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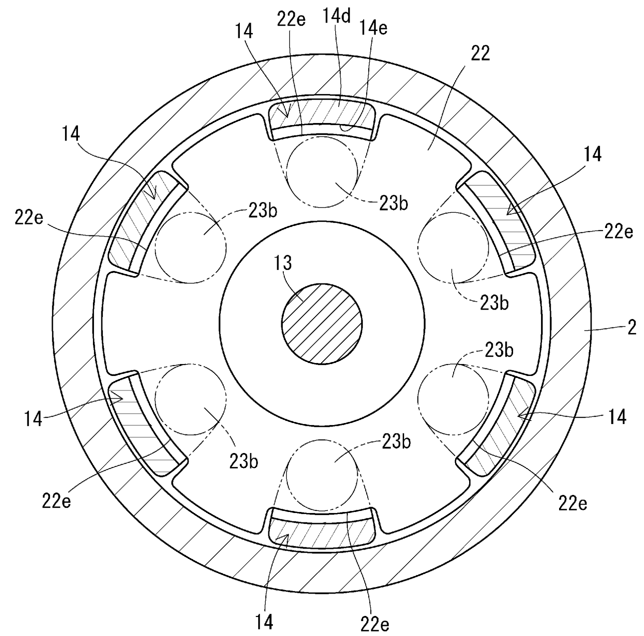
(54) Swash plate compressor

(57) A swash plate compressor which is capable of preventing a power loss due to ferry-around of the swash plate under a high durability is provided. The swash plate compressor according to the invention comprises a swash plate 22, a thrust bearing 20 and a radial bearing 21 preventing the swash plate from rotating with a drive shaft. The swash plate 22 includes a recesses 22e formed by depressing a peripheral surface, and pistons 14 are fitted to the recesses 22e. Accordingly, the swash plate 22 and the pistons 14 engage with each other and the swash plate 22 is provided with a detent structure.

Fig. 2



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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a swash plate compressor.

BACKGROUND ART

[0002] In the related art, a swash plate compressor in JP-A-10-159723 is disclosed. This compressor comprises a housing which is composed of a cylinder block, a front housing and a rear housing, and the cylinder block includes a plurality of cylinder bores penetrated therethrough. The rear housing includes a suction chamber and a discharge chamber which communicates with the respective cylinder bores via a valve unit. A crank chamber is defined by the front housing and the cylinder block, and a drive shaft is rotatably supported by the front housing. Pistons are stored in the respective cylinder bores so as to be capable of reciprocating, and the each piston defines a compression chamber in the cylinder bore.

[0003] In the crank chamber, a bush which rotated synchronously with the drive shaft is provided, and the bush is formed with a column-shaped peripheral surface having an axial line inclined with respect to the axial line of the drive shaft. The peripheral surface of the bush is provided with a swash plate via a radial bearing. Pairs of shoes are provided between the front and rear surfaces of the swash plate and seat surfaces of the respective pistons. The each shoe has substantially a semispherical shape. The swash plate is formed with recesses which are able to store the shoes on the flat sides thereof.

[0004] In this compressor, when the bush rotates in association with driving of the drive shaft, the swash plate performs only a rocking movement by the operation of the radial bearing. The rocking movement of the swash plate is transformed into a reciprocal movement of the pistons by the shoes, whereby refrigerant gas is sucked from the suction chamber into the compression chamber. The refrigerant gas is, after having compressed, discharged into the discharge chamber. Meanwhile, in the compressor, since the radial bearing is provided between the bush and the swash plate, and the shoes are stored in the recesses of the swash plate, so-called "ferry-around", which is a phenomenon that the swash plate tends to rotate with the bush, is prevented. In this manner, the power loss is prevented in this compressor.

[0005] A compressor as in JP-A-2001-221151 is also disclosed. This compressor is provided with a cam member which rotates synchronously with a drive shaft in a crank chamber, and the cam member is formed with a column-shaped peripheral surface having an axial line inclined with respect to an axial line of the drive shaft. A swash plate is provided on the back surface and the peripheral surface of the cam member respectively via a thrust bearing and a radial bearing. A plate-shaped detent plate is fixed to the swash plate via two screws, and the detent plate is formed with notches which are able to store the respective shoes on the flat sides thereof. Other components are the same as those in the compressor disclosed in JP-A-10-159723.

[0006] In this compressor as well, when the cam member rotates in association with driving of the drive shaft, the swash plate performs only a rocking movement by the operation of the thrust bearing and the radial bearing. The rocking movement of the swash plate is transferred into a reciprocal movement of the pistons by the shoes. Meanwhile, in this compressor, since the thrust bearing and the radial bearing are provided between the cam member and the swash plate, and the shoes are stored in the notches of the detent member fixed to the swash plate, the ferry-around, which is a phenomenon that the swash plate tends to rotate with the cam member is prevented. Other operations are the same as those in the compressor disclosed in JP-A-10-159723.

STATEMENT OF INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0007] However, in the both compressors described above, peripheral edges of the thin shoes tend to interfere with the recesses or the notches, so that there is concern over deterioration of durability due to deformation of the shoe, the swash plate, or the detent member.

[0008] In view of such circumstances in the related art, it is a subject to be solved by the invention to provide a swash plate compressor in which a power loss due to ferry-around of the swash plate may be prevented under a high durability.

MEANS FOR SOLVING PROBLEM

[0009] A swash plate compressor in the invention comprises a housing having a cylinder bore, a drive shaft rotatably supported by the housing, a piston stored in the cylinder bore so as to be capable of a reciprocal movement, a swash plate provided between the drive shaft and the piston for causing the surface of its own to rock by a rotational movement of the drive shaft, a pair of shoes provided between front and rear surfaces of the swash plate and seat surfaces of the piston for transferring the rocking movement of the swash plate into a reciprocal movement of the piston, and, a bearing preventing the swash plate from rotating along with the drive shaft, characterized in that: the swash plate and the piston engage with each other for providing the swash plate with a detent structure.

[0010] In the compressor in the invention, in view of the fact that the piston reciprocates in the cylinder bore and cannot rotate in the direction of rotation of the drive shaft, the swash plate and the piston engage directly with each other without the intermediary of the shoe, whereby the ferry-around of the swash plate is prevented. Therefore, the shoe is prevented from being deformed and a superior durability is demonstrated.

[0011] Therefore, according to the swash plate compressor in the invention, a power loss due to ferry-around of the swash plate is prevented under a high durability.

[0012] In the swash plate compressor in the invention, an engaging portion which engages the swash plate and the piston may be a separate member from the swash plate or the piston, and may be an integrated part with the swash plate or the piston. When integrating the engaging portion and the swash plate, it is preferable to prevent the concern over the strength of the swash plate from arising as in JP-A-10-159723. When the engaging portion is a separate member from the swash plate, there is a tendency to increase the manufacturing cost of the compressor because the number of components is increased as in JP-A-2001-221151. The engaging portion must simply be provided on at least one of the pistons. The engaging portion may be of a thickness smaller than the thickness of the swash plate.

[0013] It is possible to provide a rotary plate operating via the bearing with respect to the swash plate between the drive shaft and the swash plate. In this case, a compression reactive force acting on the swash plate may be received by the bearing provided between the rotary plate and the swash plate, so that a higher durability is demonstrated. When the inclination angle of the rotary plate may be varied while rotating synchronously with the drive shaft, so called, a double-swash-plate compressor is achieved.

[0014] As specific means in the invention, the swash plate includes a recess or recesses formed by depressing the peripheral surface thereof, and the piston or pistons may be fitted in the recess or recesses. As specific means in the invention, the swash plate includes a projection or projections projecting from the peripheral surface, and the piston or pistons may be fitted to the projection or the projections.

[0015] When providing the projection on the swash plate, if the swash plate is configured to allow variations in inclination angle with respect to a virtual plane which is substantially perpendicular to the axis of the drive shaft, the piston is preferably formed with a guiding portion of a spherical shape for guiding the pair of shoes and the projections. In this case, in the piston, since a simple improvement of the seat surface in the related art which only guides a pair of shoes may be used as the guiding portion, reduction of the manufacturing cost is achieved.

DESCRIPTION OF DRAWINGS

[0016] Fig. 1 is a vertical cross-sectional view of a capacity variable swash plate compressor according to Embodiment 1.

[0017] Fig. 2 is a lateral cross-sectional view of a principal portion of the capacity variable swash plate compressor in Embodiment 1.

[0018] Fig. 3 is an enlarged cross-sectional view of the principal portion of the capacity variable swash plate compressor in Embodiment 1.

[0019] Fig. 4 is an enlarged cross-sectional view of the principal portion of the capacity variable swash plate compressor in Embodiment 2.

[0020] Fig. 5 is a vertical cross-sectional view of the capacity variable swash plate compressor in Embodiment 3.

[0021] Fig. 6 is a vertical cross-sectional view of the capacity variable swash plate compressor in Embodiment 4.

DESCRIPTION OF SPECIFIC EMBODIMENT

[0022] Referring now to the drawings, embodied Embodiments 1 to 4 of the invention will be described.

EMBODIMENT 1

[0023] As shown in Fig. 1, a swash plate compressor in Embodiment 1 is of a capacity variable type using CO_2 as refrigerant gas. A housing is composed of a cylinder block 1, a front housing 2 and a rear housing 3, and the cylinder block 1 is formed with a plurality of cylinder bores 1a having a column shape extending in parallel with an axial line of a drive shaft 13 so as to penetrate therethrough. In Fig. 1, the left side corresponds to the front side of the compressor and the right side corresponds to the rear side of the compressor.

[0024] The rear housing 3 is formed with a suction chamber 5 and a discharge chamber 6 which communicate with the respective cylinder bores 1a via a valve unit 4. A crank chamber 7 is defined by the front housing 2 and the cylinder block 1, and the front housing 2 and the cylinder block 1 are formed with shaft holes 2a, 1b. The shaft hole 2a is provided with a radial bearing 8 and a shaft seal device 9, the shaft hole 1b is provided with a radial bearing 10 and a thrust bearing 11, and a pressing spring 12 is provided between the thrust bearing 11 and the valve unit 4. The drive shaft 13 is rotatably supported by the radial bearing 8 and so on in a state in which one end is projected from the front housing 2. Pistons 14 are reciprocally stored in the respective cylinder bores 1a, and the each piston 14 defines a compression chamber in the each cylinder bore 1a.

[0025] In the interior of the crank chamber 7, a lag plate 15 is fixed to the drive shaft 13, and a thrust bearing 16 is provided between the lag plate 15 and the front housing 2. A rotor plate 17 which is capable of varying the inclination angle with respect to a virtual surface which is substantially perpendicular to the axis of the drive shaft 13 is inserted into the drive shaft 13. Provided between the lag plate 15 and the rotor plate 17 are a link mechanism 18 and a pressing spring 19 for urging the lag plate 15 and the rotor plate 17 in the direction away from each other. A swash plate 22 is provided on the back surface of the rotor plate 17 via a thrust bearing 20 and a radial bearing 21.

[0026] Shoes 23a, 23b are provided between a set of the rotor plate 17 and the swash plate 22, and the respective pistons 14. The shoe 23a is provided between the surface of the rotor plate 17 and a seat surface 14a on the front side of the pistons 14, and the shoe 23b is provided between the surface of the swash plate 22 and a seat surface 14b on the rear side of the piston 14. The shoes 23a, 23b are formed into a substantially semi-spherical shape. In this manner, the compressor is of, so-called, a double-swash-plate type and improvement of durability is achieved by the employment of the shoes 23a, 23b.

[0027] A capacity control valve 24 is stored in the rear housing 3. The capacity control valve 24 communicates with the suction chamber 5 via a detection path 3a and communicates the discharge chamber 6 and the crank chamber 7 via a gas-supply path 3b. The capacity control valve 24 changes the opening of the gas-supply path 3b and changes the discharge capacity of the compressor by detecting the pressure of the suction chamber 5. The crank chamber 7 communicates with the suction chamber 5 via a gas-extraction path 1c. A condenser 26, an expansion valve 27 and an evaporator 28 are connected to the discharge chamber 6 via a piping 25, and the evaporator 28 is connected to the suction chamber 5 by the piping 25. An engine E as an external drive source, which is also a traveling drive source of a vehicle is operationally connected to the drive shaft 13 via a power transmission mechanism PT including an electromagnetic clutch and a pulley.

[0028] The each piston 14 includes a column-shaped body 14c which defines a compression chamber on the head side and a neck portion 14d which is integrated with the body 14c on the swash plate 22 side. The neck portion 14d is formed with a recess 14e opening toward the drive shaft 13 and storing the rotor plate 17, the thrust bearing 20, the swash plate 22 and the pair of shoes 23a, 23b. The neck portion 14d on the front side of the recess 14e is formed with the seat surface 14a for receiving the spherical surface of the shoe 23a, the neck portion 14d on the back side of the recess 14e is formed with the seat surface 14b for receiving the spherical surface of the shoe 23b. The seat surfaces 14a, 14b constitute the outer surface of the identical sphere.

[0029] As shown in Fig. 2 and Fig. 3, recesses 22e by the same number as the pistons 14 are formed on the peripheral surface of the swash plate 22. The respective pistons 14 are fitted at the neck portions 14d thereof to the respective recesses 22e.

[0030] In the compressor configured as described above, the lag plate 15 and the rotor plate 17 rotate synchronously by the rotation of the drive shaft 13. When the rotor plate 17 rotates, a relative rotation occurs between the rotor plate 17 and the swash plate 22 by the operation of the thrust bearing 20 and the radial bearing 21, and the rotational speed of the swash plate 22 is lowered to a level lower than the rotational speed of the rotor plate 17. The rocking movements of the rotor plate 17 and the swash plate 22 are transferred to a reciprocal movement of the pistons 14 by the shoes 23a, 23b. Accordingly, the compression chamber changes the capacity. Therefore, the refrigerant gas in the suction chamber 5 is taken into the compression chamber and compressed, and then discharged into the discharge chamber 6. In this manner, a refrigeration operation is carried out with a refrigeration circuit comprising the compressor, the condenser 26, the expansion valve 27 and the evaporator 28.

[0031] When the capacity control valve 24 changes the pressure in the crank chamber 7, the link mechanism 18 allows the rotor plate 17 and the swash plate 22 to be varied in inclination angle with respect to the lag plate 15, and the discharge capacity of the compressor is changed.

[0032] Meanwhile, the pistons 14 reciprocate in the cylinder bores 1a and do not rotate in the direction of rotation of the drive unit 13. The swash plate 22 engages directly the respective pistons 14 without the intermediary of the shoes 23a, 23b. In this manner, the ferry-around of the swash plate 22 is prevented. Therefore, this compressor does not suffer from deformation of the shoes 23a, 23b as in the compressor in the related art, so that a superior durability is demonstrated.

[0033] Therefore, according to the compressor described above, a power loss due to ferry-around of the swash plate 22 is prevented under a high durability.

[0034] In this compressor, the pistons 14 are prevented from being rolled by the neck portions 14d thereof fitted into the recesses 22e of the swash plate 22. Therefore, the neck portions 14d are prevented from being swung significantly in the lateral direction, so that abnormal noise generated by interference of the neck portions 14d with the front housing 2 or the swash plate 22 is also prevented. Since it is not necessary to provide the guide surface for preventing the respective pistons 14 from rolling on the front housing 2, a large capacity of the crank chamber 7 is ensured. Therefore, a large amount of lubricating oil in the crank chamber 7 may be secured, so that the concern over the power loss due to the shortage of the lubricating oil in the crank chamber 7 is also eliminated.

[0035] In this compressor, by forming the recesses 22e on the swash plate 22, the swash plate 22 and the respective pistons 14 are engaged with each other, and a separate member is not employed for preventing the ferry-around of the swash plate 22 and the rolling of the respective pistons 14. Therefore, reduction of the cost by reduction of the number of components is also realized.

[0036] In the compressor in Embodiment 1, one of more recesses 22e, but less than the number of pistons 14, may be provided on the swash plate 22. In this case as well, the ferry-around of the swash plate 22 is prevented.

EMBODIMENT 2

[0037] The compressor in Embodiment 2 is provided with projections 22f projecting from parts of the peripheral surface of the swash plate 22, as shown in Fig. 4. The neck portion 14d of the one piston 14 is formed with a recess 14f which fits to the projection 22f. Other components are the same as in Embodiment 1.

[0038] In this compressor as well, the ferry-around of the swash plate 22 is prevented.

[0039] In the compressor in Embodiment 2, it is also possible to provide the projections 22f by the same number as the number of pistons 14 on the swash plate 22 so that the projections 22f are fitted to the recesses 14f of the respective pistons 14. In this case, other effects and advantages are achieved in the same manner as in Embodiment 1.

EMBODIMENT 3

[0040] In the compressor in Embodiment 3, as shown in Fig. 5, a rotor plate 30 which is different from the rotor plate 17 in Embodiment 1 is inserted into the drive shaft 13. A swash plate 33 is provided on the back surface of the rotor plate 30 via a thrust bearing 31 and a radial bearing 32. The pairs of shoes 23a, 23b are provided between the front and rear surfaces of the swash plate 33 and the seat surfaces of the pistons 14.

[0041] The each piston 14 is formed with a guide portion 14g which constitutes the outer surface of the identical sphere as the seat surfaces 14a, 14b. Formed on the peripheral surface of the swash plate 33 are projections 33a by the same number as the number of the pistons 14. The outer surface of the each projection 33a constitutes a part of the spherical surface which is aligned with the guide portion 14g. Other components are the same as those in Embodiment 1.

[0042] In the compressor configured as described above, when the drive shaft 13 rotates, the lag plate 15 and the rotor plate 30 rotate synchronously. When the rotor plate 30 rotates, the swash plate 33 does not rotate by the actions of the thrust bearing 31 and the radial bearing 32. Therefore, the pistons 14 reciprocate in the cylinder bores 1a via the shoes 23a, 23b.

[0043] Meanwhile, in this compressor as well, the ferry-around of the swash plate 33 is prevented as in Embodiments 1 and 2. In this compressor, since the guide portion 14g is formed easily by improving the seat surfaces 14a, 14b in the related art which guide only the pair of shoes 23a, 23b in the each piston 14, the reduction of the manufacturing cost may also be achieved. Other effects and advantages are the same as those in Embodiment 1.

[0044] In the compressor in Embodiment 3, it is also possible to provide one or more of the projections 33a, but less than the number of pistons 14, on the swash plate 33, and employ the pistons 14 having the guide portion or guide portions 14g which fit the projection or projections 33a. In this case as well, the ferry-around of the swash plate 33 may be prevented.

EMBODIMENT 4

[0045] The compressor in Embodiment 4 is, as shown in Fig. 6, of a fixed capacity type, in which the housing is composed of a cylinder block 41, a front housing 42 and a rear housing 43, and the cylinder block 41 is formed with a plurality of cylinder bores 41a penetrated therethrough. In Fig. 6, the left side corresponds to the front side of the compressor and the right side corresponds to the rear side of the compressor.

[0046] The rear housing 43 is formed with a suction chamber 45 and a discharge chamber 46 which communicate with the respective cylinder bores 41a via a valve unit 44. A crank chamber 47 is defined by the front housing 42 and the cylinder block 41, the front housing 42 is formed with a shaft hole 42a, and the cylinder block 41 is formed with the shaft hole 41b in the form of depression. The shaft hole 42a is provided with a thrust bearing 48 and a shaft seal device 49, the shaft hole 41b is formed with a radial bearing 50 and a thrust bearing 51, and a pressing spring 52 is provided between the thrust bearing 51 and the bottom surface of the shaft hole 41b. A drive shaft 53 is rotatably supported by the thrust bearing 48 and so on in a state in which one end is projected from the front housing 42. Pistons 54 are reciprocally stored in the respective cylinder bores 41a, and the each piston 54 defines a compression chamber in the each cylinder bore 41a.

[0047] In the interior of the crank chamber 47, a thrust plate 55 is fixed to the drive shaft 53, and the thrust bearing 48 is provided between the thrust plate 55 and the front housing 42. A column-shaped inclined portion 55a having an axial line inclined with respect to the axial line of the drive shaft 53 is integrally formed on the back side of the thrust plate 55. A swash plate 58 is provided on the peripheral surface of the inclined portion 55a via a thrust bearing 56 and a radial bearing 57. Provided between the front and rear surfaces of the swash plate 58 and the seat surfaces of the pistons 54 are the pairs of shoes 23a, 23b.

[0048] The each piston 54 is formed with the guide portion 14g which constitutes the outer surface of the same sphere as the seat surfaces 14a, 14b. The projections 33a by the same number as the number of pistons 54 are formed so as to project from the peripheral surface of the swash plate 58. The outer surface of the each projection 33a constitutes a part of the spherical surface which is aligned with the guide portion 14g. Other components are the same as those in Embodiment 3.

[0049] In the compressor configured as described above, when the drive shaft 53 rotates, the thrust plate 55 rotates synchronously, and the swash plate 58 does not rotate by the actions of the thrust bearing 56 and the radial bearing 57. Therefore, the pistons 54 reciprocate in the cylinder bores 41a via the shoes 23a, 23b. In this compressor as well, the same effects and advantages as those in Embodiment 3 are achieved.

[0050] Although the invention has been described above on the basis of Embodiments 1 to 4, it is needless to say that the invention is not limited to the Embodiments 1 to 4, and modifications may be made as needed without departing the scope of the invention.

[0051] For example, in the compressor in Embodiments 1 to 4, a guide surface may be provided on the housing for preventing the pistons 14, 54 from rolling.

EXPLANATION OF INDUSTRIAL APPLICATION OF INVENTION

[0052] The invention is applicable in air-conditioning apparatuses for vehicles.

A swash plate compressor which is capable of preventing a power loss due to ferry-around of the swash plate under a high durability is provided. The swash plate compressor according to the invention comprises a swash plate 22, a thrust bearing 20 and a radial bearing 21 preventing the swash plate from rotating with a drive shaft. The swash plate 22 includes a recesses 22e formed by depressing a peripheral surface, and pistons 14 are fitted to the recesses 22e. Accordingly, the swash plate 22 and the pistons 14 engage with each other and the swash plate 22 is provided with a detent structure.

Claims

1. A swash plate compressor comprising:

a housing having a cylinder bore;
a drive shaft rotatably supported by the housing;
a piston stored in the cylinder bore so as to be capable of a reciprocal movement;
a swash plate provided between the drive shaft and the piston for causing a surface of its own to rock by a rotational movement of the drive shaft;
a pair of shoes provided between front and rear surfaces of the swash plate and seat surfaces of the piston for transferring the rocking movement of the swash plate into a reciprocal movement of the piston; and
a bearing preventing the swash plate from rotating along with the drive shaft, **characterized in that**:

the swash plate and the piston engage with each other for providing the swash plate with a detent structure.

2. The swash plate compressor according to Claim 1, **characterized in that**:

a rotary plate operating via the bearing with respect to the swash plate is provided between the drive shaft and the swash plate.

3. The swash plate compressor according to Claim 1 or 2, **characterized in that**:

the swash plate includes a recess or recesses formed by depressing a peripheral surface thereof, and the piston is fitted in the recess or recesses.

4. The swash plate compressor according to Claim 1 or 2, **characterized in that**:

the swash plate includes a projection or projections projecting from a peripheral surface thereof and the piston is fitted to the projection or the projections.

5. The swash plate compressor according to Claim 4, wherein the swash plate is configured to allow variations in inclination angle with respect to a virtual plane which is substantially perpendicular to the axis of the drive shaft, **characterized in that**:

the piston is formed with a guiding portion of a spherical shape for guiding the pair of shoes and the projections.

Fig. 1

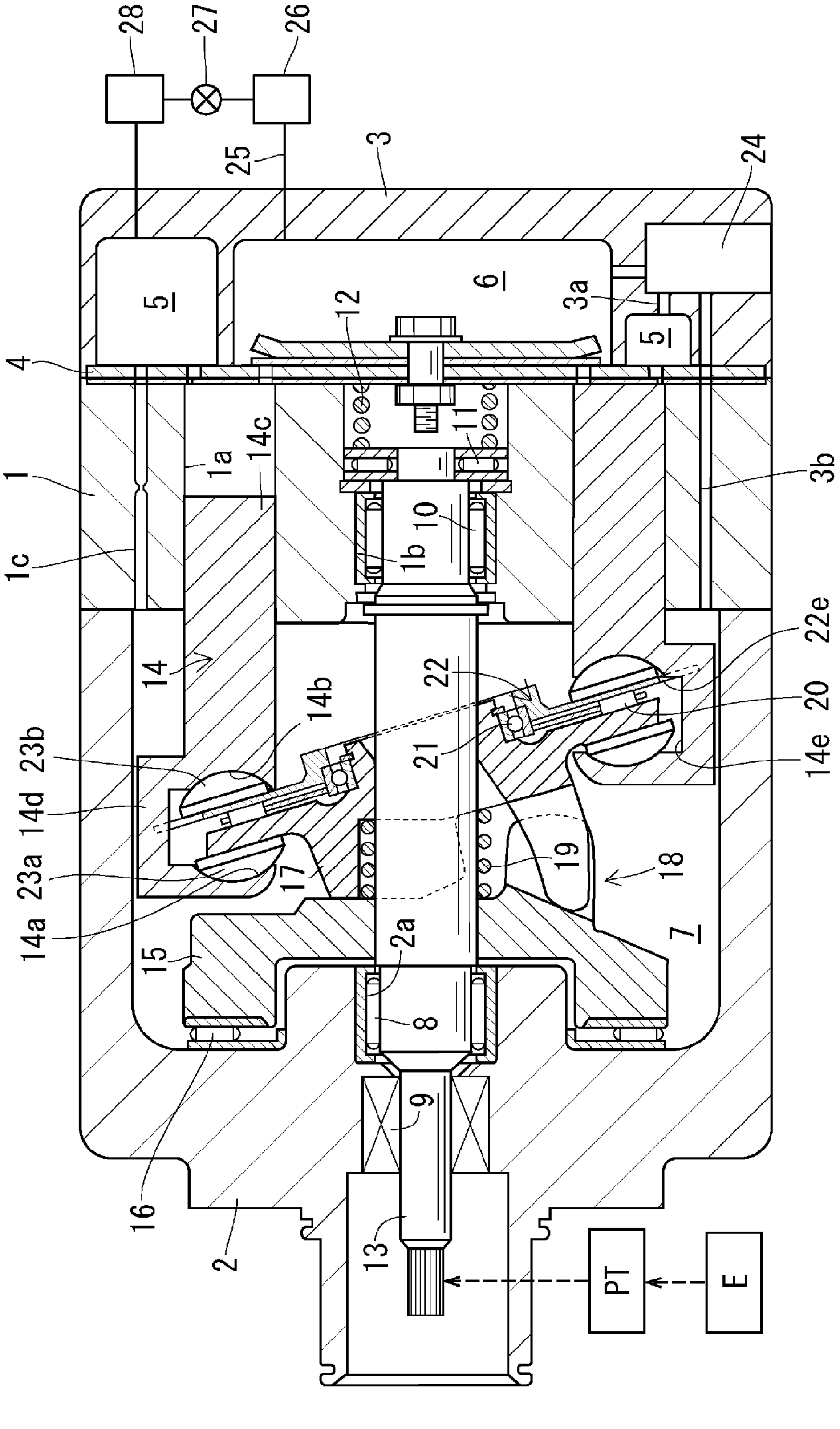
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Fig. 2

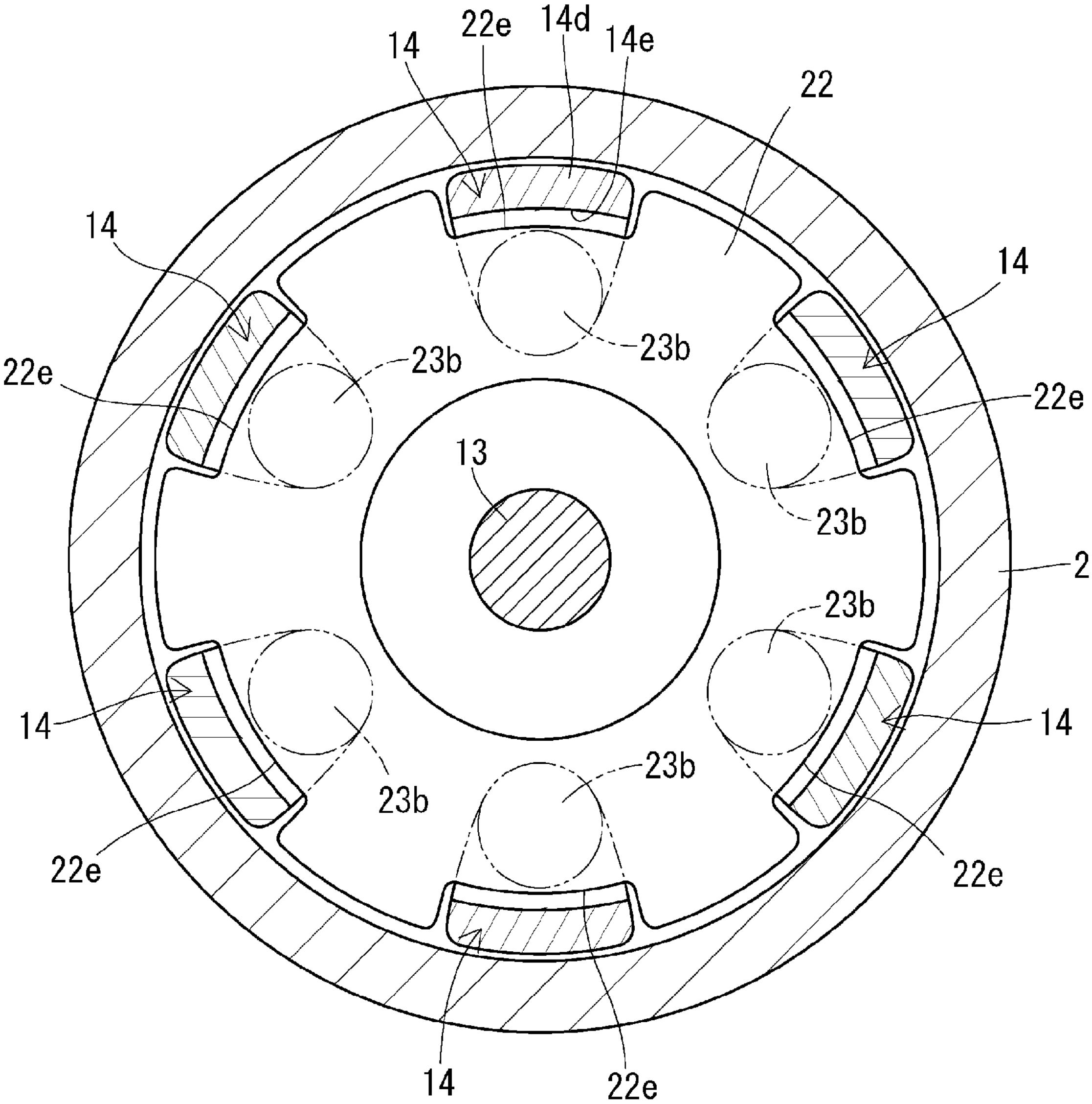
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Fig. 3

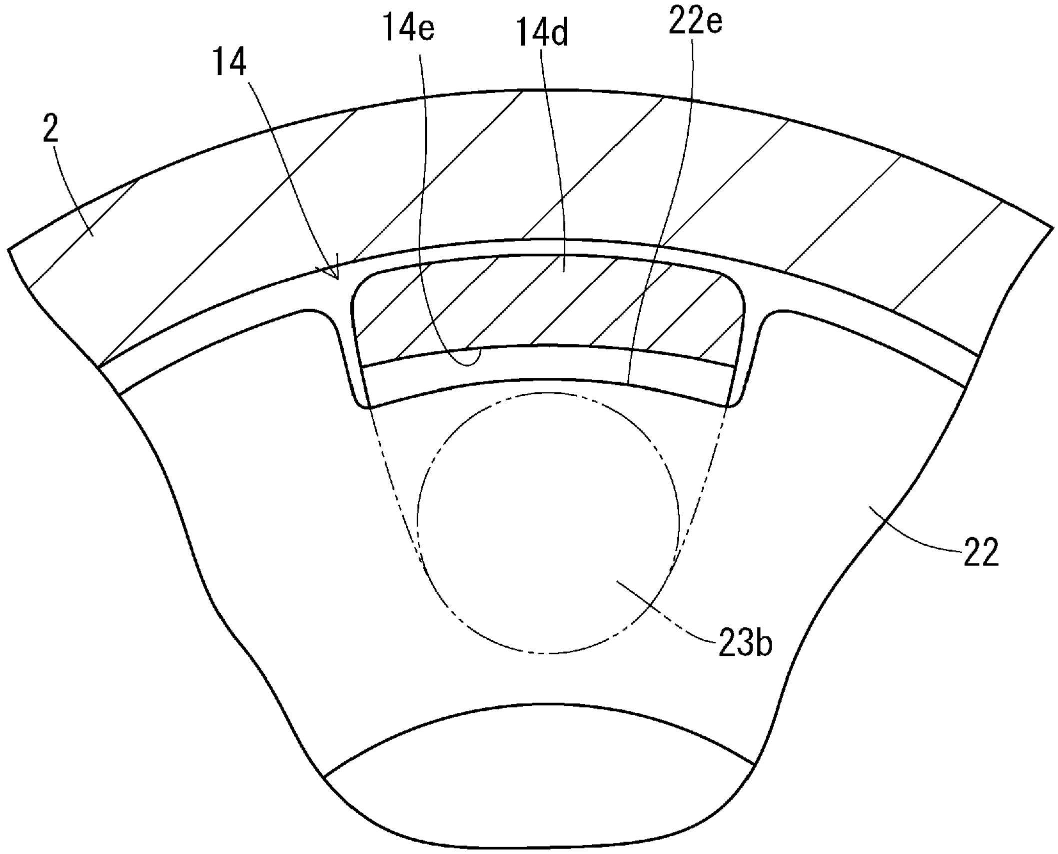

Fig. 4

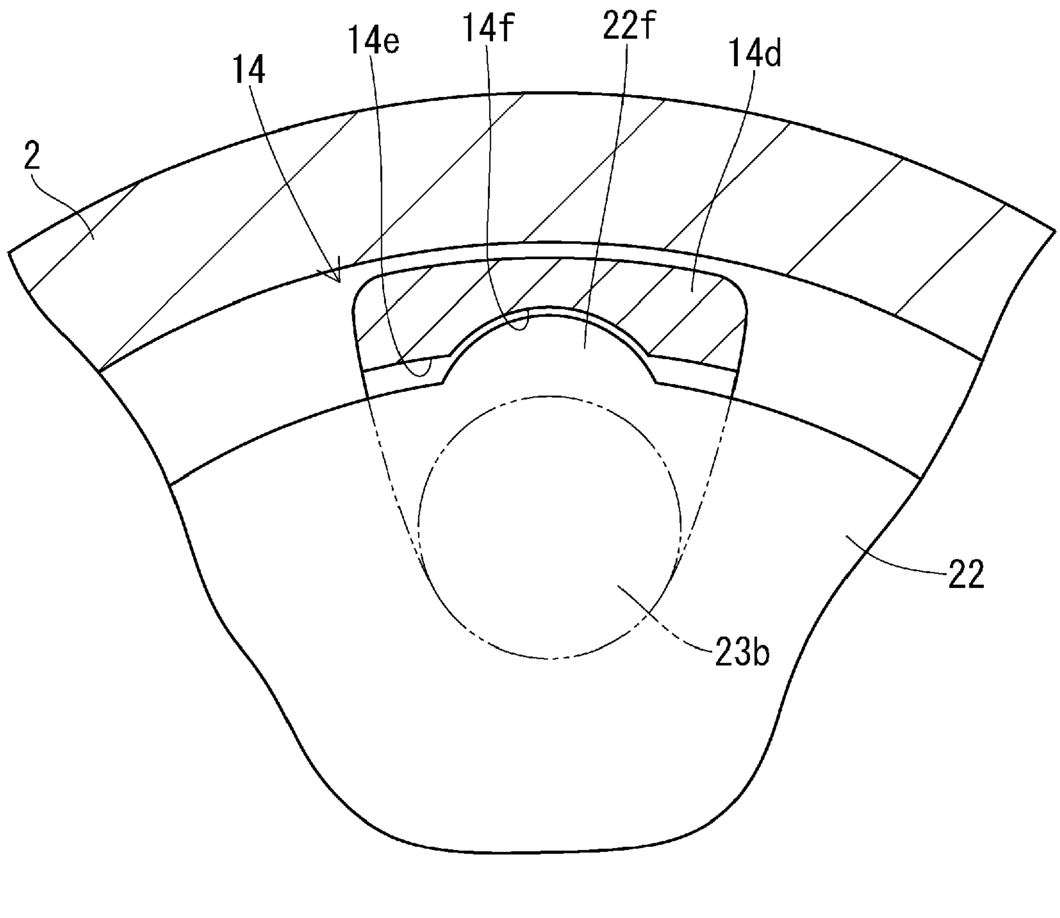

Fig. 5

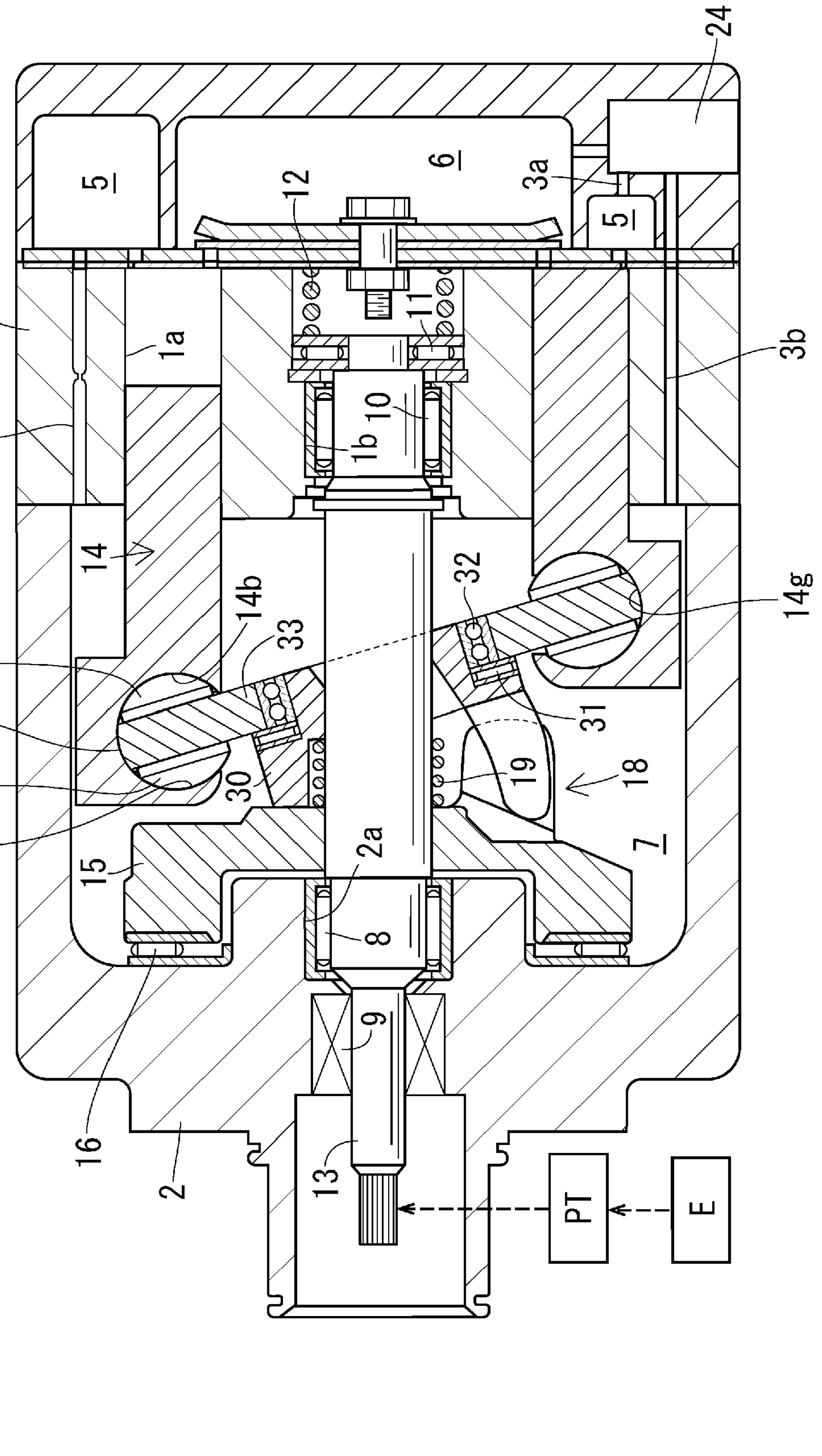
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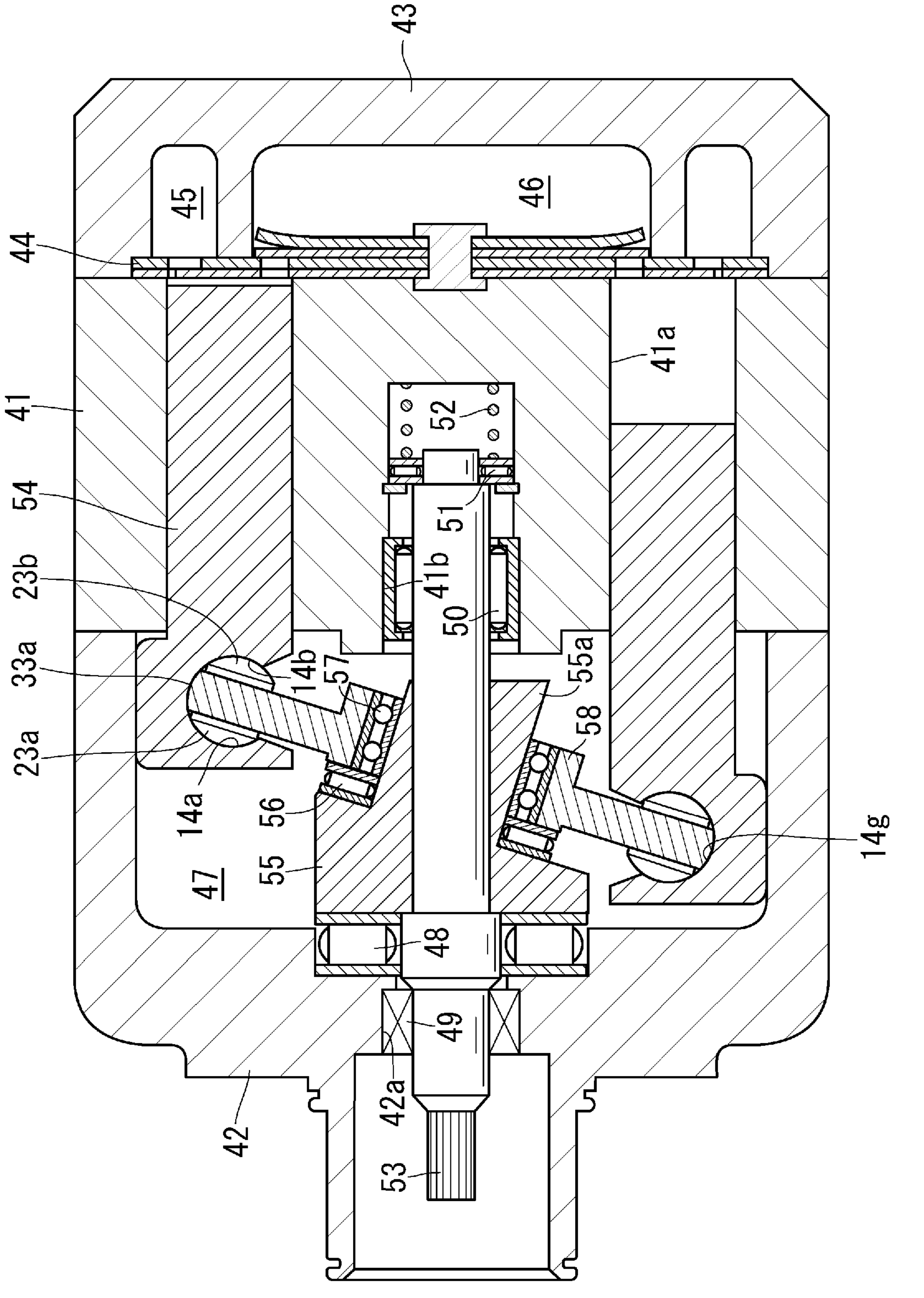
Fig. 6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REFERENCES CITED IN THE DESCRIPTION

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