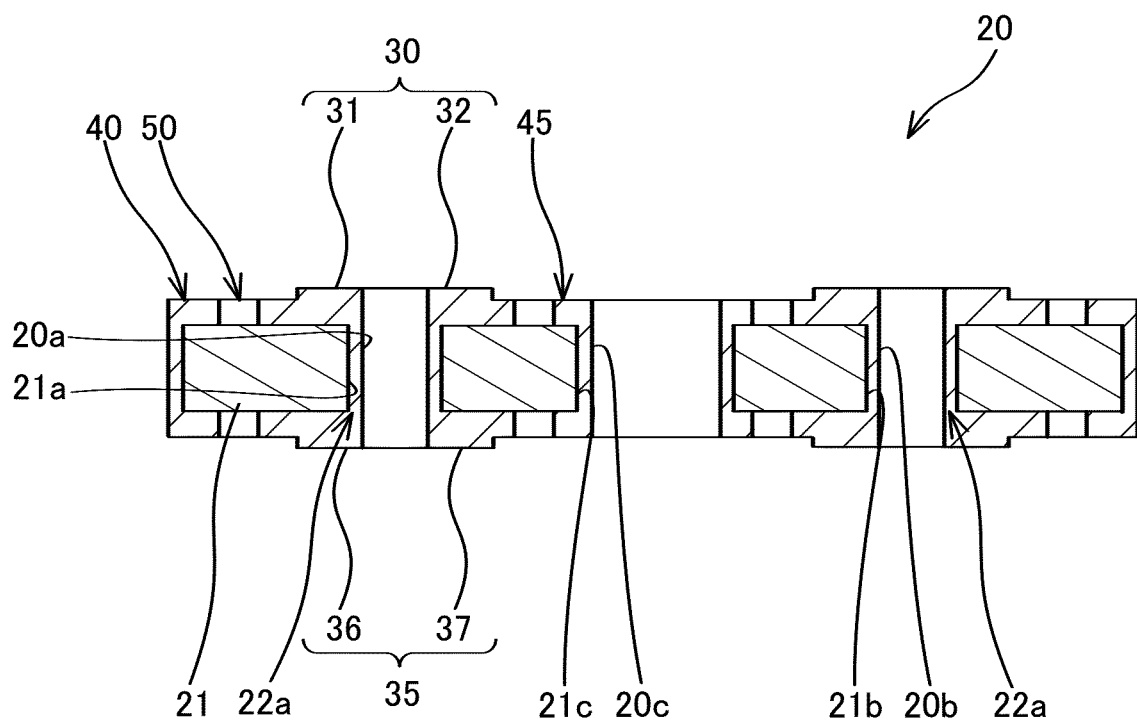


FIG. 7

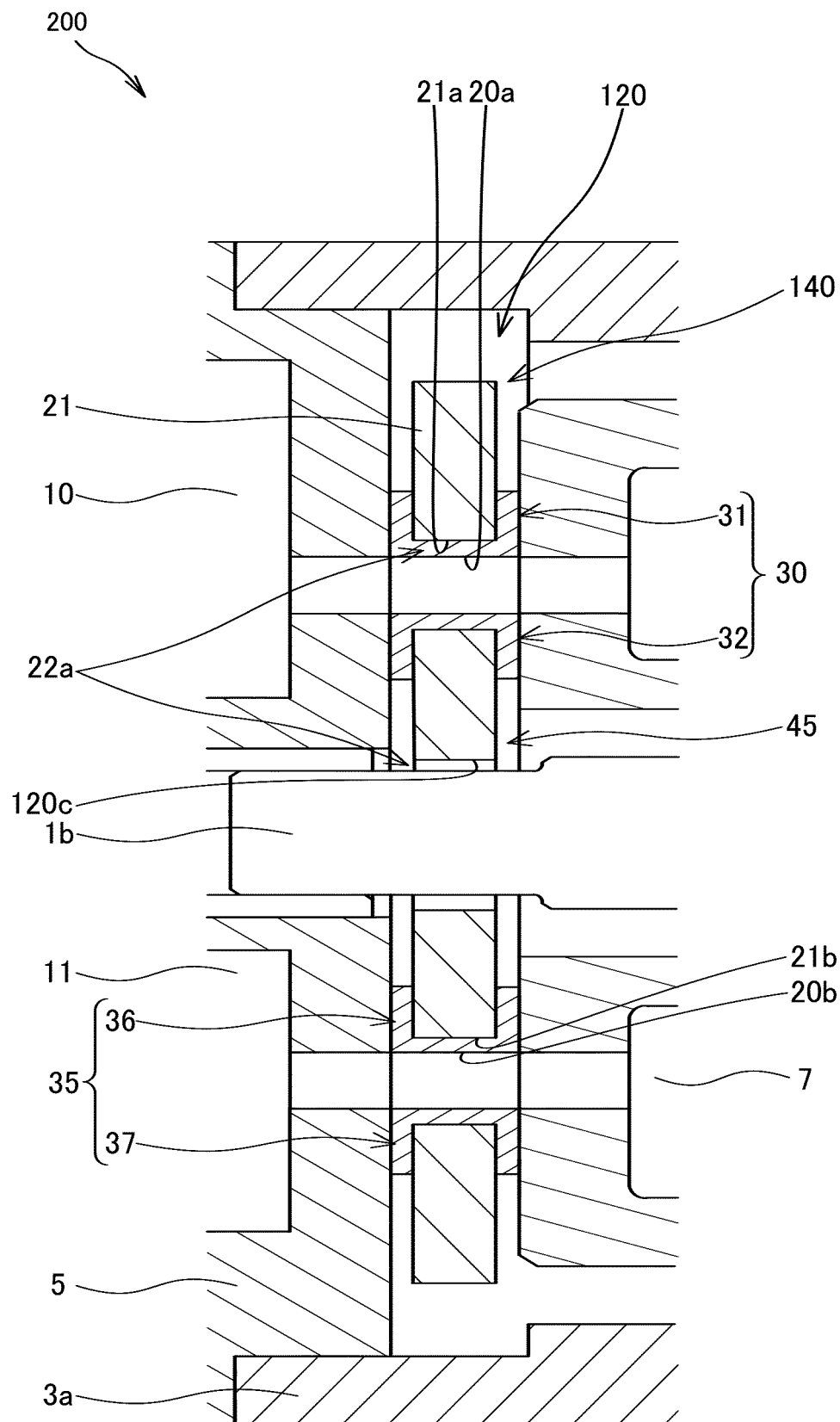


FIG. 8

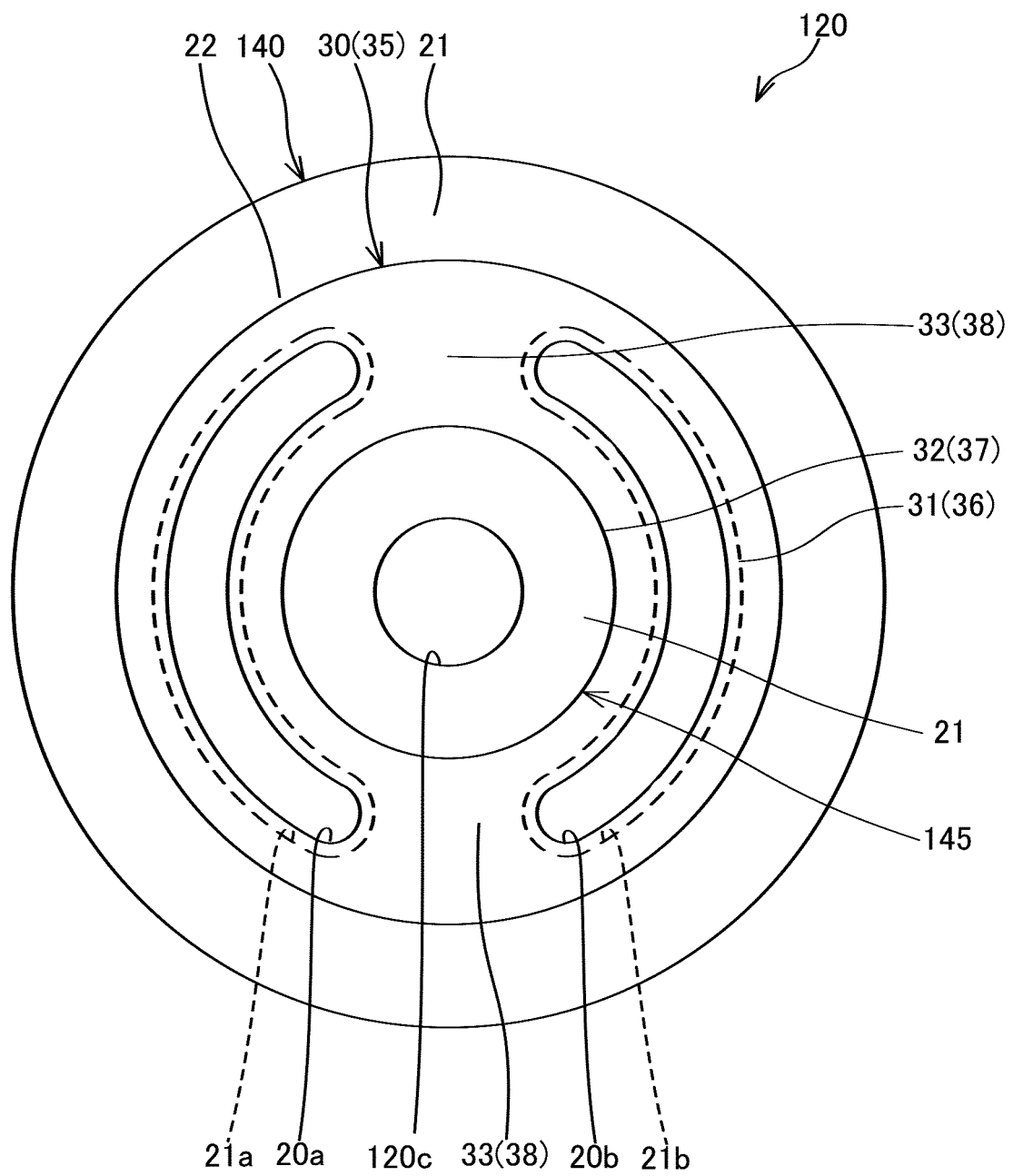


FIG. 9

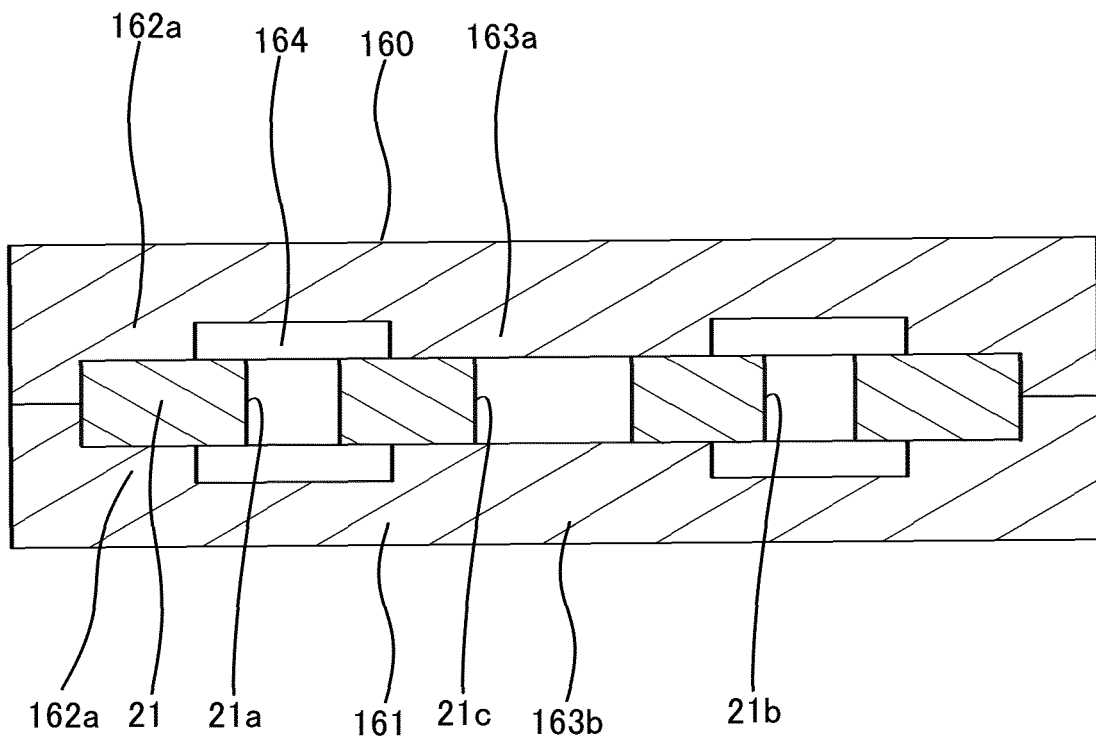


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/077189

A. CLASSIFICATION OF SUBJECT MATTER

F04B1/22(2006.01)i, F03C1/253(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)

F04B1/22, F03C1/253

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	JP 7-310674 A (Danfoss A/S), 28 November 1995 (28.11.1995), paragraphs [0009] to [0015]; fig. 1 to 4 & US 5573380 A column 3, line 62 to column 6, line 17; fig. 1 to 4	1-8
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 161893/1988(Laid-open No. 83383/1990) (Director General, Agency of Industrial Science and Technology), 27 June 1990 (27.06.1990), specification, page 4, line 16 to page 6, line 3; fig. 1 to 2, 5 (Family: none)	1-8

☒ 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
06 December 2016 (06.12.16)Date of mailing of the international search report
20 December 2016 (20.12.16)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/077189

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 69099/1986 (Laid-open No. 180676/1987) (Mitsubishi Heavy Industries, Ltd.), 16 November 1987 (16.11.1987), specification, page 4, lines 5 to 14; fig. 5(a), (b), (c) (Family: none)	1-8
Y	JP 57-56147 A (Nippon Light Metal Co., Ltd.), 03 April 1982 (03.04.1982), page 2, upper right column, line 7 to page 3, upper left column, line 14; fig. 1 to 5 (Family: none)	5-6
A	EP 0661451 A1 (Danfoss A/S), 05 July 1995 (05.07.1995), & DE 4341846 C1	1-8

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 7179616 A [0002] [0003]
- JP 2015183215 A [0091]