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(72) Inventors:

- **SA, Bumdong**
Seoul 08592 (KR)
- **SEOL, Seseok**
Seoul 08592 (KR)
- **KANG, Seoungmin**
Seoul 08592 (KR)

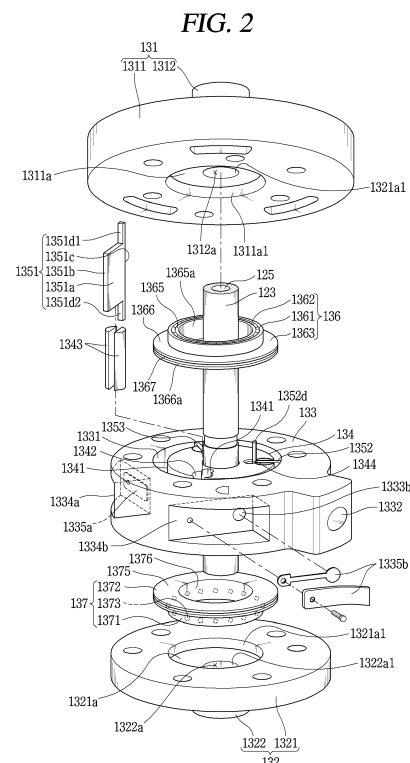
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(74) Representative: **Vossius & Partner**
Patentanwälte Rechtsanwälte mbB
Siebertstraße 3
81675 München (DE)

(71) Applicant: **LG Electronics Inc.**
Yeongdeungpo-gu
Seoul 07336 (KR)

(54) **ROTARY COMPRESSOR**

(57) A rotary compressor according to the present embodiment comprises: a main bearing and a sub-bearing which are respectively provided on both sides of a cylinder in the axial direction and each provided with a guide groove; a roller which is accommodated in the cylinder and rotated along with a rotary shaft; at least one vane which is slidably inserted in the roller, and on which a guide protrusion that is slidably inserted in the guide groove in the circumferential direction is extended in the axial direction; and a bearing member which is provided between the guide groove of at least one bearing between the main bearing and the sub-bearing and the guide protrusion of the vane. As such, the frictional loss between the vane or the roller and the main bearing or the sub-bearing facing same can be reduced to improve the compressor efficiency.



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Description

Technical Field

[0001] The present disclosure relates to a vane rotary compressor in which a vane is coupled to a rotating roller.

Background Art

[0002] A rotary compressor may be divided into two types, namely, a type in which a vane is slidably inserted into a cylinder to be in contact with a roller, and another type in which a vane is slidably inserted into a roller to be in contact with a cylinder. In general, the former is called a roller eccentric rotary compressor (hereinafter, referred to as a "rotary compressor"), and the latter is referred to as a vane concentric rotary compressor (hereinafter, referred to as a "vane rotary compressor").

[0003] As for a rotary compressor, a vane inserted in a cylinder is pulled out toward a roller by elastic force or back pressure to come into contact with an outer circumferential surface of the roller. On the other hand, as for a vane rotary compressor, a vane inserted in a roller rotates together with the roller, and is pulled out by centrifugal force and back pressure to come into contact with an inner circumferential surface of a cylinder.

[0004] A rotary compressor independently forms compression chambers as many as the number of vanes per revolution of a roller, and the compression chambers simultaneously perform suction, compression, and discharge strokes. On the other hand, a vane rotary compressor continuously forms as many compression chambers as the number of vanes per revolution of a roller, and the compression chambers sequentially perform suction, compression, and discharge strokes. Accordingly, the vane rotary compressor has a higher compression ratio than the rotary compressor. Therefore, the vane rotary compressor is more suitable for high pressure refrigerants such as R32, R410a, and CO₂, which have low ozone depletion potential (ODP) and global warming index (GWP).

[0005] In such vane rotary compressors, since a plurality of vanes rotate together with a roller, sealing surfaces of the vanes slide in contact with the inner circumferential surface of the cylinder, thereby increasing frictional losses as compared with general rotary compressors.

[0006] Such a vane rotary compressor is disclosed in Patent Document 1 (US Patent Publication No. US2015-0064042 A1). The vane rotary compressor disclosed in Patent Document 1 has a structure in which suction refrigerant is filled in an inner space of a motor room as in a low-pressure type but a plurality of vanes are slidably inserted into a rotating roller.

[0007] In the vane rotary compressor disclosed in Patent Document 1, an inner circumferential surface of a cylinder forming a compression space is defined by a plurality of curves. For example, the inner circumferential

surface of the cylinder disclosed in Patent Document 1 may be formed in an asymmetrical elliptical shape that is eccentric with respect to an axial center of a rotating shaft. Accordingly, the inner circumferential surface of the cylinder is provided with a proximal portion closest to the axial center and a remote portion farthest from the axial center, and curved surfaces having different aspect ratios are connected between the proximal portion and the remote portion.

[0008] On the other hand, the roller is formed in a circular shape with a constant curvature on an outer circumferential surface and is disposed concentrically with respect to the axial center of the rotating shaft. The roller is provided with a plurality of vane slots that are split and recessed by a predetermined depth at equal intervals along the outer circumferential surface.

[0009] In the vane rotary compressor as described above, an inner circumferential surface of the cylinder and an end portion of the vane (i.e., sealing surface) always move relative to each other in a contact state or with an oil film interposed therebetween. This may increase mechanical frictional loss between the cylinder and the vane.

[0010] Accordingly, as in Patent Document 2 (Korean Patent Publication No. 10-2011-0095155), a structure for suppressing mechanical frictional loss between a vane and a cylinder by regulating a radial motion of the vane is known. That is, in Patent Document 2, a ring is disposed on a main bearing or a sub bearing, and a pin that slides along the ring in a circumferential direction is disposed on the vane. This merely allows the vane to perform a rotary motion along the roller and restricts a radial motion toward the cylinder. Then, since the vane always maintains its position relative to the cylinder, friction between the cylinder and the vane can be suppressed.

[0011] In the vane rotary compressor as described above, since the position of the vane is determined by the ring, when there is a large machining or assembly error, the vane and the cylinder may be excessively closely attached or, on the contrary, excessively spaced apart. In addition, frictional loss between an axial side surface of the roller and an axial side surface of the bearing facing the same may still occur.

[0012] Thus, as in Patent Document 3 (Japanese Laid-Open Patent Publication No. 2012-167578), a structure of restricting a contact between a front end portion (sealing surface) of a vane and a cylinder but enabling a radial motion of the vane is disclosed. That is, in Patent Document 3, a circular vane guide groove that is eccentric with respect to a bearing is provided, and a semicircular vane guide is applied to rotate along the vane guide groove. Accordingly, while moving radially with respect to an inner circumferential surface of the cylinder, the vane is maintained in a non-contact state with the inner circumferential surface of the cylinder. This may reduce mechanical frictional loss between the cylinder and the vane by reducing a contact area between the cylinder and the vane.

[0013] However, in the related art vane rotary compressor as described above, as the vane guide slides along an inner circumferential surface of the vane guide groove, mechanical frictional loss may occur between the vane guide and the vane guide groove.

[0014] In addition, in the related art vane rotary compressor, mechanical frictional loss may also occur between an axial side surface of a roller and an axial side surface of a main bearing or sub bearing facing the roller.

Disclosure of Invention

Technical Problem

[0015] The present disclosure describes a rotary compressor capable of reducing mechanical frictional loss due to a rotation of a vane.

[0016] The present disclosure also describes a rotary compressor capable of reducing mechanical frictional loss between a main bearing or/and a sub bearing and a vane while restricting the vane from being drawn out by using the main bearing or/and sub bearing.

[0017] The present disclosure further describes a rotary compressor capable of reducing mechanical frictional loss between a main bearing or/and a sub bearing and a vane by providing a bearing member between the main bearing or/and sub bearing and the vane.

[0018] The present disclosure further describes a rotary compressor capable of reducing mechanical frictional loss due to a rotation of a roller.

[0019] The present disclosure further describes a rotary compressor capable of reducing mechanical frictional loss between a main bearing or/and a sub bearing and a roller facing the same.

[0020] The present disclosure further describes a rotary compressor capable of reducing mechanical frictional loss between a main bearing or/and sub bearing and a roller by providing a bearing member between the main bearing or/and sub bearing and the roller.

Solution to Problem

[0021] To achieve these and other advantages and in accordance with the purpose of the present disclosure, as embodied and broadly described herein, there is provided a rotary compressor, in which a guide groove is formed in a surface, facing an axial side surface of a roller, of at least one of a main bearing and a sub bearing, a guide protrusion having a contact surface extends axially from an axial end portion of a vane facing the guide groove to be inserted into the guide groove and slid along an inner circumferential surface of the guide groove, and a bearing member is disposed between the inner circumferential surface of the guide groove and the contact surface of the guide protrusion facing the same. This configuration can reduce mechanical frictional loss in a radial direction between the vane and the main bearing or sub bearing supporting the vane.

[0022] In addition, in order to achieve the aspect of the present disclosure, guide grooves may be formed in a main bearing and a sub bearing supporting a rotating shaft, and guide protrusions may be formed on a vane slidably inserted into a roller to be slidably inserted into the guide grooves and locked in a radial direction, and ball bearings may be disposed between the guide grooves and the guide protrusions. This can facilitate a bearing member to be installed between the vane and the main bearing or sub bearing supporting the vane.

[0023] For example, inner rings constituting the respective ball bearings may further include rotating plate portions extending between the main bearing and the roller and between the sub bearing and the roller. This can reduce mechanical frictional loss in an axial direction between the roller and the main bearing or sub bearing facing the roller.

[0024] As another example, the rotating plate portion may be rotatably inserted into an inner circumferential surface of the cylinder. This can more effectively reduce the axial mechanical frictional loss between the roller and the main bearing or sub bearing facing the roller.

[0025] In addition, in order to achieve the aspect of the present disclosure, guide grooves may be formed in a main bearing and a sub bearing supporting a rotating shaft, and guide protrusions may be formed on a vane slidably inserted into a roller to be slidably inserted into the guide grooves and locked in a radial direction, a first bearing portion may be disposed between the guide groove and the guide protrusion, a second bearing portion may be disposed between the main bearing and the roller and/or between the sub bearing and the roller, and the first bearing portion and the second bearing portion may be formed integrally with each other. This can reduce radial frictional loss between the vane and the main or sub bearing and axial frictional loss between the roller and the main or sub bearing.

[0026] As one example, the first bearing portion and the second bearing portion may be integrally formed with each other. This can facilitate manufacture of a bearing member that can reduce radial and axial frictional losses.

[0027] As another example, an outer circumferential surface of the second bearing portion may be disposed to face an inner circumferential surface of the cylinder, and a sealing portion may be formed on the outer circumferential surface of the second bearing portion. This can effectively suppress refrigerant leakage in a compression space even while the second bearing portion rotates in the cylinder.

[0028] In addition, in order to achieve the aspect of the present disclosure, an inner circumferential surface of the cylinder may be formed in an annular shape. The main bearing and the sub bearing disposed on both sides of the cylinder in an axial direction may form a compression space together with the cylinder, and each may have a guide groove on a side surface thereof forming the compression space. A roller accommodated in the cylinder may be disposed to rotate along with a rotating shaft. At

least one vane slidably inserted into the roller may include the guide protrusion that extends therefrom in the axial direction so as to be slidably inserted into the guide groove in a circumferential direction. A bearing member may be disposed between the guide groove of at least one of the main bearing and the sub bearing and the guide protrusion of the vane. This configuration can reduce frictional loss between the vane and the main bearing or sub bearing supporting the vane, thereby enhancing compression efficiency.

[0029] Specifically, the bearing member may include: an outer ring inserted into an inner circumferential surface of the guide groove; an inner ring disposed inside the outer ring, and having an inner circumferential surface slidably brought into contact with a contact surface of the guide protrusion; and a sliding member disposed between the outer ring and the inner ring to allow a relative motion between the outer ring and the inner ring. This can more effectively reduce mechanical frictional loss between the vane and the main bearing or sub bearing and simultaneously facilitate installation of the bearing member.

[0030] In one example, one of the outer ring or the inner ring may further include a rotating plate portion extending between the roller and the main bearing and the sub bearing facing the roller. This can more effectively reduce axial mechanical frictional loss between the roller and the main bearing or sub bearing facing the roller.

[0031] As one example, the bearing member may include: a first bearing portion disposed between at least one of the main bearing and the sub bearing and the vane facing the at least one bearing in a radial direction; and a second bearing portion disposed between at least one of the main bearing and the sub bearing and the roller facing the at least one bearing in an axial direction. This can reduce radial frictional loss between the vane and the main or sub bearing and axial frictional loss between the roller and the main or sub bearing.

[0032] As another example, the first bearing portion and the second bearing portion may be integrally formed with each other. This can facilitate manufacture of the bearing member that can reduce the radial and axial frictional losses.

[0033] As another example, the second bearing portion may be thicker than the first bearing portion. Accordingly, a sealing area can be secured between the cylinder and the bearing member and simultaneously a sealing portion can be easily formed on an outer circumferential surface of the second bearing portion.

[0034] As another example, the first bearing portion may be formed in an annular shape, and the second bearing portion may be formed in a disk shape.

[0035] As another example, the first bearing portion may include: an outer ring inserted into the guide groove of at least one of the main bearing and the sub bearing; an inner ring disposed inside the outer ring, and having an inner circumferential surface slidably brought into contact with the guide protrusion of the vane; and a sliding

member disposed between the outer ring and the inner ring to allow a relative motion between the outer ring and the inner ring. The second bearing portion may extend radially from one end of the inner ring or the outer ring of the first bearing portion to be disposed on an axial side surface of the roller and an axial side surface of the at least one of the main bearing and the sub bearing facing the axial side surface of the roller. This can reduce radial frictional loss between the vane and the main or sub bearing and axial frictional loss between the roller and the main or sub bearing.

[0036] As another example, the second bearing portion may be disposed such that an axial side surface thereof is spaced apart from an axial side surface of the main bearing or the sub bearing facing the same. This can suppress a contact between the second bearing portion and the main bearing or the sub bearing, thereby effectively reducing frictional loss.

[0037] As another example, the second bearing portion may be inserted into the cylinder so that an outer circumferential surface thereof faces an inner circumferential surface of the cylinder. This can allow a sealing surface to be defined between the second bearing portion and the inner circumferential surface of the cylinder, thereby effectively reducing refrigerant leakage in the compression space.

[0038] As another example, a sealing portion may be disposed between the outer circumferential surface of the second bearing portion and the inner circumferential surface of the cylinder. This can more effectively suppress the refrigerant leakage in the compression space even while the second bearing portion is spaced apart from the cylinder.

[0039] As another example, the outer circumferential surface of the second bearing portion may have the same shape as the inner circumferential surface of the cylinder. This can allow the second bearing portion to rotate inside the cylinder, thereby suppressing a relative motion between the roller and the second bearing portion.

[0040] As an example, the bearing member may be disposed between at least one of the main bearing and the sub bearing and the vane facing the at least one bearing in a radial direction, and an axial side surface of the roller may be in sliding contact with an axial side surface of the main bearing and an axial side surface of the sub bearing facing the same. This can suppress mechanical frictional loss between the second bearing portion and the roller.

[0041] As another example, the inner circumferential surface of the cylinder may be formed in a circular or elliptical shape. A discharge port may be formed in at least one of the axial side surface of the main bearing and the axial side surface of the sub bearing. With the configuration, the inner circumferential surface of the cylinder can be formed in various shapes, and overcompression can be suppressed by extending a compression cycle.

[0042] As an example, bush grooves may be formed

in the roller, two swing bushes may be rotatably inserted into the bush grooves, and the vane may be slidably inserted between the swing bushes. This can allow a front end portion of the vane to have the same curvature as the inner circumferential surface of the cylinder, thereby securing a sealing area between the cylinder and the vane.

Advantageous Effects of Invention

[0043] In a rotary compressor according to an embodiment, bearing members may be disposed between guide grooves disposed in a main bearing and a sub bearing and guide protrusions of vanes facing the guide grooves. This configuration can reduce frictional loss between the vane and the main bearing or sub bearing supporting the vane, thereby enhancing compression efficiency.

[0044] In addition, in the rotary compressor according to the embodiment of the present disclosure, a ball bearing that includes an outer ring, an inner ring, and a sliding member may be disposed between an inner circumferential surface of the guide groove and the guide protrusion facing the guide groove. This can more effectively reduce the mechanical frictional loss between the vane and the main bearing or sub bearing and simultaneously facilitate installation of a bearing member.

[0045] In the rotary compressor according to the embodiment of the present disclosure, one of the outer ring or the inner ring constituting the ball bearing may further include a rotating plate portion extending between the roller and the main bearing and the sub bearing facing the roller. This can more effectively reduce axial mechanical frictional loss between the roller and the main bearing or sub bearing facing the roller.

[0046] In addition, the rotary compressor according to the embodiment of the present disclosure may include a first bearing portion disposed between the main bearing and the sub bearing and the vane facing the same in a radial direction, and a second bearing portion disposed between the main bearing and the sub bearing and the roller facing the same in the axial direction. This can reduce radial frictional loss between the vane and the main or sub bearing and axial frictional loss between the roller and the main or sub bearing.

[0047] Also, in the rotary compressor according to the embodiment of the present disclosure, the first bearing portion and the second bearing portion may be formed integrally with each other. This can facilitate manufacture of a bearing member that can reduce radial and axial frictional losses.

[0048] Also, in the rotary compressor according to the embodiment of the present disclosure, the second bearing portion may be formed to be thicker than the first bearing portion. Accordingly, a sealing area can be secured between the cylinder and the bearing member and simultaneously a sealing portion can be easily formed on an outer circumferential surface of the second bearing portion.

[0049] In the rotary compressor according to the embodiment of the present disclosure, the second bearing portion may be disposed such that an axial side surface thereof is spaced apart from an axial side surface of the main bearing or the sub bearing facing the same. This can suppress a contact between the second bearing portion and the main bearing or the sub bearing, thereby effectively reducing frictional loss.

[0050] Also, in the rotary compressor according to the embodiment of the present disclosure, the second bearing portion may be inserted into the cylinder so that its outer circumferential surface faces the inner circumferential surface of the cylinder. This can allow a sealing surface to be defined between the second bearing portion and the inner circumferential surface of the cylinder, thereby effectively reducing refrigerant leakage in the compression space.

[0051] Also, in the rotary compressor according to the embodiment of the present disclosure, a sealing portion may be disposed between the outer circumferential surface of the second bearing portion and the inner circumferential surface of the cylinder. This can more effectively suppress refrigerant leakage in the compression space even while the second bearing portion is spaced apart from the cylinder.

[0052] In the rotary compressor according to the embodiment of the present disclosure, the inner circumferential surface of the cylinder may be formed in a circular or elliptical shape, and a discharge port may be formed through at least one of an axial side surface of the main bearing and an axial side surface of the sub bearing. With the configuration, the inner circumferential surface of the cylinder can be formed in various shapes, and overcompression can be suppressed by extending a compression cycle.

[0053] In the rotary compressor according to the embodiment of the present disclosure, bush grooves may be formed in the roller, two swing bushes may be rotatably inserted into the bush grooves, and the vane may be slidably inserted between the swing bushes. This can allow a front end portion of the vane to have the same curvature as the inner circumferential surface of the cylinder, thereby securing a sealing area between the cylinder and the vane.

Brief Description of Drawings

[0054]

FIG. 1 is a longitudinal sectional view of an exemplary vane rotary compressor according to the present disclosure.

FIG. 2 is an exploded perspective view illustrating a compression unit in **FIG. 1**.

FIG. 3 is an assembled perspective view of the compression unit in **FIG. 2**.

FIG. 4 is a planar view of **FIG. 3**.

FIG. 5 is an enlarged sectional view of the compres-

sion unit in FIG. 1.

FIG. 6 is a cut-out perspective view of a vane bearing in FIG. 5.

FIG. 7 is a cross-sectional view illustrating a state in which the vane bearing of FIG. 6 is mounted on a main bearing.

FIGS. 8 and 9 are cross-sectional views illustrating different embodiments of a sealing portion of the vane bearing in FIG. 5.

FIG. 10 is a cross-sectional view illustrating still another example of a vane bearing.

FIG. 11 is a cross-sectional view illustrating still another embodiment of a vane bearing.

Mode for the Invention

[0055] Description will now be given in detail of a vane rotary compressor according to exemplary embodiments disclosed herein, with reference to the accompanying drawings. For reference, a vane slot of a roller according to the present disclosure may be equally applied to a vane rotary compressor in which a vane is slidably inserted into the roller. For example, the present disclosure may be applied not only to an example in which the vane slot is formed in a radial direction but also to an example in which the vane slot is inclined.

[0056] FIG. 1 is a longitudinal sectional view of an exemplary vane rotary compressor according to the present disclosure, FIG. 2 is an exploded perspective view illustrating a compression unit in FIG. 1, FIG. 3 is an assembled perspective view of the compression unit in FIG. 2, and FIG. 4 is a planar view of FIG. 3.

[0057] Referring to FIG. 1, a vane rotary compressor according to an embodiment of the present disclosure includes a casing 110, a driving (or drive) motor 120, and a compression unit 130. The drive motor 120 is installed in an upper inner space 110a of the casing 110, and the compression unit 130 is installed in a lower inner space 110b of the casing 110. The drive motor 120 and the compression unit 130 are connected through a rotating shaft 123.

[0058] The casing 110 that defines an outer appearance of the compressor may be classified as a vertical type and a horizontal type according to a compressor installation method. As for the vertical type casing, the drive motor 120 and the compression unit 130 are disposed at upper and lower sides in an axial direction, respectively. As for the horizontal type casing, the drive motor 120 and the compression unit 130 are disposed at left and right sides, respectively. The casing according to the embodiment of the present disclosure may be illustrated as the vertical type.

[0059] The casing 110 includes an intermediate shell 111 having a cylindrical shape, a lower shell 112 covering a lower end of the intermediate shell 111, and an upper shell 113 covering an upper end of the intermediate shell 111. The drive motor 120 and the compression unit 130 may be inserted into the intermediate shell 111 to be fixed

thereto, and a suction pipe 115 may penetrate through the intermediate shell 111 to be directly connected to the compression unit 130.

[0060] The lower shell 112 may be coupled to the lower end of the intermediate shell 111 in a sealing manner, and an oil storage space 110b in which oil to be supplied to the compression unit 130 is stored may be formed below the compression unit 130. The upper shell 113 may be coupled to the upper end of the intermediate shell 111 in a sealing manner, and an oil separation space 110c may be formed above the drive motor 120 to separate oil from refrigerant discharged from the compression unit 130.

[0061] The drive motor 120 that constitutes a motor part supplies power to cause the compression unit 130 to be driven. The drive motor 120 includes a stator 121, a rotor 122, and a rotating shaft 123.

[0062] The stator 121 may be fixedly inserted into the casing 110. The stator 121 may be fixed to an inner circumferential surface of the cylindrical casing 110 in a shrink-fitting manner or the like. For example, the stator 121 may be press-fitted into an inner circumferential surface of the intermediate shell 111.

[0063] The rotor 122 may be rotatably inserted into the stator 121, and the rotating shaft 123 may be press-fitted into a center of the rotor 122. Accordingly, the rotating shaft 123 rotates concentrically together with the rotor 122.

[0064] An oil flow path 125 having a hollow hole shape may be formed in a central portion of the rotating shaft 123, and oil passage holes 126a and 126b may be formed through a middle portion of the oil flow path 125 toward an outer circumferential surface of the rotating shaft 123. The oil passage holes 126a and 126b include a first oil passage hole 126a belonging to a range of a main bearing portion 1312 to be described later and a second oil passage hole 126b belonging to a range of a second bearing portion. Each of the first oil passage hole 126a and the second oil passage hole 126b may be provided by one or in plurality. This embodiment shows an example in which a plurality of oil passage holes is formed.

[0065] An oil pickup 127 may be installed in a middle or lower end of the oil flow path 125. A gear pump, a viscous pump, or a centrifugal pump may be used for the oil pickup 127. This embodiment illustrates a case in which the centrifugal pump is employed. Accordingly, when the rotating shaft 123 rotates, oil filled in the oil storage space 110b is pumped by the oil pickup 127 and is sucked along the oil flow path 125, so as to be introduced into a sub bearing surface 1322b of the sub bush portion 1322 through the second oil passage hole 126b and into a main bearing surface 1311a of the main bearing portion 1312 through the first oil passage hole 126a. This will be described again later.

[0066] The compression unit 130 includes a main bearing 131, a sub bearing 132, a cylinder 133, a roller 134, and a plurality of vanes 1351, 1352, and 1353. The main bearing 131 and the sub bearing 132 are respectively

provided at upper and lower parts of the cylinder 133 to define a compression space V together with the cylinder 133, the roller 134 is rotatably installed in the compression space V, and the vanes 1351, 1352, and 1353 are slidably inserted into the roller 134 to divide the compression space V into a plurality of compression chambers.

[0067] Referring to FIGS. 1 and 2, the main bearing 131 may be fixedly installed in the intermediate shell 111 of the casing 110. For example, the main bearing 131 may be inserted into the intermediate shell 111 and welded thereto.

[0068] The main bearing 131 may be coupled to an upper end of the cylinder 133 in a close contact manner. Accordingly, the main bearing 131 defines an upper surface of the compression space V, and supports an upper surface of the roller 134 in the axial direction while supporting an upper-half portion of the rotating shaft 123 in the radial direction.

[0069] The main bearing 131 may include a main plate portion 1311 and a main bearing portion 1312. The main plate portion 1311 covers an upper part of the cylinder 133 to be coupled thereto, and the main bearing portion 1312 axially extends from a center of the main plate portion 1311 toward the drive motor 120 so as to support the upper portion of the rotating shaft 123.

[0070] The main plate portion 1311 may have a disk shape, and an outer circumferential surface of the main plate portion 1311 may be fixed to the inner circumferential surface of the intermediate shell 111 in a close contact manner. A main guide groove 1311a may be formed in an axial lower surface of the main plate portion 1311, that is, in an axial lower surface that faces an upper surface of the roller 134 in the axial direction, to accommodate a guide protrusion 1351d to be described later.

[0071] The main guide groove 1311a may accommodate a main bearing hole 1312a to be described later, but may be formed eccentrically with respect to a bearing hole center (axial center or rotation center of the roller) (no reference numeral given) forming the center of the main bearing hole 1312a. For example, a center Og formed by an inner circumferential surface 1311a1 of the main guide groove 1311a may be aligned to be coaxial with a center Ov of the compression space V formed by an inner circumferential surface 1331 of the cylinder 133. Accordingly, the center Og of the main guide groove 1311a and the center Ov of the compression space V may be formed eccentrically with respect to a rotation center Or of the roller 134.

[0072] In other words, as in this embodiment, when a first bearing portion 1365 and a second bearing portion 1366 of a vane bearing 136, 137 to be described later rotate together, as described above, the center Og of the main guide groove 1311a and the center Ov of the compression space V may be located on the same axis while being eccentric with respect to the rotation center Or of the roller 134.

[0073] However, when the second bearing portion 1366 is excluded or the second bearing portion 1366 is

fixed, the center Og of the main guide groove 1311a and the center Ov of the compression space V may be eccentric from each other.

[0074] The entirety of the main guide groove 1311a may be formed at approximately the same depth and communicate with the oil passage 125 provided in the rotating shaft 123. For example, as the main guide groove 1311a may be formed in a stepped shape on an edge of an inner circumferential surface of the main plate portion 1311 or an edge of a lower end of the main bearing 131, the main guide groove 1311a may be located at a position where it communicates with the oil passage hole 126a of the rotating shaft 123 in the radial direction directly or through a main bearing surface 1312a1 that is formed by an inner circumferential surface of the main bearing hole 1312a. Accordingly, oil of discharge pressure or pressure equivalent thereto may be introduced into the main guide groove 1311a.

[0075] The inner circumferential surface of the main guide groove 1311a may be located at a position not communicating with the compression space V, for example, at a position between the main bearing surface 1312a1 formed by the inner circumferential surface of the main bearing hole 1312a and an outer circumferential surface 1341 of the roller 134. This can secure a sealing distance between the main bearing 131 and the roller 134. Accordingly, even if oil of discharge pressure or pressure equivalent thereto flows into the main guide groove 1311a, the oil may be suppressed from flowing into the compression space V.

[0076] The inner circumferential surface 1311a1 of the main guide groove 1311a may be formed in the same shape as an outer circumferential surface 1341 of the roller 134 to be described later. For example, the inner circumferential surface 1311a1 of the main guide groove 1311a may be formed in the same circular shape as the outer circumferential surface 1341 of the roller 134 to be described later. Accordingly, a sealing surface (or sealing distance) between the main guide groove 1311a and the outer circumferential surface of the roller can be defined uniformly along the circumferential direction.

[0077] The main bearing portion 1312 may be formed in the shape of a hollow bush through which the main bearing hole 1312a is formed, and an oil groove (not shown) may be formed in the main bearing surface 1312a1 that is the inner circumferential surface of the main bearing hole 1312a.

[0078] Referring to FIGS. 1 and 2, the sub bearing 132 may be coupled to be in close contact with the lower end of the cylinder 133. Accordingly, the sub bearing 132 defines a lower surface of the compression space V, and supports a lower surface of the roller 134 in the axial direction while supporting a lower-half portion of the rotating shaft 123 in the radial direction.

[0079] The sub bearing 132 may be formed similarly to the main bearing 131 described above. For example, the sub bearing 132 according to the embodiment of the present disclosure may include a sub plate portion 1321

and a sub bearing portion 1322.

[0080] The sub plate portion 1321 is coupled to the cylinder 133 to cover a lower side of the cylinder 133, and the sub bearing portion 1322 extends axially from a center of the sub plate portion 1321 toward the lower shell 112 to support the lower-half portion of the rotating shaft 123.

[0081] The sub plate portion 1321 may have a disk shape like the main plate portion 1311, and its outer diameter may be substantially the same as an outer diameter of the cylinder 133. Accordingly, an outer circumferential surface of the sub plate portion 1321 may be spaced apart from an inner circumferential surface of the intermediate shell 111.

[0082] A sub guide groove 1321a may be formed in an upper surface of the sub plate portion 1321 in the axial direction. Since the sub guide groove 1321a is formed symmetrically with the previously described main guide groove 1311a around the roller 134, the description of the sub guide groove 1321a will be replaced with the description of the main guide groove 1312a.

[0083] The sub bearing portion 1322 may be formed in the shape of a hollow bush through which the sub bearing hole 1322a is formed, and an oil groove (not shown) may be formed in the sub bearing surface 1322a1 that is an inner circumferential surface of the sub bearing hole 1322a.

[0084] Referring to FIGS. 1 to 3, the cylinder 133 according to this embodiment may be in close contact with the lower surface of the main bearing 131 and may be coupled to the main bearing 131 by a bolt together with the sub bearing 132. Accordingly, the cylinder 133 may be fixedly coupled to the casing 110 by the main bearing 131.

[0085] The cylinder 133 may be formed in an annular shape having a compression space V in its center. For example, the inner circumferential surface 1331 of the cylinder 133 constituting the compression space V may be formed in a circular shape having the same inner diameter along the circumferential direction, and the center O_v of the compression space V (illustrated in FIG. 4) may be eccentric with respect to the rotation center O_r (illustrated in FIG. 4) of the roller 134 constituting the axial center O_s (illustrated in FIG. 4). Accordingly, the inner circumferential surface 1331 of the cylinder 133 may be eccentric with respect to the outer circumferential surface 1341 of the roller 134, and a proximity point (or contact point) where the inner circumferential surface 1331 of the cylinder 133 and the outer circumferential surface 1341 of the roller 134 are almost in contact with each other may be formed between the inner circumferential surface 1331 of the cylinder 133 and the outer circumferential surface 1341 of the roller 134.

[0086] The cylinder 133 may be provided with a suction port 1332 and discharge ports 1333a and 1333b in both sides in the circumferential direction, respectively, based on the proximity point P. Accordingly, the suction port 1332 and the discharge ports 1333a and 1333b may be

separated from each other by the proximity point P.

[0087] The suction port 1332 may be directly connected to a suction pipe 115 penetrating through the casing 110. The discharge ports 1333a and 1333b may communicate with an inner space of the casing 110n to be indirectly connected to a discharge pipe 116 coupled through the casing 110. Accordingly, refrigerant may be suctioned directly into the compression space V through the suction port 1332 while compressed refrigerant may be discharged into the inner space of the casing 110 through the discharge port 1333a, 1333b, and then discharged to the discharge pipe 116. As a result, the inner space of the casing 110 may be maintained in a high-pressure state forming discharge pressure.

[0088] In addition, a suction valve may not be separately disposed in the suction port 1332, however, discharge valves 1335a and 1335b for opening and closing the discharge ports 1333a and 1333b may be disposed in the discharge ports 1333a and 1333b, respectively. Each of the discharge valves 1335a and 1335b may be a reed-type valve having one end fixed and another end free. However, various types of valves such as a piston valve, other than the reed-type valve, may be used as the discharge valve 1335a, 1335b as necessary.

[0089] When the discharge valves 1335a and 1335b are configured as the reed-type valves, valve accommodating grooves 1334a and 1334b may be formed in the outer circumferential surface of the cylinder 133 to mount the discharge valves 1335a and 1335b therein, respectively. This can minimize the length of the discharge port 1333a, 1333b, thereby decreasing a dead volume. Each of the valve accommodating grooves 1334a and 1334b may be formed in a triangular shape so as to secure a flat valve seat surface as illustrated in FIG. 2.

[0090] Meanwhile, the discharge port 1333a, 1333b may be provided in plurality along a compression path (a compression proceeding direction). For convenience of explanation of the plurality of discharge ports 1333a and 1333b, a discharge port located at an upstream side of the compression path is referred to as a first discharge port 1333a, and a discharge port located at a downstream side of the compression path is referred to as a second discharge port 1333b.

[0091] However, the discharge port may not be provided in plurality. For example, if the inner circumferential surface of the cylinder 133 has a long compression cycle to appropriately reduce overcompression of refrigerant, only one discharge port may be provided.

[0092] Meanwhile, referring to FIG. 4, the roller 134 described above may be rotatably disposed in the compression space V of the cylinder 133. The roller 134 may be formed so that its rotation center O_r is located on the same axis as the axial center O_s of the rotating shaft 123. The roller 134 may be integrally formed or assembled with the rotating shaft 123. Accordingly, the roller 134 can rotate together with the rotating shaft 123 centering on the axial center O_s.

[0093] The outer circumferential surface 1341 of the

roller 134 may be formed in a circular shape, and a plurality of bush grooves 1342 may be formed in the outer circumferential surface 1341 of the roller 134 at preset intervals along the circumferential direction. The bush grooves 1342 may be defined as a first bush groove (no reference numeral given), a second bush groove (no reference numeral given), and a third bush groove (no reference numeral given) along the compression proceeding direction (rotating direction of the roller), and the first bush groove, the second bush groove, and the third bush groove may be formed identically.

[0094] A swing bush 1343 that forms a kind of vane slot may be rotatably coupled to each bush groove 1342. As for the swing bush 1343, two bushes formed in a substantially semicircular shape may be inserted into the bush grooves 1342 at an interval equal to a thickness of the vane 1351, 1352, 1353. Accordingly, the vane 1351, 1352, 1353 coupled to the swing bush 1343 may rotate using the swing bush 1343 as a hinge point while moving along the inner circumferential surface 1331 of the cylinder 133.

[0095] As described above, when the vane 1351, 1352, 1353 is rotatably supported relative to the roller 134 by the swing bush 1343, the vane 1351, 1352, 1353 may always face the center Ov of the compression space V even though the roller 134 rotates in the state where the rotation center Or of the roller 134 is eccentric from the center Ov of the compression space V. Then, a vane front end portion 1351b, 1352b, 1353b defining a front surface of the vane 1351, 1352, 1353, which will be described later, may be formed to have the same curvature as the inner circumferential surface 1331 of the cylinder 133, to secure a sealing area between the vane 1351, 1352, 1353 and the cylinder 133.

[0096] Meanwhile, a back pressure chamber 1344 may be formed inside the bush groove 1342, that is, between the bush groove 1342 and the rotation center Or of the roller 134. The back pressure chamber 1344 may communicate with the bush groove 1342 in the radial direction and at the same time communicate with the main guide groove 1311a or/and the sub guide groove 1321a described above in the axial direction. Accordingly, the vane 1351, 1352, 1353 may be pressed toward the inner circumferential surface 1331 of the cylinder 133 by pressure of high-pressure oil (or refrigerant) that flows into the main guide groove 1311a or/and the sub guide groove 1321a.

[0097] Each of the back pressure chambers 1344 may be sealed by the main bearing 131 and the sub bearing 132, and as described above, may axially communicate with the main guide groove 1311a or/and the sub guide groove 1321a. The back pressure chamber 1344 may communicate with the main guide groove 1311a or/and the sub guide groove 1321a.

[0098] Referring to FIGS. 2 to 4, each of the plurality of vanes 1351, 1352, and 1353 according to the embodiment of the present disclosure may include a vane body 1351a, 1352a, 1353a, a front end portion (or front sur-

face) 1351b, 1352b, 1353b, a vane rear end portion (or rear surface) 1351c, 1352c, 1353c, and guide protrusions 1351d, 1352d, 1353d. The vane front end portion 1351b, 1352b, 1353b may be understood as a surface in contact with the inner circumferential surface 1331 of the cylinder 133, and the vane rear end portion 1351c, 1352c, and 1353c may be understood as a surface facing the back pressure chamber 1343a, 1343b, 1343c.

[0099] Each of the vane bodies 1351a, 1352a, and 1353a may be formed in a substantially rectangular parallelepiped shape. Accordingly, each of the vane bodies 1351a, 1352a, and 1353a can smoothly slide between the swing bushes 1343 along the longitudinal direction.

[0100] Each of the vane front end portions 1351b, 1352b, and 1353b may be formed in a curved shape so as to be in line-contact with the inner circumferential surface 1331 of the cylinder 133, and a sealing surface defining the front surface of the vane front end portion 1351b, 1352b, 1353b may have substantially the same curvature as the inner circumferential surface 1331 of the cylinder 133. Accordingly, even if the vane front end portion 1351b, 1352b, 1353b is slightly spaced apart from the inner circumferential surface 1331 of the cylinder 133, a sealing area between the vane front end portion 1351b, 1352b, 1353b and the cylinder can be secured, thereby suppressing leakage between compression chambers.

[0101] The vane rear end portions 1351c, 1352c, and 1353c may be formed flat. Accordingly, a pressure receiving surface defining a rear surface of each vane rear end portion 1351c, 1352c, and 1353c may evenly receive back pressure force of the back pressure chamber 1344, and the vane 1351, 1352, 1353 can stably behave while rapidly moving toward the cylinder 133.

[0102] The guide protrusions 1351d, 1352d, and 1353d may extend axially from both rear axial side surfaces of the vane bodies 1351a, 1352a, and 1353a, respectively, constituting the vane rear end portions 1351c, 1352c, and 1353a. For example, the guide protrusions 1351d, 1352d, 1353d may include an upper guide protrusion (hereinafter, referred to as a first guide protrusion) 1351d1, (not shown), (not shown) extending axially upward toward the main guide groove 1311a, and a lower guide protrusion (hereinafter, referred to as a second guide protrusion) 1351d2, (not shown), (not shown) extending axially downward toward the sub guide groove 1321a.

[0103] The first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) may have the same shape and size and be formed on the same axis. However, in some cases, the first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) may be formed in different shapes and sizes, and may be located at positions eccentric from each other. Hereinafter, a description will be mainly given of an example in which the first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) have

the same shape and size and are formed on the same axis.

[0104] The first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) may have the same width as the vane body 1351a, 1352a, 1353a. However, in some cases, the first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) may be wider or narrower than the vane body 1351a, 1352ad, 1353a. For example, the first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) may extend in the circumferential direction from both side surfaces or one side surface of the vane body 1351a, 1352ad, 1353a. In this case, the first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) may preferably be formed in an arcuate shape to correspond to the inner circumferential surface 1311a1, 1321a1 of each guide groove 1311a, 1321a. In addition, in this case, the first guide protrusions 1351d1, 1352d1, and 1353d1 and the second guide protrusions 1351d2, 1352d2, and 1353d2 may be formed identically in the circumferential direction, but may be formed differently in the circumferential direction.

[0105] The first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) may each have a flat outer circumferential surface. However, since the inner circumferences 1311a1 and 1321a1 of the guide grooves 1311a and 1321a that the first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) face are formed in a circular curved surface, outer circumferential surfaces of the first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) may be preferably formed in a circular curved shape to correspond to the inner circumferential surfaces 1311a1 and 1321a1 of the respective guide grooves 1311a and 1321a, more precisely, an inner circumferential surface 1365a of the first bearing portion 1365 to be described later.

[0106] Meanwhile, referring to FIGS. 1 to 4, vane bearings 136 and 137 may be disposed between the outer circumferential surfaces of the first guide protrusions 1351d1, 1352d1, and 1353d1 and the second guide protrusions 1351d2, 1352d2, and 1353d2 and the inner circumferential surfaces 1311a1 and 1321a1 of the main guide groove 1311a and the sub guide groove 1321a facing them. The vane bearings 136 and 137 may be configured as various bearings, such as ball bearings, roller bearings, bush bearings, foil bearings, etc. In the embodiment of the present disclosure, an example in which the vane bearings 136 and 137 are configured as the ball bearings will be described, and the description of the vane bearings 136 and 137 will be described again later.

[0107] Hereinafter, an operation of the vane rotary

compressor will be described.

[0108] That is, when power is applied to the drive motor 120, the rotor 122 of the drive motor 120 and the rotating shaft 123 coupled to the rotor 122 rotate together, causing the roller 134 coupled to the rotating shaft 123 or integrally formed therewith to rotate together with the rotating shaft 123.

[0109] Then, the plurality of vanes 1351, 1352, and 1353 slidably inserted into the swing bushes 1343 of the roller 134 serving as vane slots are pulled out from or pushed into the roller 134 by centrifugal force generated by the rotation of the roller 134 and back pressure of the back pressure chambers 1343 disposed in the rear sides of the respective vanes 1351, 1352, and 1353, such that the vane front end portions 1351b, 1352b, and 1353b of the vanes 1351, 1352, and 1353 are brought into contact with the inner circumferential surface 1332 of the cylinder 133.

[0110] Accordingly, the compression space V of the cylinder 133 are partitioned by the plurality of vanes 1351, 1352, and 1353 into as many compression chambers (including suction chamber or discharge chamber) V1, V2, and V3 as the number of the vanes 1351, 1352, and 1353. The compression chambers V1, V2, and V3 are changed in volume by the shape of the inner circumferential surface 1332 of the cylinder 133 and eccentricity of the roller 134 while moving in response to the rotation of the roller 134. Then, refrigerant suctioned into each of the respective compression chambers V1, V2, and V3 is compressed while moving along the roller 134 and the vanes 1351, 1352, and 1353, and discharged into the inner space of the casing 110 through the discharge ports 1333a and 1333b formed through the inner circumferential surface 1331 of the cylinder 133. This series of processes are repeatedly carried out.

[0111] At this time, the plurality of vanes 1351, 1352, and 1353 are pulled out from the roller 134, and the vane front end portions 1351b, 1352b, and 1353b forming the front surfaces of the respective vanes 1351, 1352, and 1353 are brought into contact with the inner circumferential surface 1332 of the cylinder 133 to separate the compression chambers.

[0112] However, when the vane front end portions 1351b, 1352b, and 1353b of the vanes 1351, 1352, and 1353 slide while always being in contact with the inner circumferential surface 1331 of the cylinder 133, mechanical loss due to friction (or frictional loss) between the cylinder 133 and the vanes 1351, 1352, and 1353 may greatly increase. On the other hand, in consideration of this, when the back pressure for the vanes 1351, 1352, and 1353 is lowered, the vane front end portions 1351b, 1352b, and 1353b of the vanes 1351, 1352, and 1353 may be spaced apart from the inner circumferential surface 1331 of the cylinder 133, thereby causing refrigerant leakage between the compression chambers. In particular, in the process of performing a compression stroke, the vane 1351, 1352, 1353 may be pushed out from the cylinder 133 by receiving gas force of the compression

chamber as pressure in the corresponding compression chamber increases. Then, a distance between the cylinder 133 and the vane 1351, 1352, 1353 may further increase so that refrigerant leakage may increase.

[0113] Therefore, the back pressure applied to the vane rear end portions 1351c, 1352c, and 1353c may be appropriately lowered, so that the cylinder 133 and the vanes 1351, 1352, and 1353 can move relative to each other in a spaced state within a range that refrigerant does not leak between the inner circumferential surface 1331 of the cylinder 133 and the front surfaces of the vanes 1351, 1352, and 1353. Through this, it is preferable to reduce the mechanical frictional loss between the cylinder 133 and the vanes 1351, 1352, and 1353, and simultaneously suppress refrigerant leakage by securing back pressure acting on the vanes 1351, 1352, and 1353.

[0114] Therefore, in the embodiment of the present disclosure, as described above, the main guide groove 1311a may be formed in the main plate portion 1311 and the sub guide groove 1321a may be formed in the sub plate portion 1321, respectively, and each vane body 1351a, 1352a, and 1353a facing the main guide groove 1311a and the sub guide groove 1321a may include the first guide protrusion 1351d1, (not shown), (not shown) on the axial upper end, and the second guide protrusion 1351d2, (not shown), (not shown) on the axial lower end. Accordingly, the first guide protrusion 1351d1, (not shown), (not shown) and the second guide protrusion 1351d2, (not shown), (not shown) may be caught by the main guide groove 1311a and the sub guide groove 1321a, thereby restricting the extent that the vane protrudes. This can reduce the mechanical frictional loss between the cylinder 133 and the vanes 1351, 1352, and 1353 and suppress the refrigerant leakage by securing the back pressure acting on the vanes 1351, 1352, and 1353.

[0115] Even when the guide grooves 1311a and 1321a and the guide protrusions 1351d, 1352d, and 1353d are formed as described above, frictional loss may occur between the guide grooves 1311a and 1321a and the guide protrusions 1351d, 1352d, and 1353d. Accordingly, in the embodiment of the present disclosure, the vane bearings 136 and 137 described above may be disposed between the guide grooves 1311a and 1321a and the guide protrusions 1351d, 1352d and 1353d, respectively, to reduce the frictional loss between the guide grooves 1311a and 1321a and the guide protrusions 1351d, 1352d, and 1353d.

[0116] FIG. 5 is an enlarged sectional view of the compression unit in FIG. 1, FIG. 6 is a cut-out perspective view of the vane bearing in FIG. 5, and FIG. 7 is a cross-sectional view illustrating a state in which the vane bearing of FIG. 6 is mounted on the main bearing.

[0117] Referring to FIGS. 5 to 7, in the embodiment of the present disclosure, the vane bearings 136 and 137 may be disposed between the main guide groove 1311a and the first guide protrusion 1351 d1, (not shown), (not shown) and/or between the sub guide groove 1321a and

the second guide protrusion 1351d2, (not shown), (not shown).

[0118] As described above, various types of bearings, such as ball bearings, roller bearings, bush bearings, foil bearings, etc. may be applied to the vane bearings 136 and 137, but in the embodiment of the present disclosure, an example in which the vane bearings 136 and 137 are made of ball bearings will be mainly described.

[0119] In addition, the vane bearings 136 and 137 may extend between the roller 134 and the main bearing 131 and the sub bearing 132 facing the roller 134. In the embodiment of the present disclosure, an example in which the vane bearings 136 and 137 are disposed between the guide grooves 1311a and 1321a and the guide protrusions 1351d, 1352d and 1353d and between the roller 134 and the bearings 131 and 132, respectively, will be mainly described.

[0120] In addition, the vane bearings 136 and 137 may be defined as a main-side vane bearing 136 that is disposed between the main guide groove 1311a and the first guide protrusion 1351d1, (not shown), (not shown), and a sub-side vane bearing 137 that is disposed between the sub guide groove 1321a and the second guide protrusion 1351d2, (not shown), (not shown), and hereinafter, the main-side vane bearing will be described as a representative example.

[0121] The vane bearing 136 according to the embodiment of the present disclosure may include an outer ring 1361, an inner ring 1362, and a plurality of balls 1363.

[0122] The outer ring 1361 may be formed in an annular shape, and a center Oob of the outer ring 1361 may be located on the same axis as the center Og of the main guide groove 1311a. In other words, the center Oob of the outer ring 1361 may be provided eccentrically with respect to the rotation center Or of the roller 134.

[0123] In addition, an outer diameter of the outer ring 1361 may be formed to be substantially the same as or slightly smaller than an inner diameter of the main guide groove 1311a. For example, when the outer diameter of the outer ring 1361 is formed almost the same as the inner diameter of the main guide groove 1311a, the outer ring 1361 may be press-fitted into the main guide groove 1311a, and when the outer diameter of the outer ring 1361 is slightly smaller than the inner diameter of the main guide groove 1311a, the outer ring 1361 may freely rotate in the main guide groove 1311a. In the embodiment of the present disclosure, an example in which the outer diameter of the outer ring 1361 is substantially the same as the inner diameter of the main guide groove 1311a, so that the outer ring 1361 is press-fitted to the inner circumferential surface of the main guide groove 1311a will be mainly described.

[0124] The inner ring 1362 may include a first bearing portion 1365 and a second bearing portion 1366. The first bearing portion 1365 may be formed in an annular shape, and the second bearing portion 1366 may be formed in a disk shape with a hollow central portion.

[0125] An outer diameter of the first bearing portion

1365 may be smaller than that of the outer ring 1361 and an inner diameter thereof may be larger than that of the main bearing hole 1312a. A center Ob1 of the first bearing portion 1365 may be located on the same axis as the center Oob of the outer ring 1361, that is, the center Ob1 of the first bearing portion 1365 may be eccentric with respect to the rotation center Or of the roller 134. Accordingly, the inner ring 1362 including the first bearing portion 1365 may be rotatably inserted inside the outer ring 1361.

[0126] The second bearing portion 1366 may extend in a flange shape from a lower end of the first bearing portion 1365 or an outer circumferential surface around the lower end. The second bearing portion 1366 may extend integrally from the first bearing portion 1365 or may be formed separately to be assembled to the first bearing portion 1365 later.

[0127] For example, when the second bearing portion 1366 is formed integrally with the first bearing portion 1365, an entire assembly process of the inner ring may be excluded so as to reduce a manufacturing cost. On the other hand, when the second bearing portion 1366 is assembled to the first bearing portion 1365, a thickness t2 of the second bearing portion 1366 may be formed thicker than a thickness t1 of the first bearing portion 1365 to facilitate the formation of a sealing portion 1367, 1377 to be described later.

[0128] However, even when the first bearing portion 1365 and the second bearing portion 1366 are formed integrally with each other, the thickness t2 of the second bearing portion 1366 may be thicker than the thickness t1 of the first bearing portion 1365, and even when a separate sealing portion 1367 is not formed, the thickness t2 of the second bearing portion 1366 may be thicker than the thickness t1 of the first bearing portion 1365. Through this, a sealing area can be secured between an outer circumferential surface 1366a of the second bearing portion 1366 and the inner circumferential surface 1331 of the cylinder 133.

[0129] An inner diameter D1 of the second bearing portion 1366 may be large enough for the back pressure chamber 1344 to communicate with the main guide groove 1311a, for example, may be smaller than an inner diameter D2 of the main guide groove 1311a and larger than a diameter D3 of a virtual circle drawn by connecting inner ends of the respective back pressure chambers 1344. Accordingly, high-pressure oil flowing into the main guide groove 1311a can smoothly flow into each back pressure chamber 1344 without being blocked by the second bearing portion 1366.

[0130] An outer diameter D12 of the second bearing portion 1366 may be substantially equal to or slightly smaller than an inner diameter D4 of the inner circumferential surface 1331 of the cylinder 133, that is, the compression space V. Accordingly, the second bearing portion 1366 can be rotatably inserted into the inner space of the cylinder 133, that is, the compression space V, so as to rotate together with the first bearing portion 1365 centering on the rotation center Or of the roller 134.

Therefore, the first bearing portion 1365 may be defined as a rotating ring portion, and the second bearing portion 1366 may be defined as a rotating plate portion.

[0131] In this case, the second bearing portion 1366 may be formed such that one side surface thereof in the axial direction is spaced apart a preset gap t3 from a lower surface of the main plate portion 1311 or an upper surface of the sub plate portion 1321 facing the one side surface. For example, a lower end of the second bearing portion 1366 may be slightly longer than a lower end of the first bearing portion 1365, so that the second bearing portion 1366 is axially spaced apart from the main plate portion 1311 or the sub plate portion 1321. This can suppress the second bearing portion from being in contact with the main plate portion 1311 or the sub plate portion 1321 during the rotation of the second bearing portion, thereby reducing mechanical frictional loss.

[0132] In addition, the second bearing portions 1366 and 1375 of the vane bearings 136 and 137 disposed on both axial sides of the roller may seal both axial sides of the compression space V defining the inner space of the cylinder 133, thereby providing a substantial compression space. Accordingly, a sealing portion 1367 for sealing the compression space V may be further disposed between the outer circumferential surface of the second bearing portion 1366 and the inner circumferential surface 1331 of the cylinder 133 facing the same.

[0133] The sealing portion 1367 may include at least one or more sealing grooves provided in an annular shape on the outer circumferential surface of the second bearing portion 1366 along the circumferential direction. FIGS. 8 and 9 are cross-sectional views illustrating different embodiments of a sealing portion of the vane bearing in FIG. 5.

[0134] For example, the sealing portion 1367 may be configured as a single sealing groove as shown in FIG. 5 or may be configured by a plurality of sealing grooves spaced apart from one another by preset intervals along the axial direction as shown in FIG. 8. Accordingly, oil or refrigerant may be filled in the sealing portion 1367 to seal between compression chambers.

[0135] Alternatively, as shown in FIG. 9, the sealing portion 1367 may be configured by including a sealing groove 1367a formed in the outer circumferential surface of the second bearing portion 1366, and a sealing member 1367b formed in an annular shape and inserted into the sealing groove 1367a. In this case, the sealing member 1367b may be made of a Teflon material or the like having a lubricating property.

[0136] Referring to FIGS. 6 and 7, a plurality of balls 1363 may be inserted between the inner circumferential surface of the outer ring 1361 and the outer circumferential surface of the inner ring 1362. Accordingly, the inner ring 1362 in contact the first guide protrusion 1351d1, (not shown), (not shown) of the vane 1351, 1352, 1353 may perform a relative motion with respect to the outer ring 1361.

[0137] On the other hand, referring to FIG. 5, the afore-

mentioned sub-side vane bearing 137 may be equally applied to a position between the sub guide groove 1321a of the sub bearing 132 and the second guide protrusion 1351 d2, (not shown), (not shown) of the vane 1351, 1352, 1353. The sub-side vane bearing 137, similar to the main-side vane bearing, includes an outer ring 1371, an inner ring 1372, and a plurality of balls 1373, and thus will be understood by the description of the main-side vane bearing 136.

[0138] Although not shown in the drawings, the sub-side vane bearing 137 may alternatively be formed in a shape different from that of the main-side vane bearing 136. For example, the main-side vane bearing 136 may be configured as a ball bearing, while the sub side vane bearing 137 may be configured as a roller bearing or bush bearing.

[0139] As described above, the vane bearings 136 and 137 configured as the ball bearings are disposed between the main guide groove 1311a and the first guide protrusion 1351d1, (not shown), (not shown) and between the sub guide groove 1321a and the second guide protrusion 1351d2, (not shown), (not shown). Accordingly, even though the guide protrusions 1351d, 1352d, 1353d of each vane 1351, 1352, 1353 rotate together with the roller 134, the inner rings 1362 and 1372 of the vane bearings 136 and 137, with which the guide protrusions 1351d, 1352d 1353d of the vane 1351, 1352, 1353 are in contact, rotate relative to the outer rings 1361 and 1371 by the plurality of balls 1363 and 1373. This can remarkably reduce frictional loss that may occur in the radial direction between the guide protrusions 1351d, 1352d, and 1353d, of the vane 1351, 1352, and 1353 and the guide grooves 1311a and 1321a even when the guide protrusions 1351d, 1352d, and 1353d are disposed on the vane 1351, 1352, 1353.

[0140] At the same time, the inner rings 1362 and 1372 according to the embodiment of the present disclosure may include the first bearing portions 1365 and 1375 between the guide protrusions 1351d, 1352d, and 1353d and the guide grooves 1311a and 1321a, and the second bearing portions 1366 and 1376 extending between the main plate portion 1311 and the upper surface of the roller 134 and between the sub plate portion 1321 and the lower surface of the roller 134, and the second bearing portions 1366 and 1376 may rotate together with the roller 134. This can significantly reduce even axial frictional loss that occurs between the main bearing 131 and the roller 134 and between the sub bearing 132 and the roller 134.

[0141] In this way, the frictional loss between the vane front end portion and the cylinder can be suppressed by limiting the extent that the vane protrudes and simultaneously radial frictional loss between the guide protrusion and the guide groove and axial frictional loss between the main bearing and the roller and between the sub bearing and the roller can be significantly reduced. This can reduce mechanical frictional loss in the compression unit, thereby enhancing efficiency of the compressor.

[0142] Hereinafter, a description will be given of another embodiment of a vane bearing.

[0143] That is, the previous embodiment illustrates that the inner ring includes the first bearing portion and the second bearing portion, but in some cases, the outer ring of the vane bearing may include the first bearing portion and the second bearing portion. For convenience, hereinafter, the main-side vane bearing will be mainly described, and a description of the sub-side vane bearing will be replaced with the description of the main-side vane bearing.

[0144] FIG. 10 is a cross-sectional view illustrating still another example of a vane bearing.

[0145] Referring to FIG. 10, a main-side vane bearing 136 according to an embodiment of the present disclosure may include an outer ring 1361, an inner ring 1362, and a plurality of balls 1363. Since the outer ring 1361, the inner ring 1362, and the plurality of balls 1363 are similar to those of the previous embodiments, a detailed description thereof will be replaced by the description of the previous embodiments.

[0146] However, in this embodiment, the outer ring 1361 may include a first bearing portion 1365 and a second bearing portion 1366, and the inner ring 1362 may be formed in an annular shape. Even in this case, the second bearing portion 1366 may be inserted into the compression space V of the cylinder 133 to define an upper surface of the compression space V.

[0147] An outer circumferential surface 1365a of the first bearing portion 1365 of the outer ring 1361 according to the embodiment may be fixed by being press-fitted to the inner circumferential surface 1311a1 of the main guide groove 1311a as in the previous embodiment, or may be inserted to be rotatable with respect to the inner circumferential surface 1311a1 of the main guide groove 1311a.

[0148] For example, when the outer ring 1361 is press-fitted into the main guide groove 1311a as in the previous embodiment, the second bearing portion 1366 may also be fixed to the main plate portion 1311. Accordingly, the outer circumferential surface 1366a of the second bearing portion 1366 and the inner circumferential surface 1331 of the cylinder 133 can be brought into close contact with each other, thereby suppressing leakage in the compression space V more effectively. In addition, as the second bearing portion 1366 is fixed, the inner circumferential surface of the cylinder 133 may be formed in various shapes, such as a symmetrical ellipse or an asymmetrical ellipse in which a plurality of ellipses are combined, in addition to a circular shape, thereby enhancing compression efficiency.

[0149] On the other hand, when the first bearing portion 1365 of the outer ring 1361 is rotatably inserted with respect to the inner circumferential surface 1311a1 of the main guide groove 1311a, as in the previous embodiment, the second bearing portion 1366 may rotate together with the roller 134. Then, radial frictional loss in the first bearing portion 1365 as well as axial frictional

loss in the second bearing portion 1366 can be suppressed, and thus compressor efficiency can be improved.

[0150] Hereinafter, a description will be given of still embodiment of a vane bearing.

[0151] That is, the previous embodiments illustrate that the inner ring or the outer ring of the vane bearing includes the first bearing portion and the second bearing portion, but in some cases, the inner ring or outer ring of the vane bearing may merely include the first bearing portion. For convenience, hereinafter, the main-side vane bearing will be mainly described, and a description of the sub-side vane bearing will be replaced with the description of the main-side vane bearing.

[0152] FIG. 11 is a cross-sectional view illustrating still another embodiment of a vane bearing.

[0153] Referring to FIG. 11, a vane bearing 136 according to an embodiment of the present disclosure may include an outer ring 1361, an inner ring 1362, and a plurality of balls 1363. Since the outer ring 1361, the inner ring 1362, and the plurality of balls 1363 are similar to those of the previous embodiments, a detailed description thereof will be replaced by the description of the previous embodiments.

[0154] However, in this embodiment, each of the outer ring 1361 and the inner ring 1362 may merely include a first bearing portion 1365. For example, the inner ring 1362 may merely include the first bearing portion 1365 disposed between the inner circumferential surface 1311a1 of the main guide groove 1311a and the first guide protrusion 1351d1, (not shown), (not shown). The shape and size of the first bearing portion 1365 may be identical to those of the first bearing portion 1365 in the previous embodiments.

[0155] As described above, when each of the outer ring 1361 and the inner ring 1362 merely includes the first bearing portions 1365, radial frictional loss that occurs between the inner circumferential surface 1311a1 of the main guide groove 1311a and the first guide protrusion 1351d1, (not shown), (not shown) can be suppressed.

[0156] In addition, when the second bearing portion 1366 is excluded as in this embodiment, the inner circumferential surface 1331 of the cylinder 133 may be formed in various shapes. For example, the inner circumferential surface 1331 of the cylinder 133 may be formed in a symmetrical ellipse or an asymmetrical ellipse in which a plurality of ellipses are combined, in addition to a circular shape. Through this, the inner circumferential surface 1331 of the cylinder 133 can be formed so that a compression cycle in the compression space V becomes longer, which can reduce compression loss due to overcompression.

[0157] In addition, when the second bearing portion 1366 is excluded as in this embodiment, a discharge port (not shown) may be formed in the main plate portion 1311 or the sub plate portion 1321. This can suppress insufficient surface pressure with respect to the vane front end

portion 1351b, 1352b, which may occur when the discharge port (not shown) is formed through the inner circumferential surface 1331 of the cylinder 133. Therefore, partial damage to the vane front end portion 1351b, 1352b, 1353b or the inner circumferential surface 1331 of the cylinder 133 facing the same can be suppressed, which may result in suppressing leakage between compression chambers and reduction in compression efficiency in advance.

[0158] On the other hand, the foregoing embodiments illustrate the examples in which the swing bushes are disposed in the roller, but the swing bush does not necessarily need to be provided. For example, the present disclosure may equally be applied even to a case where one or more vane slots are formed in an outer circumferential surface of a roller and a vane is slid into the vane slot, which is the configuration of a typical vane rotary compressor.

Claims

1. A rotary compressor comprising:

a cylinder having an inner circumferential surface in an annular shape;
a main bearing and a sub bearing disposed on both sides of the cylinder in an axial direction to form a compression space together with the cylinder, and each having a guide groove on a side surface thereof forming the compression space;
a roller accommodated in the cylinder and rotating together with a rotating shaft;
at least one vane slidably inserted into the roller, and having a guide protrusion extending in the axial direction to be slidably inserted into the guide groove in a circumferential direction; and
a bearing member disposed between the guide groove of at least one of the main bearing and the sub bearing and the guide protrusion of the vane.

2. The rotary compressor of claim 1, wherein the bearing member comprises:

an outer ring inserted into an inner circumferential surface of the guide groove;
an inner ring disposed inside the outer ring, and having an inner circumferential surface slidably brought into contact with a contact surface of the guide protrusion; and
a sliding member disposed between the outer ring and the inner ring to allow a relative motion between the outer ring and the inner ring.

3. The rotary compressor of claim 2, wherein one of the outer ring or the inner ring further comprises a rotating plate portion extending between the roller

and the main bearing and the sub bearing facing the roller.

4. The rotary compressor of claim 1, wherein the bearing member comprises:

a first bearing portion disposed between at least one of the main bearing and the sub bearing and the vane facing the at least one bearing in a radial direction; and
a second bearing portion disposed between the at least one of the main bearing and the sub bearing and the roller facing the at least one bearing in an axial direction.

5. The rotary compressor of claim 4, wherein the first bearing portion and the second bearing portion are formed integrally with each other.

6. The rotary compressor of claim 4, wherein the second bearing portion is thicker than the first bearing portion.

7. The rotary compressor of claim 4, wherein the first bearing portion is formed in an annular shape, and the second bearing part is formed in a disk shape.

8. The rotary compressor of claim 4, wherein the first bearing portion comprises:

an outer ring inserted into the guide groove of at least one of the main bearing and the sub bearing;
an inner ring disposed inside the outer ring, and having an inner circumferential surface slidably brought into contact with the guide protrusion of the vane; and
a sliding member disposed between the outer ring and the inner ring to allow a relative motion between the outer ring and the inner,
the second bearing portion extends radially from one end of the inner ring or the outer ring of the first bearing portion to be disposed on an axial side surface of the roller and an axial side surface of the at least one of the main bearing and the sub bearing facing the axial side surface of the roller.

9. The rotary compressor of claim 4, wherein the second bearing portion is disposed such that an axial side surface thereof is spaced apart from an axial side surface of the main bearing or the sub bearing facing the same.

10. The rotary compressor of claim 4, wherein the second bearing portion is inserted into the cylinder so that an outer circumferential surface thereof faces an inner circumferential surface of the cylinder.

11. The rotary compressor of claim 10, wherein a sealing portion is disposed between the outer circumferential surface of the second bearing portion and the inner circumferential surface of the cylinder.

12. The rotary compressor of claim 10, wherein the outer circumferential surface of the second bearing portion has the same shape as the inner circumferential surface of the cylinder.

13. The rotary compressor of claim 1, wherein the bearing member is disposed between at least one of the main bearing and the sub bearing and the vane facing the at least one bearing in a radial direction, and an axial side surface of the roller is in sliding contact with an axial side surface of the main bearing and an axial side surface of the sub bearing facing the same.

14. The rotary compressor of claim 13, wherein the inner circumferential surface of the cylinder is formed in a circular or elliptical shape, and a discharge port is formed in at least one of the axial side surface of the main bearing and the axial side surface of the sub bearing.

15. The rotary compressor of any of claims 1 to 14, wherein bush grooves are formed in the roller, two swing bushes are rotatably inserted into the bush grooves, and the vane is slidably inserted between the swing bushes.

FIG. 1

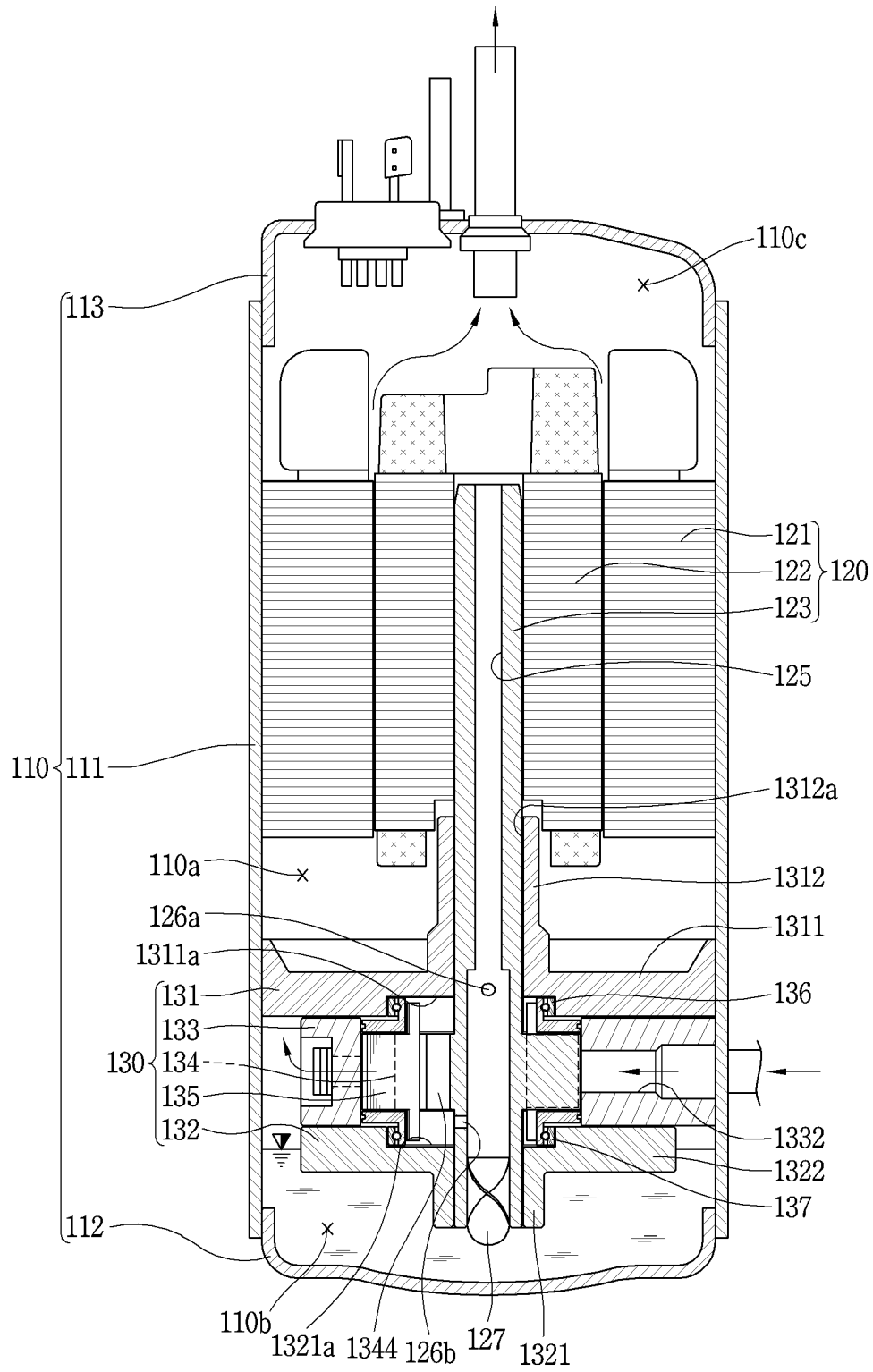


FIG. 2

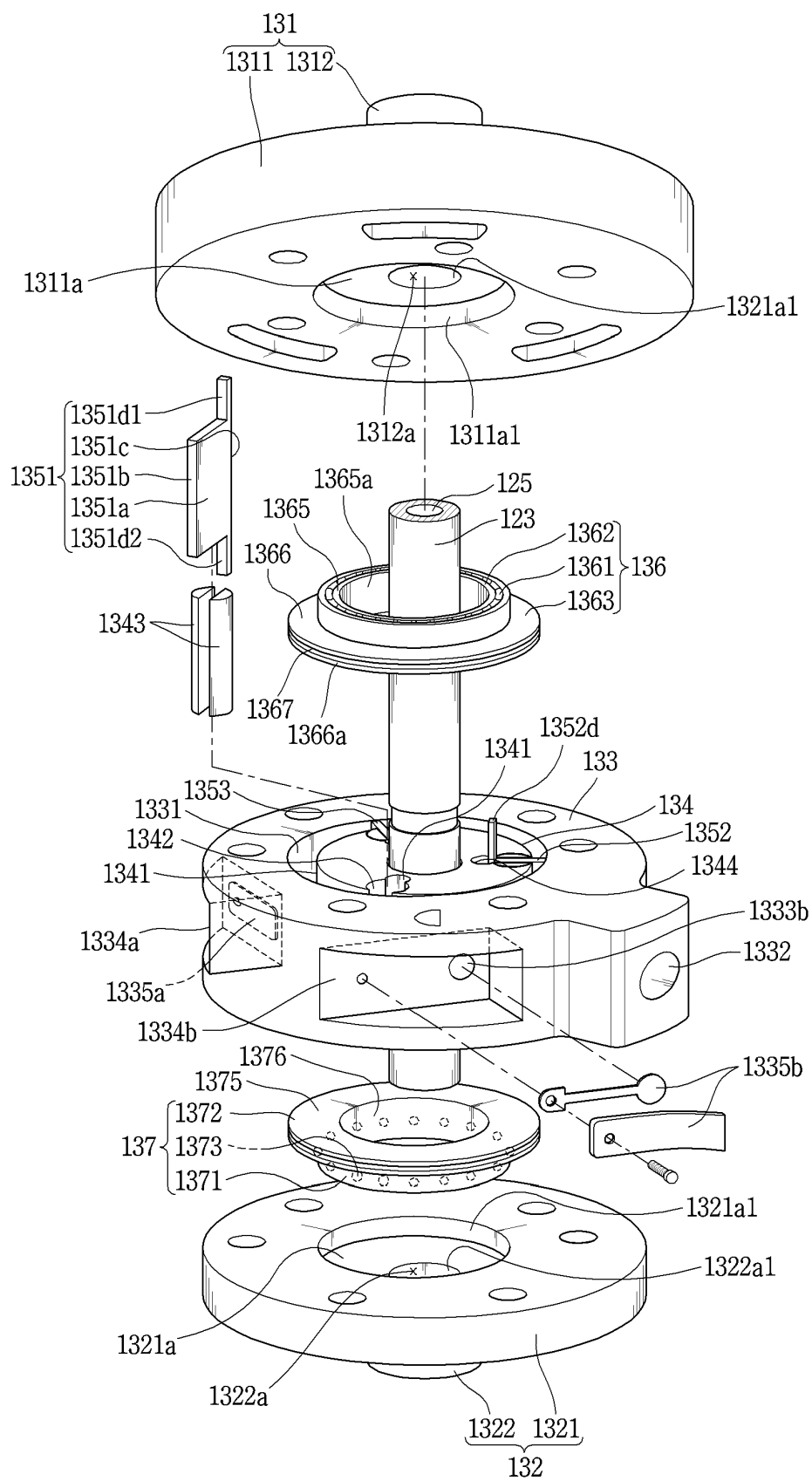


FIG. 3

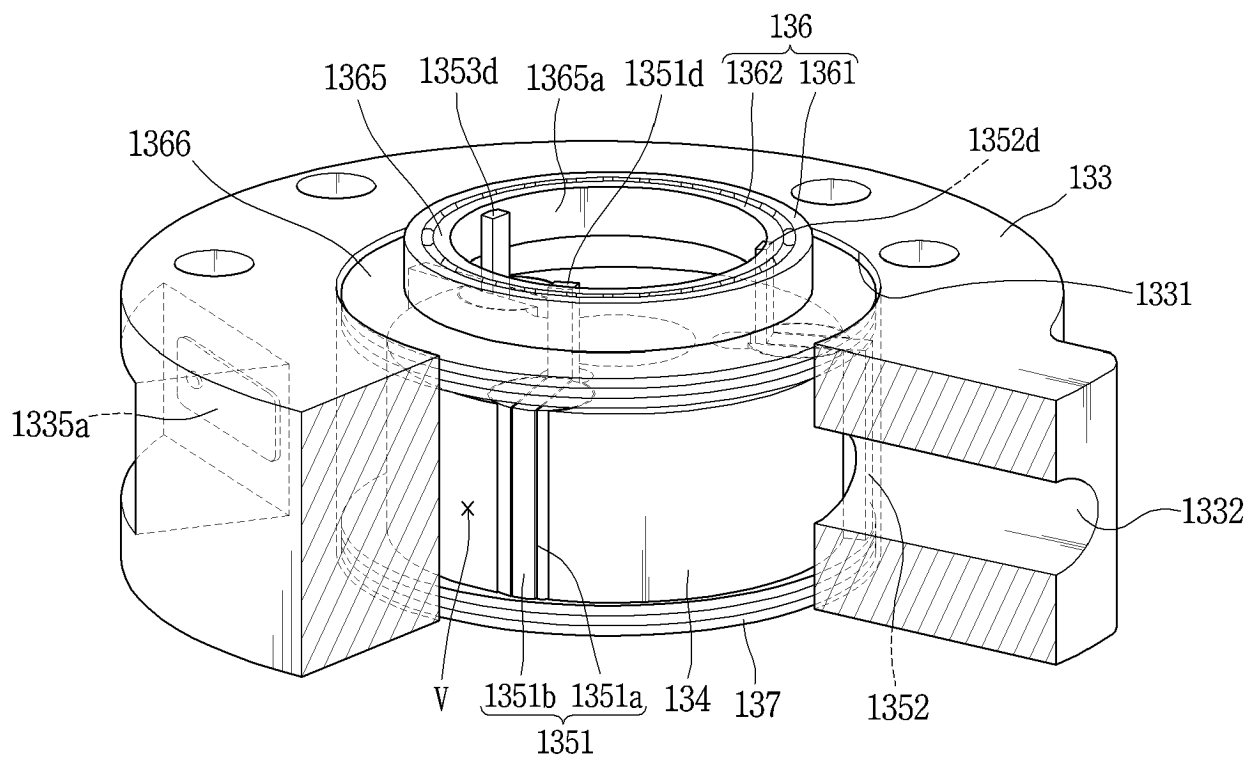


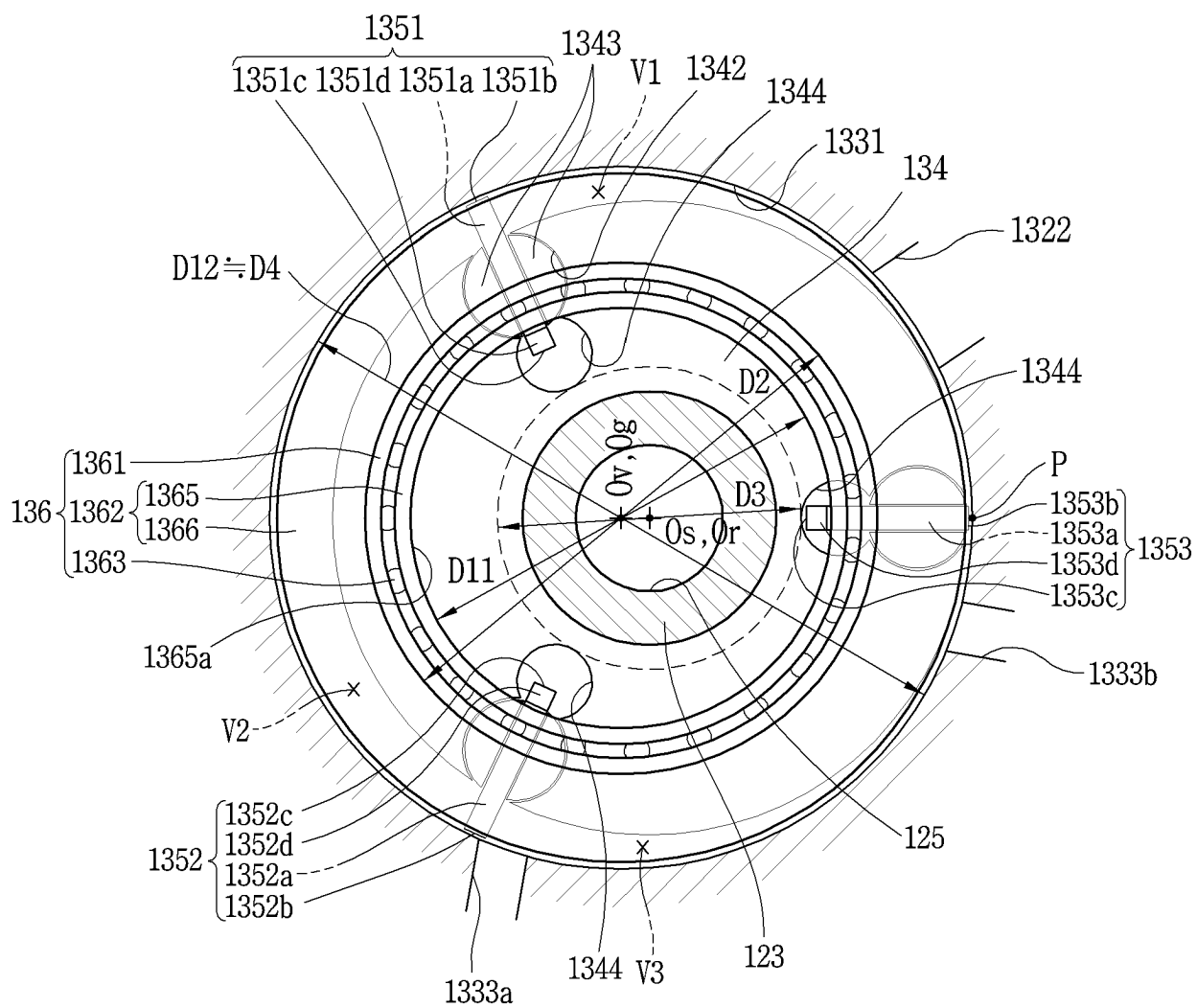
FIG. 4

FIG. 5

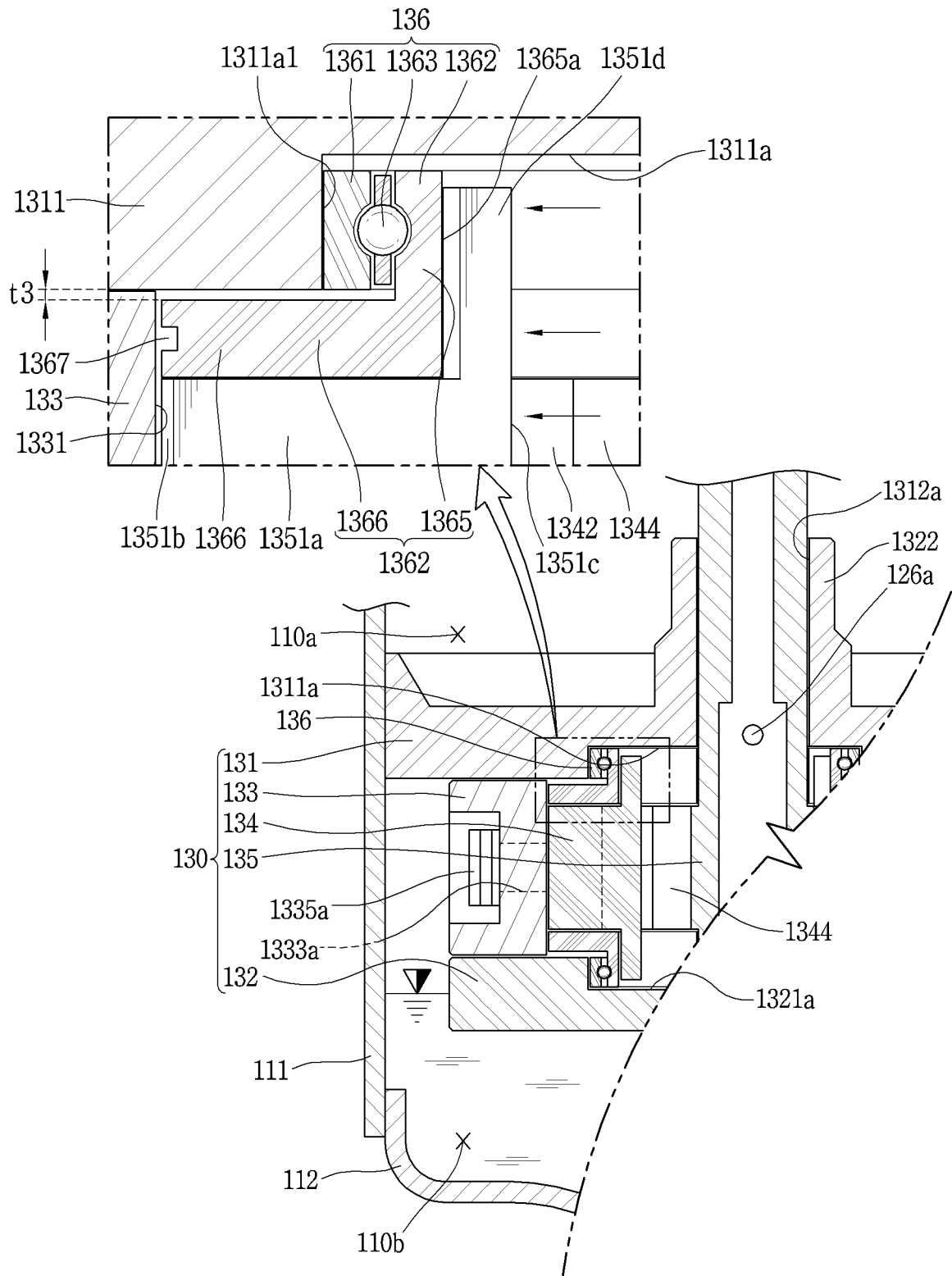


FIG. 6

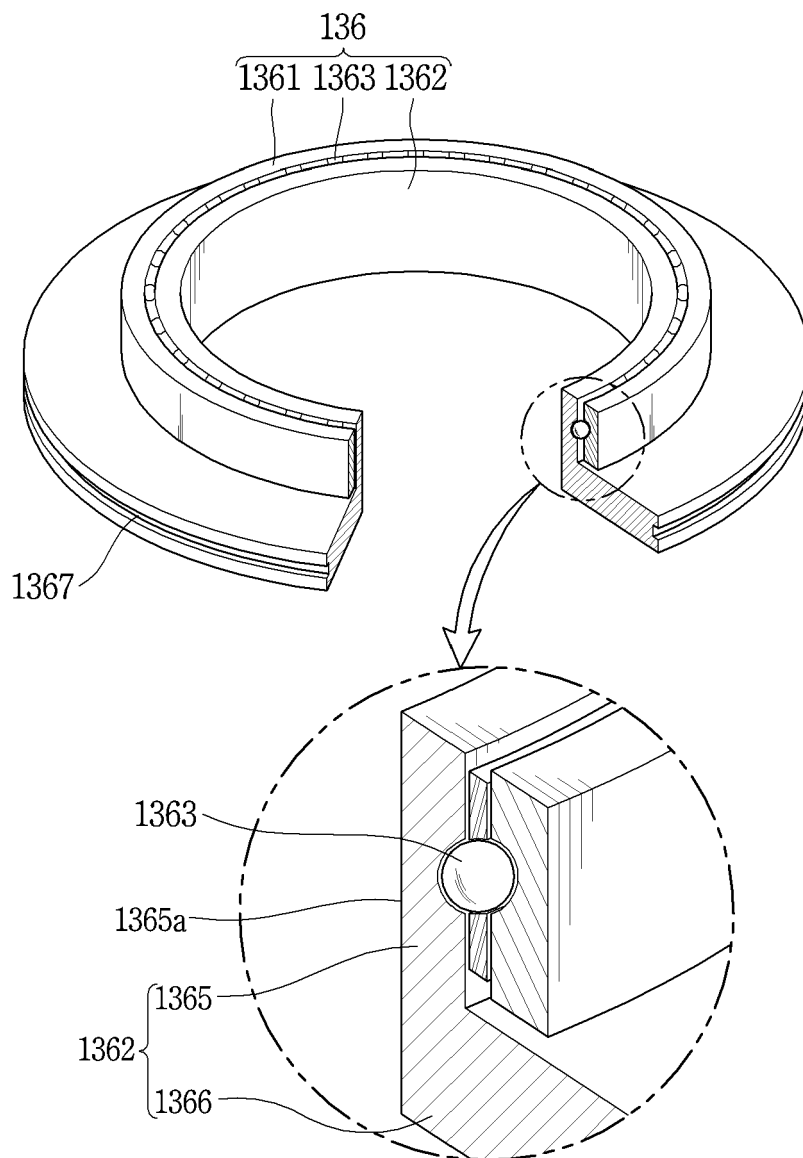


FIG. 7

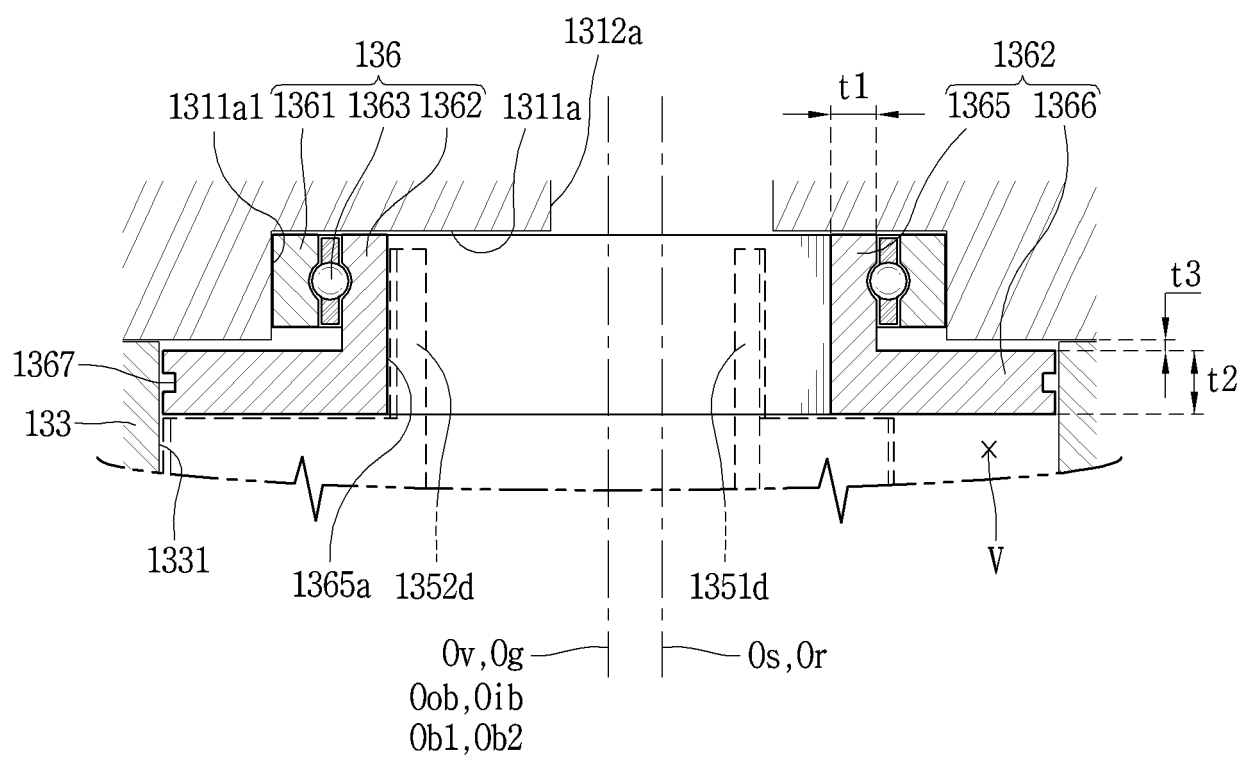


FIG. 8

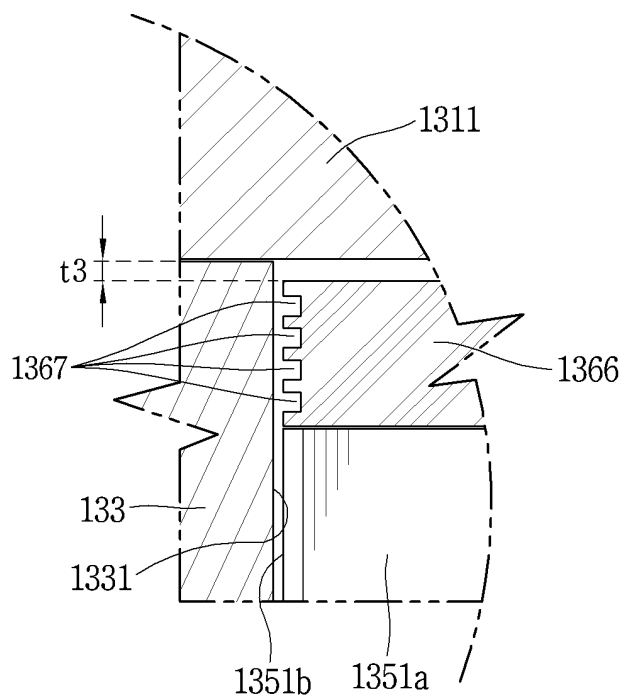


FIG. 9

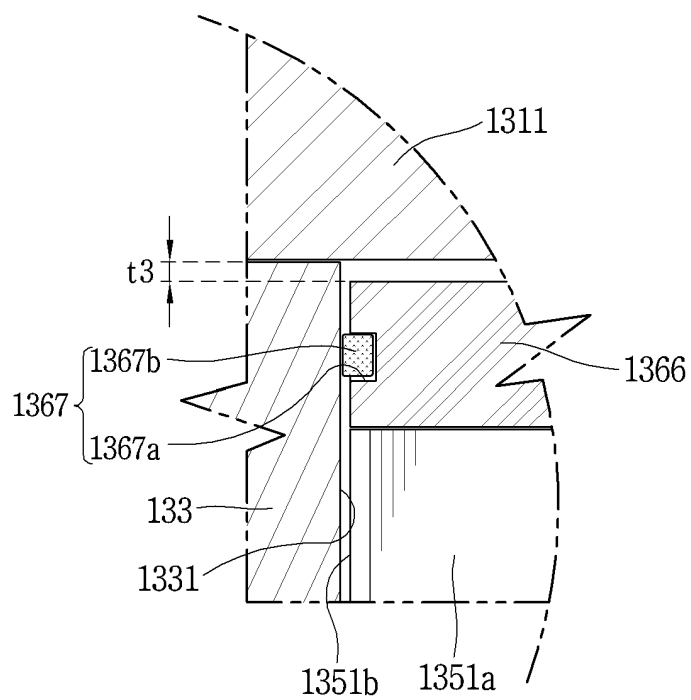


FIG. 10

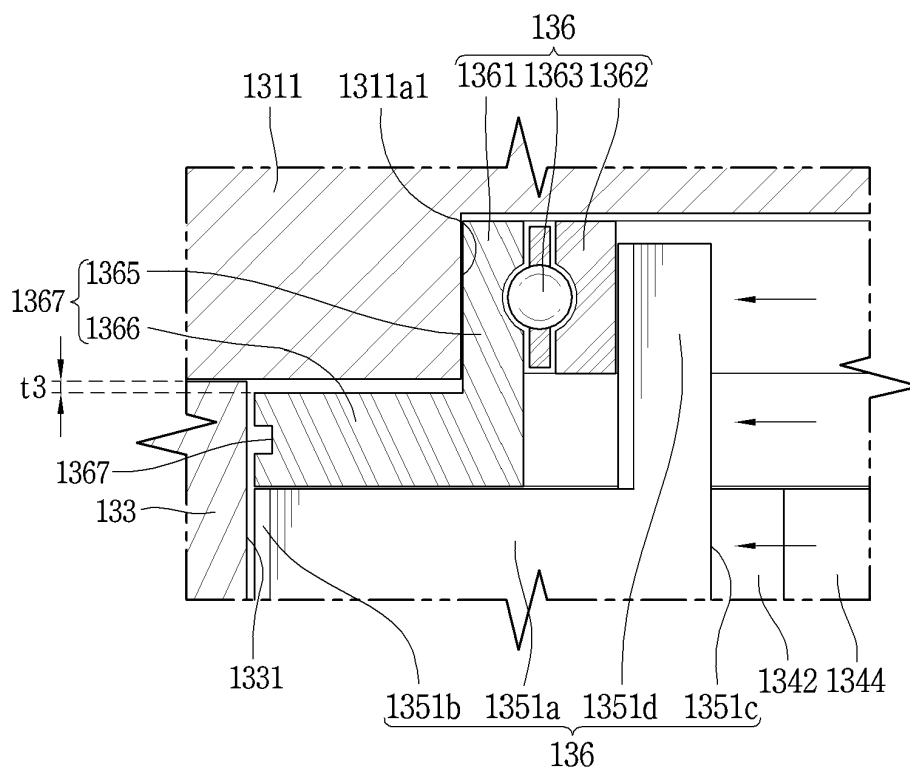
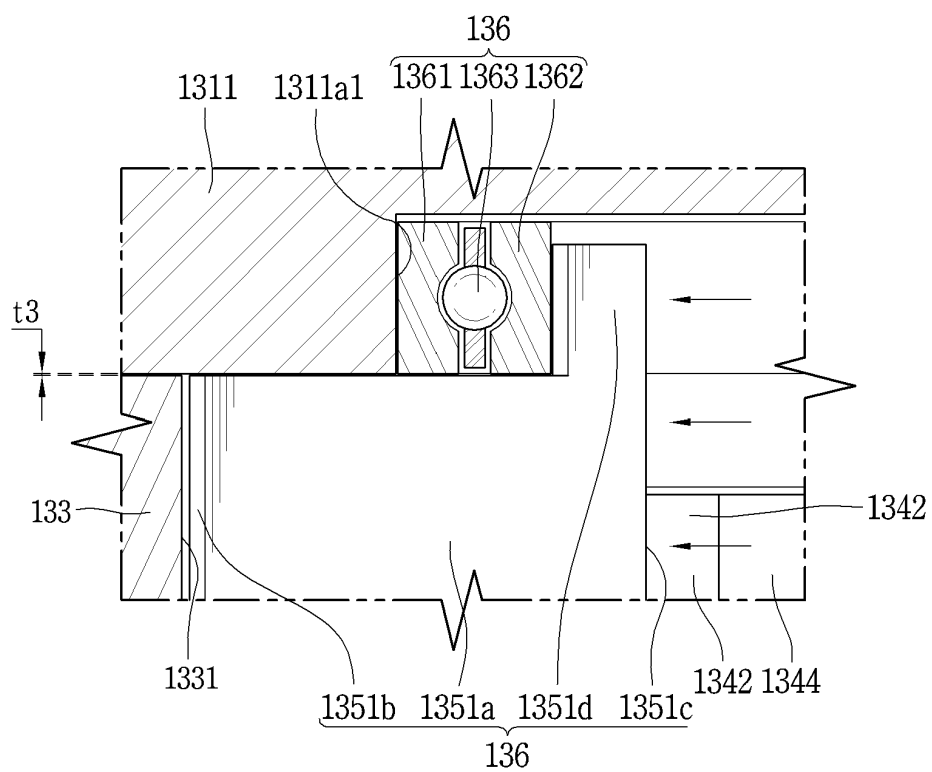


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/000227

A. CLASSIFICATION OF SUBJECT MATTER**F04C 18/344**(2006.01)i; **F04C 29/12**(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)

F04C 18/344(2006.01); F01C 1/344(2006.01); F04B 39/10(2006.01); F04C 2/344(2006.01); F04C 29/00(2006.01)

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

Korean utility models and applications for utility models: IPC as above

Japanese utility models and applications for utility models: IPC as above

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

eKOMPASS (KIPO internal) & keywords: 로터리 압축기(rotary compressor), 베인(vane), 베어링(bearing), 롤러(roller), 실링부(sealing part)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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

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Date of the actual completion of the international search

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Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon Building 4, 189 Cheongsang-ro, Seo-gu, Daejeon 35208

Facsimile No. +82-42-481-8578

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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