



(11)

EP 3 988 792 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
27.04.2022 Bulletin 2022/17

(51) International Patent Classification (IPC):
F04C 29/02 ^(2006.01)

(21) Application number: **19939139.2**

(52) Cooperative Patent Classification (CPC):
F04C 29/02

(22) Date of filing: **31.07.2019**

(86) International application number:
PCT/JP2019/030101

(87) International publication number:
WO 2021/019750 (04.02.2021 Gazette 2021/05)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

- **SHIDA, Shogo**
Fuji-shi, Shizuoka 416-8521 (JP)
- **TODA, Hayato**
Fuji-shi, Shizuoka 416-8521 (JP)
- **KAWABE, Isao**
Fuji-shi, Shizuoka 416-8521 (JP)
- **HIRAYAMA, Takuya**
Fuji-shi, Shizuoka 416-8521 (JP)

(71) Applicant: **Toshiba Carrier Corporation**
Kawasaki-Shi,
Kanagawa 212-8585 (JP)

(74) Representative: **Gramm, Lins & Partner**
Patent- und Rechtsanwälte PartGmbB
Theodor-Heuss-Straße 1
38122 Braunschweig (DE)

(72) Inventors:
• **HIRANO, Koji**
Fuji-shi, Shizuoka 416-8521 (JP)

(54) **HERMETIC COMPRESSOR AND REFRIGERATION CYCLE DEVICE**

(57) This hermetic compressor (2) is provided with a cylinder (31), a rotary shaft (32), a first bearing (33), a second bearing (34), and a hermetic container (10). The rotary shaft has a main shaft part (32a) supported by the first bearing on one end side thereof in the axial direction thereof with an eccentric section (32c) as a boundary, and a sub shaft part (32b) supported by the second bearing on the other end side thereof. The sub shaft part has, on the outer circumferential surface (32g) thereof, an oil flow groove (54) which is for a lubrication oil (I) and spirally extends toward the one axial end side along the rotational direction (R) of the rotary shaft from the one axial end side, rather than the other axial end (32e), that serves as a base end (54a). The second bearing has a flange part (34b) and a cylindrical part (34a) protruding from the flange part, wherein the wall thickness of a portion of the cylindrical part, which is the other axial end section and overlaps the base end of the oil flow groove when viewed in the radial direction of the rotary shaft, is smaller than those of other sections of the cylindrical part.

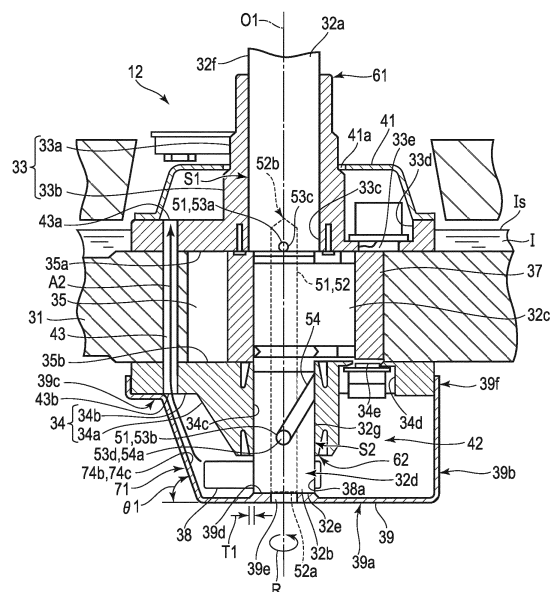


FIG. 2

Description

Technical Field

5 **[0001]** Embodiments described herein relate generally to a hermetic compressor and a refrigeration cycle device comprising the hermetic compressor.

Background Art

10 **[0002]** A refrigeration cycle device such as an air conditioner is equipped with a hermetic compressor. The hermetic compressor comprises a compression mechanism unit and a motor unit as main elements. These are accommodated in a sealed container with the motor unit positioned above and the compression mechanism unit positioned below. The compression mechanism unit has a rotating shaft having an eccentric part and is joined to the motor unit via the rotating shaft. The rotating shaft is supported by each of an upper first bearing (main bearing) and a lower second bearing (sub-bearing) and rotates by the rotational driving force of the motor unit. The motor unit comprises a rotor attached to the rotating shaft and a stator arranged to surround the rotor.

15 **[0003]** Sliding parts between the main and sub-bearings and the rotating shaft are lubricated by using, for example, the rotational force of the rotating shaft. As an example of a lubricating structure, a structure is known in which the rotating shaft is hollow in the axial direction and a radiating hole communicating with the hollow part (hollow hole) and an oil groove communicating with the radiating hole are provided. The hollow hole sucks up a refrigeration machine oil (lubricating oil) stored in a bottom of a closed container to a radiating hole by the rotational force of the rotating shaft. The radiating hole is provided on the rotating shaft perpendicular to the axial direction, and supplies the lubricating oil sucked up to the hollow hole to the sliding parts of the bearings and the rotating shaft. Oil grooves are provided on, for example, either an outer peripheral surface of the rotating shaft or an inner peripheral surface of the bearing to spread the lubricating oil over the entire sliding part between the bearings and the rotating shaft. The lubricating oil that has lubricated the sliding parts is returned to the bottom of the sealed container.

Citation List

30 Patent Literatures

[0004]

35 Patent Literature 1: JP S61-45079 A
Patent Literature 2: JP S61-94296 U
Patent Literature 3: JP 2018-165502 A

Summary of Invention

40 Technical Problem

[0005] The lubrication of the sliding parts between the bearings and the rotating shaft is maintained by supplying the lubricating oil to tiny gaps between the bearings and the rotating shaft to form an oil film. In a process of compressing a refrigerant in the compression mechanism unit, however, since a compressive load acts on the rotating shaft and deflection and deformation thereby occur on the rotating shaft, it is not easy to appropriately manage this tiny gap where the oil film exists. In particular, in order to improve the lubrication at the sliding part between the part which is lower than the eccentric part of the rotating shaft and which is supported by the sub-bearing and the sub-bearing, it is required to manage the tiny gap between the parts more appropriately.

50 **[0006]** Embodiments described herein aim to provide a hermetic compressor which promotes supplying oil to the sliding part between the sub-bearing and the rotating shaft and which attempts to improve the lubrication, and a refrigeration cycle device comprising the hermetic compressor.

Solution to Problem

55 **[0007]** According to one embodiment, a hermetic compressor accommodates a compression mechanism unit comprising: a cylinder forming a cylinder chamber; a rotating shaft which is arranged in the cylinder chamber and which includes an eccentric portion; and a first bearing defining an end surface on one axial end side of the rotating shaft in the cylinder chamber and a second bearing defining an end surface on an other end side, the first bearing and the

second bearing rotatably supporting the rotating shaft, and comprises a sealed container where a lubricating oil for lubricating a sliding portion of the compression mechanism unit is stored. The rotating shaft includes a main shaft part supported by the first bearing at one axial end side with respect to an eccentric part, and a sub-shaft part supported by the second bearing at the other end side. The sub-shaft part includes on its outer peripheral surface an oil passage groove of a lubricating oil, which is spirally continuous to one axial end side along a rotation direction of the rotating shaft with respect to the one end side used as a base end rather than the other axial end. The second bearing includes a flange part and a cylindrical part protruding from the flange part, and a thickness of the other axial end portion, of the cylindrical part, which is a portion lapping over the base end of the oil passage groove as viewed from the radial direction of the rotating shaft, is smaller than thicknesses of other portions of the cylindrical part.

Brief Description of Drawings

[0008]

FIG. 1 is a schematic diagram showing a refrigeration cycle device (air conditioner) comprising a hermetic compressor according to an embodiment.

FIG. 2 is an enlarged view showing a compression mechanism unit of the hermetic compressor according to the embodiment.

FIG. 3 is a longitudinal sectional view showing an example of a configuration of a second bearing of the hermetic compressor according to the embodiment.

FIG. 4 is a longitudinal sectional view showing another example of a configuration of a second bearing of the hermetic compressor according to the embodiment.

FIG. 5 is a plan view showing a balancer cover of the hermetic compressor according to the embodiment as viewed from a lower side.

FIG. 6 is a schematic diagram illustrating conditions for particles of a lubricating oil to rise on an inclined surface in the hermetic compressor according to the embodiment.

Mode for Carrying Out the Invention

[0009] One of embodiments will be described hereinafter with reference to FIG. 1 to FIG. 6.

[0010] FIG. 1 is a schematic diagram showing an air conditioner 1, which is an example of a refrigeration cycle device according to the embodiment. The air conditioner 1 comprises a hermetic compressor 2, a condenser 3, an expansion device 4, an evaporator 5, and an accumulator 6 as main elements. In the air conditioner 1, a refrigerant, which is a working fluid, circulates in a circulation circuit 7 while changing its phase into a gas phase refrigerant and a liquid phase refrigerant. The circulation circuit 7 is a circuit from a discharge side (discharge pipe 10b) of the hermetic compressor 2 to a suction side (suction pipe 36) through the condenser 3, the expansion device 4, the evaporator 5, and the accumulator 6. As the refrigerant, an HFC-based refrigerant such as R410A or R32, an HFO-based refrigerant such as R1234yf or R1234ze, or a natural refrigerant such as carbon dioxide (CO₂) can be used as appropriate.

[0011] The condenser 3 dissipates a high-temperature and high-pressure gas-phase refrigerant discharged from the hermetic compressor 2 and changes the refrigerant into a high-pressure liquid-phase refrigerant.

[0012] The expansion device 4 decompresses the high-pressure liquid-phase refrigerant derived from the condenser 3 and changes the refrigerant into a low-pressure gas-liquid two-phase refrigerant.

[0013] The evaporator 5 causes the low-pressure gas-liquid two-phase refrigerant derived from the condenser 3 to carry out heat exchange with air. At this time, the gas-liquid two-phase refrigerant takes heat from the air and evaporates, changing into a low-temperature and low-pressure gas-phase refrigerant. The air passing through the evaporator 5 is cooled by latent heat of evaporation of the liquid-phase refrigerant, becomes cold air and is sent to a place to be air-conditioned (cooled).

[0014] The low-temperature and low-pressure gas-phase refrigerant that has passed through the evaporator 5 is led to the accumulator 6. If the liquid phase refrigerant that has not fully evaporated is mixed in the refrigerant, the refrigerant is separated into the liquid phase refrigerant and the gas phase refrigerant. The low-temperature and low-pressure gas-phase refrigerant separated from the liquid-phase refrigerant is sucked from the accumulator 6 to the hermetic compressor 2 through the suction pipe 36, and is compressed again by the hermetic compressor 2 into a high-temperature and high-pressure gas-phase refrigerant, which is discharged from the discharge pipe 10b.

[0015] Next, a specific configuration of the hermetic compressor 2 used in the air conditioner 1 will be described. As shown in FIG. 1, the hermetic compressor 2 is a so-called vertical rotary compressor, and comprises a sealed container 10, a motor unit 11, and a compression mechanism unit 12 as the main elements. FIG. 1 shows a longitudinal section of the hermetic compressor 2 in two predetermined planes including a central axis O1 of the sealed container 10, which will be described later.

[0016] The sealed container 10 includes a peripheral wall 10a of a cylindrical shape and is erected along a vertical direction. A discharge pipe 10b is provided at an upper end of the sealed container 10. The discharge pipe 10b is connected to the condenser 3 via the circulation circuit 7. Furthermore, an oil reservoir 10c where lubricating oil I is stored is provided at a lower part of the sealed container 10.

[0017] As the lubricating oil I, for example, polyol ester oil, polyvinyl ether oil, polyalkylene glycol oil, mineral oil, and the like are applicable.

[0018] The motor unit 11 is accommodated in a middle part along the central axis O1 of the sealed container 10 so as to be located between the compression mechanism unit 12 and the discharge pipe 10b. The motor unit 11 includes a so-called inner rotor type motor and comprises a rotor 21 and a stator 22.

[0019] FIG. 2 is an enlarged view showing the compression mechanism unit 12 in FIG. 1. As shown in FIG. 1 and FIG. 2, the compression mechanism unit 12 is accommodated in the lower part of the sealed container 10 so as to be immersed in the lubricating oil I. The compression mechanism unit 12 has a single type cylinder structure and comprises a cylinder 31, a rotating shaft 32, a first bearing 33, and a second bearing 34 as main elements. The compression mechanism unit 12 is not limited to a single type, but may be provided with two or more cylinders.

[0020] The cylinder 31 is fixed to an inner peripheral surface of the peripheral wall 10a of the sealed container 10. The first bearing 33 is fixed to an upper part of the cylinder 31, and the second bearing 34 is fixed to a lower part of the cylinder 31. A space surrounded by a bore of the cylinder 31, the first bearing 33 and the second bearing 34 constitutes a cylinder chamber 35. The cylinder chamber 35 is arranged coaxially with the central axis O1 of the sealed container 10. The cylinder chamber 35 is connected to the accumulator 6 via a suction pipe 36 that is a part of the circulation circuit 7. The gas phase refrigerant separated from the liquid phase refrigerant in the accumulator 6 is led to the cylinder chamber 35 through the suction pipe 36.

[0021] In the cylinder 31, vanes (omitted in the figure) are arranged to divide the cylinder chamber 35 into an inlet chamber and a compression chamber. Vane grooves (omitted in the figure) extending outwardly in the radial direction are formed on an inner peripheral part of the cylinder 31. The vanes are urged inwardly in the radial direction by urging means (omitted in the figure), and supported by the cylinder 31 with their tips pressed against an outer peripheral surface of a roller 37 to be described later. The vanes advance and retreat in the cylinder chamber 35 with the eccentric rotation of the roller 37. As a result, the volume of the inlet chamber and the compression chamber of the cylinder chamber 35 is varied, and the gas phase refrigerant sucked from the suction pipe 36 into the cylinder chamber 35 is compressed.

[0022] The rotating shaft 32 has an axial center located coaxially with the central axis O1 of the sealed container 10, and passes through the first bearing 33, the cylinder chamber 35, and the second bearing 34. In the present embodiment, the axial center (central axis O1) of the rotating shaft 32 extends vertically, and one end side along the axial center of the rotating shaft 32 corresponds to an upper side and the other end side corresponds to a lower side.

[0023] The rotating shaft 32 includes a main shaft part 32a, a sub-shaft part 32b, and an eccentric part 32c interposed therebetween.

[0024] The main shaft part 32a extends toward one end (upper end) of the rotating shaft 32 in the axial center direction (hereinafter simply referred to as an axial center direction) with respect to the eccentric part 32c. The rotor 21 of the motor unit 11 is mounted on the upper part of the main shaft part 32a. The sub-shaft part 32b extends toward the other axial end (lower end) with respect to the eccentric part 32c. When the rotating shaft 32 rotates, the main shaft part 32a rotates (slides) while sliding so as to be in contact with the first bearing 33, and the sub-shaft part 32b slides with the second bearing 34. That is, the main shaft part 32a is a part of the rotating shaft 32 that slides so as to be in contact with the first bearing 33, at one axial end side (upper end side) rather than the eccentric part 32c. The sub-shaft part 32b is a part of the rotating shaft 32 that slides so as to be in contact with the second bearing 34, at the other axial end side (lower end side) rather than the eccentric part 32c.

[0025] The eccentric part 32c is eccentric to the axial center (central axis O1) of the rotating shaft 32 (main shaft part 32a and sub-shaft part 32b) and is arranged in the cylinder chamber 35. A roller 37 is fitted into an outer peripheral surface of the eccentric part 32c. A slight gap is provided between the inner peripheral surface of the roller 37 and the outer peripheral surface of the eccentric part 32c to allow rotation of the roller 37 with respect to the eccentric part 32c. As a result, the roller 37 rotates eccentrically with respect to the axis center of the rotating shaft 32 inside the cylinder chamber 35 when the rotating shaft 32 rotates, and a part of the outer peripheral surface is brought into contact with the inner peripheral surface of the cylinder chamber 35 via an oil film.

[0026] The rotating shaft 32 is provided with a balancer 38 at the other axial end part. In the embodiment, the sub-shaft part 32b protrudes lower than the second bearing 34, and the balancer 38 is arranged on a protruding part 32d thereof. The shape of the balancer 38 is not particularly limited, but is, for example, a disk shape or a semi-cylindrical disk shape. A through hole 38a in the axial center direction is formed in the balancer 38. A protruding part 32d of the sub-shaft part 32b is fixed to the through hole 38a by press-fitting, screwing, or the like. The center of the balancer 38 is eccentric in a direction opposite to the eccentric direction of the eccentric part 32c with respect to the axial center (central axis O1) of the rotating shaft 32. That is, the balancer 38 and the eccentric part 32c are arranged with a phase difference of 180° in the circumferential direction of the rotating shaft 32. The arrangement angle of the balancer 38

differs depending on the number of the eccentric parts.

[0027] In the embodiment, the sub-shaft part 32b has an axial length shorter than the main shaft part 32a. Therefore, by providing the balancer 38 on the sub-shaft part 32b, the distance between the balancer 38 and the second bearing 34 supporting the sub-shaft part 32b, which is the arrangement part of the balancer 38, can be shortened as compared with the case where, for example, the balancer is provided on the upper surface of the rotor 21 of the motor unit 11. As a result, the rotational balance of the rotating shaft 32 having the eccentric part 32c is stabilized and the flexure and the like of the rotor 21 are suppressed.

[0028] The balancer 38 is covered with a balancer cover 39. The balancer cover 39 is fixed to the second bearing 34 with a bolt 40 (see FIG. 5) and covers the balancer 38 from below. The balancer cover 39 comprises a bottom part 39a, a wall part 39b standing up from the bottom part 39a, and a flange part 39c continuous with the wall part 39b.

[0029] The bottom part 39a is in contact with the other end surface of the rotating shaft 32, that is, a lower end surface 32e of the sub-shaft part 32b. Such a contact part is a thrust support part 39d which receives an axial load acting on the rotating shaft 32 and slidably supports the lower end surface 32e. The thrust support part 39d is provided to raise the bottom part 39a upwardly. An upper surface of the thrust support part 39d (the surface in contact with the lower end surface 32e) has a flat shape orthogonal to the axial center direction. An oil supply hole 39e penetrating in the vertical direction is formed in the center of the thrust support part 39d, and its lower end faces the lubricating oil I stored in the oil reservoir 10c of the sealed container 10. The wall part 39b is a part covering the outer periphery of the balancer 38. The flange part 39c is a part fixed to the second bearing 34 by the bolt 40 and has a pawl 39f which supports the second flange part 34b to be described below from the circumferential direction.

[0030] The first bearing 33 and the second bearing 34 rotatably support the rotating shaft 32. The first bearing 33 defines an upper surface 35a of the cylinder chamber 35, and the second bearing 34 defines a lower surface 35b of the cylinder chamber 35. The upper surface 35a is an end surface on one axial end side of the rotating shaft 32, and the lower surface 35b is an end surface on the other axial end side of the rotating shaft 32. That is, the first bearing 33 corresponds to a member that closes the cylinder chamber 35 from above, and the second bearing 34 corresponds to a member that closes the cylinder chamber 35 from below.

[0031] The first bearing 33 comprises a first flange part 33b and a first cylindrical part 33a protruding from the first flange part 33b.

[0032] The first flange part 33b is located at the lower end of the first cylindrical part 33a and extends outwardly in the radial direction. The first flange part 33b has a portion into which the main shaft part 32a is inserted to be rotatably supported, on its inner periphery. A first discharge hole 33d is formed in the first flange part 33b to discharge the refrigerant from the compression chamber of the cylinder chamber 35. The first discharge hole 33d vertically penetrates a part of the first flange part 33b and communicates with the inside of the compression chamber of the cylinder chamber 35. The first discharge hole 33d is opened and closed by a first discharge valve mechanism 33e. The first discharge valve mechanism 33e opens the first discharge hole 33d as the pressure in the compression chamber rises, and discharges the high-temperature and high-pressure gas-phase refrigerant from the cylinder chamber 35.

[0033] A muffler 41 is provided above the first bearing 33 to cover the first bearing 33. The muffler 41 has a communication hole 41a which connects the inside and outside (upper and lower parts) of the muffler 41. The high-temperature and high-pressure gas-phase refrigerant discharged through the first discharge hole 33d is discharged into the sealed container 10 through the communication hole 41a.

[0034] The first cylindrical part 33a is a part which protrudes from the upper end of the first flange part 33b and through which the rotating shaft 32, more specifically, the main shaft part 32a is inserted to be rotatably supported, in the first bearing 33. In the main shaft part 32a being inserted into the first cylindrical part 33a, an outer peripheral surface 32f slides on the inner peripheral surface 33c of the first cylindrical part 33a.

[0035] The second bearing 34 comprises a second flange part 34b and a second cylindrical part 34a protruding from the second flange part 34b.

[0036] The second flange part 34b is located at an upper end of the second cylindrical part 34a and extends outwardly in the radial direction. The second flange part 34b has a portion through which the sub-shaft part 32b is inserted to be rotatably supported, on its inner periphery. A second discharge hole (hereinafter referred to as a discharge port) 34d is formed in the second flange part 34b to discharge the refrigerant from the compression chamber of the cylinder chamber 35. The discharge port 34d vertically penetrates a part of the second flange part 34b and connects with the inside of the compression chamber of the cylinder chamber 35. The discharge port 34d is opened and closed by a second discharge valve mechanism 34e. The second discharge valve mechanism 34e opens the discharge port 34d as the pressure in the compression chamber rises, and discharges the high-temperature and high-pressure gas-phase refrigerant from the cylinder chamber 35. The high-temperature and high-pressure gas-phase refrigerant discharged through the discharge port 34d is discharged into the cover space 42 of the balancer cover 39. The cover space 42 is a space in which the balancer cover 39 covers the balancer 38 from below and which is surrounded by the bottom part 39a and the wall part 39b.

[0037] The second cylindrical part 34a is a part which protrudes from the lower end of the second flange part 34b and through which the rotating shaft 32, more specifically, the sub-shaft part 32b is inserted to be rotatably supported, in the

second bearing 34. In the sub-shaft part 32b being inserted into the second cylindrical part 34a, an outer peripheral surface 32g slides on the inner peripheral surface 34c of the second cylindrical part 34a.

[0038] The first bearing 33, the cylinder 31, and the second bearing 34 include a connection passage 43 that connects the upper space of the lubricating oil storage surface 1s in the sealed container 10 with the cover space 42. The connection passage 43 vertically penetrates the first flange part 33b, the cylinder 31, and the second flange part 34b. The connection passage 43 is configured, for example, as a tube penetrating the first flange part 33b, the cylinder 31, and the second flange part 34b, or by connecting through holes formed respectively in these parts. An opening 43a on one end (upper end) side of the connection passage 43 faces the inside of the muffler 41, and an opening 43b on the other end (lower end) side faces the cover space 42.

[0039] The number of the connection passages 43 is not particularly limited. In the present embodiment, for example, two connection passages 431 and 432 are provided (see FIG. 5). The details of these connection passages 431 and 432 will be described later.

[0040] In the compression mechanism unit 12 having the above-described configuration, each sliding part between elements is lubricated by the lubricating oil I. Next, the lubricating structure of the compression mechanism unit 12 in the present embodiment, more specifically, the lubricating structure for the sliding portion between the rotating shaft 32 and the first bearing 33 and the second bearing 34 (hereinafter referred to as a bearing lubricating portion) will be described.

[0041] The rotating shaft 32 includes an oil supply channel 51 for supplying the lubricating oil I from the oil reservoir 10c of the sealed container 10 to the bearing lubricating portion. The oil supply channel 51 is configured to include a main oil supply channel 52 and sub oil supply channels 53a and 53b.

[0042] The main oil supply channel 52 is constituted by making a part of the rotating shaft 32 hollow in the axial center direction.

[0043] A lower end part of the main oil supply channel 52 is opened on the lower end surface 32e of the rotating shaft 32 (sub-shaft part 32b). The opening 52a is connected with the oil supply hole 39e of the balancer cover 39. That is, the lower end part of the main oil supply channel 52 is connected with the inside of the sealed container 10, more specifically, the oil reservoir 10c, through the opening 52a and the oil supply hole 39e. As a result, when the rotating shaft 32 rotates, the lubricating oil I is sucked up from the oil reservoir 10c into the main oil supply channel 52.

[0044] The upper end part 52b of the main oil supply channel 52 ends in a middle part of the rotating shaft 32 in the axial center direction, more specifically, in the vicinity of the lower end part of the main shaft part 32a. The position of the upper end part 52b (height from the lower end part in the axial center direction) may reach at least the position of the cylinder 31. For example, the main oil supply channel 52 may be opened on the upper end surface of the rotating shaft 32 (main shaft part 32a). In addition, the inner surface of the main oil supply channel 52 may be provided with a spiral guide or the like to promote the rise of the lubricating oil I as the rotating shaft 32 rotates.

[0045] The sub oil supply channels 53a and 53b branch off from the main oil supply channel 52, extend in a direction (radial direction) perpendicular to the shaft center direction, and open on the outer peripheral surfaces 32f and 32g of the rotating shaft 32. That is, the sub oil supply channels 53a and 53b are radial channels extending from the main oil supply channel 52.

[0046] One of the two sub oil supply channels 53a and 53b branching from the main oil supply channel 52 is a first sub oil supply channel 53a formed in the main shaft part 32a, and the other is a second sub oil supply channel 53b formed in the sub-shaft part 32b.

[0047] The first sub oil supply channel 53a is formed at a connection portion with the eccentric part 32c in the main shaft part 32a. The first sub oil supply channel 53a opens on the outer peripheral surface 32f of the main shaft part 32a, and the opening 53c thereof faces the inner peripheral surface 33c of the first flange part 33b of the first bearing 33.

[0048] The second sub oil supply channel 53b is formed above the lower end of the sub-shaft part 32b (the position of the lower end surface 32e), in the radial direction of the rotating shaft 32. The second sub oil supply channel 53b opens on the outer peripheral surface 32g of the sub-shaft part 32b, and the opening 53d thereof faces the inner peripheral surface 34c of the second cylindrical part 34a of the second bearing 34.

[0049] In addition to the main oil supply channels 52 and the sub oil supply channels 53a and 53b, the sub-shaft part 32b includes an oil passage groove 54 for spreading the lubricating oil I to the sliding portion with the second bearing 34. The oil passage groove 54 is formed on the outer peripheral surface 32g of the sub-shaft part 32b. The oil passage groove 54 is a groove which is spirally continues to one axial end (upper end) side, from the second sub oil supply channel 53b, along a rotation direction (i.e., a direction indicated by an arrow R shown in FIG. 2) of the sub-shaft part 32b (terminally, the rotating shaft 32). The spiral is continuous so as to ascend the outer peripheral surface 32g in the direction of rotation of the sub-shaft part 32b. The length of the continuous oil passage groove 54 is arbitrary and may not wind around the sub-shaft part 32b or may wind around the sub-shaft part 32b one or more times. FIG. 2 shows, as an example, an oil passage groove 54 which does not wind around the sub-shaft part 32b. The oil passage groove 54 extends from the second cylindrical part 34a of the second bearing 34 to the inner peripheral surface 34c of the second flange part 34b over the entire length.

[0050] A base end 54a of the oil channel 54 is connected with the opening 53d on the outer peripheral surface 32g of the second sub oil supply channel 53b. That is, the second sub oil supply channel 53b is open at the groove bottom of the oil supply channel 54, and the opening 53d is the base end 54a of the oil supply channel 54. Therefore, the base end 54a is located above the lower end of the sub-shaft part 32b (i.e., the position of the lower end surface 32e) in the radial direction of the rotating shaft 32. The position of the base end 54a is defined as the center position of the opening 53d. The tip of the oil passage groove 54 reaches the upper end part of the sub-shaft part 32b, in other words, the connection part with the eccentric part 32c.

[0051] When the rotating shaft 32 rotates, the lubricating oil I sucked up into the main oil supply channel 52 through the oil supply hole 39e is discharged from the opening 53c toward the inner peripheral surface 34c of the second cylindrical part 34a of the second bearing 34 through the first sub oil supply channel 53a. Then, the lubricating oil I spreads over a sliding portion (inner peripheral surface 33c and outer peripheral surface 32f) S1 of the first cylindrical part 33a and the first flange part 33b of the first bearing 33 and the main shaft part 32a in accordance with the rotating shaft 32 (main shaft part 32a), and lubricates the sliding portion S1.

[0052] In addition, the lubricating oil I sucked up into the main oil supply channel 52 is led from the second sub oil supply channel 53b to the oil passage groove 54 through the opening 53d. The lubricating oil I led to the oil groove 54 rises from the base end 54a to the tip through the oil channel 54. Meanwhile, the lubricating oil I spreads over a sliding portion (inner peripheral surface 34c and outer peripheral surface 32g) S2 of the second cylindrical part 34a and the second flange part 34b of the second bearing 34 and the sub-shaft part 32b in accordance with the rotation of the rotating shaft 32 (sub-shaft part 32b), and lubricates the sliding portion S2.

[0053] In the embodiment, the first bearing 33 has a first support end portion 61 at one axial end part (upper end part), and the second bearing 34 has a second support end portion 62 at the other axial end part (lower end part). The thickness (T1 shown in FIG. 2) of the second support end portion 62 of the second bearing 34 is smaller than that of the first support end portion 61 of the first bearing 33. The thickness T1 of the second support end portion 62 is the thickness at the thinnest position of the second support end portion 62.

[0054] The first support end portion 61 is an axial end portion of the support portion of the main shaft part 32a in the first bearing 33. In other words, the portion is a part of the portion in which the main shaft part 32a slides in the first cylindrical part 33a and is an upper axial end portion. In the embodiment, for example, the first support end portion 61 corresponds to a thin portion formed such that the first cylindrical part 33a is tapered toward the upper end part.

[0055] Thus, by making the first support end portion 61 thinner than other portions of the first cylindrical part 33a in which the main shaft part 32a slides, the support pressure of the first cylindrical part 33a on the sliding main shaft part 32a does not become excessive and is maintained appropriately.

[0056] The second support end portion 62 is the other axial end portion of the support portion of the sub-shaft part 32b in the second bearing 34. In other words, the portion is a part of the portion in which the sub-shaft part 32b slides in the second cylindrical part 34a and is a lower axial end portion. A specific configuration of the second support end portion 62 will be described below.

[0057] FIG. 3 and FIG. 4 are longitudinally cross-sectional views showing a configuration example of the second bearing 34. FIG. 3 and FIG. 4 show a state of the second bearing 34 longitudinally sectioned in two predetermined planes including the central axis O1 of the sealed container 10.

[0058] In the configuration example shown in FIG. 3, the second support end portion 62 is configured as an inner wall part 63a of a groove 63 provided in a lower end surface 34f of the second cylindrical part 34a. The groove 63 is provided continuously on the lower end surface 34f in a circumferential direction, and is composed of an inner wall part 63a, an outer wall part 63b, and a bottom part 63c. The inner wall part 63a is a part defining an inner groove wall (inner peripheral surface) in the radial direction, and the outer wall part 63b is a part defining an outer groove wall (outer peripheral surface) in the radial direction. The bottom part 63c is a part defining a groove bottom (bottom surface) sandwiched between the inner wall part 63a and the outer wall part 63b. The lower end part of the second cylindrical part 34a is thereby bisected into the inner wall part 63a and the outer wall part 63b by the groove 63. The inner wall part 63a is a part in which the sub-shaft part 32b slides at the lower end part of the second cylindrical part 34a. The inner wall part 63a is thinner in thickness than the other parts of the support portion of the sub-shaft part 32b in the second cylindrical part 34a of the second bearing 34.

[0059] In addition, a groove 64 is provided substantially opposite to the groove 63 in the axial center direction, on the upper end surface 34g of the second flange part 34b. The groove 64 is provided continuously in the circumferential direction on the upper end surface 34g and is composed of an inner wall part 64a, an outer wall part 64b, and a bottom part 64c defining each portion in the same manner as the groove 63. The upper end part of the second flange part 34b is thereby bisected into an inner wall part 64a and an outer wall part 64b by the groove 64. The inner wall part 64a is a part in which the sub-shaft part 32b slides at the upper end part of the second flange part 34b. The outer wall part 64b is continuous with a portion which expands in the radial direction of the rotating shaft 32, in the second flange part 34b.

[0060] In the configuration example shown in FIG. 4, the second support end portion 62 is configured as a thin portion 65 formed such that the second cylindrical part 34a is tapered toward the lower end part. The thin portion 65 is formed

continuously in the circumferential direction at the lower end part of the second cylindrical part 34a. As a result, unlike the inner wall part 63a shown in FIG. 3, the second cylindrical part 34a, in the thin portion 65, is a part in which the thickness of the lower end part itself is small over the entire periphery. The thin portion 65 is a portion in which the sub-shaft part 32b slides at the lower end part of the second cylindrical part 34a. The thin portion 65 is thinner in thickness than the other parts of the support portion of the sub-shaft part 32b in the second cylindrical part 34a of the second bearing 34.

[0061] In addition, a groove 64 composed of an inner wall part 64a, an outer wall part 64b, and a bottom part 64c is provided in the upper end surface 34g of the second cylindrical part 34a, similarly to the configuration example shown in FIG. 3. In this case, the groove 64 is provided such that the inner wall part 64a is arranged to be substantially overlaid on the thin portion 65 as viewed from the axial center direction.

[0062] Thus, in addition to the groove 64, the second bearing 34 includes the inner wall part 63a (or the groove 63 if viewed in the other manner) and the thin portion 65 as the second support end portion 62 having a smaller thickness than the other thicknesses of the second cylindrical part 34a, such that the flexibility of the second cylindrical part 34a can be increased and the structure can be made elastically deformable. Thus, when an outward load in the radial direction is applied from the sub-shaft part 32b to the second cylindrical part 34a, the second support end portion 62 can be slightly deformed in addition to the inner wall part 64a. As a result, the gap of the sliding portion (inner peripheral surface 34c and outer peripheral surface 32g) S2 between the second cylindrical part 34a and the sub-shaft part 32b can be enlarged.

[0063] For this reason, even when the base end 54a of the oil passage groove 54 is located above the lower end of the sub-shaft part 32b (position of the lower end surface 32e) in the radial direction of the rotating shaft 32, the lubricating oil I can be spread to every corner of the sliding portion S2 to enhance the lubricating performance. At this time, since the base end 54a is positioned above the lower end of the sub-shaft part 32b, the lubricating oil I can be prevented from falling into the oil reservoir 10c without contributing to lubrication of the sliding portion S2. By enhancing the lubricating performance by them, the reliability of the hermetic compressor 2 can be improved.

[0064] Furthermore, the second support end portion 62 is arranged such that the base end 54a of the oil passage groove 54 laps over the second support end portion 62 when viewed from the radial direction of the rotating shaft 32, more specifically, the sub-shaft part 32b.

[0065] For example, when the second support end portion 62 is the inner wall part 63a, the axial center position of the base end 54a, more specifically, the opening part 53d laps over the axial position of the inner wall part 63a, as viewed from the radial direction of the sub-shaft part 32b. As viewed in the other manner, from the radial direction of the sub-shaft part 32b, the center position of the opening 53d may be above the tip of the inner wall part 63a and below the bottom part 63c corresponding to the base end portion.

[0066] In addition, when the second support end portion 62 is the thin portion 65, the center position of the opening 53d laps over the axial position of the thin portion 65 as viewed from the radial direction of the sub-shaft part 32b. As viewed in the other manner, from the radial direction of the sub-shaft part 32b, the center position of the opening 53d may be above the tip of the thin portion 65 and below the base part 65a.

[0067] By arranging the second support end portion 62 (inner wall part 63a or thin portion 65) in this manner, the lubricating oil I discharged from the opening 53d can be supplied to the sliding portion (inner peripheral surface 34c and outer peripheral surface 32g) S2 between the second cylindrical part 34a and the sub-shaft part 32b, and the lubricating oil I can be supplied upwardly from the sliding portion S2 through the oil passage groove 54 and downwardly from the base end 54a. At this time, the inner wall part 64a and the second support end portion 62 can be slightly deformed to enlarge the gap of the sliding portion S2, such that the lubricating oil I can be spread evenly over both the upper and lower sides of the sliding portion S2. In addition, since the base end 54a of the oil passage groove 54 and the second support end portion 62 are arranged to lap over each other as viewed from the radial direction of the sub-shaft part 32b, the lubricating oil I can be easily supplied to the lower part of the sliding portion S2 by the minute deformation of the inner wall part 64a and the second support end portion 62. Furthermore, since the base end 54a of the oil passage groove 54 does not reach the lower end of the sub-shaft part 32b and the deformation of the inner wall part 64a and the second support end portion 62 is minute, excessive outflow of the lubricating oil I from the lower end of the sub-shaft part 32b can be prevented.

[0068] Since the sub-shaft part 32b is shorter in the axial center direction than the main shaft part 32a, the second cylindrical part 34a of the second bearing 34 that rotatably supports the sub-shaft part 32b is shorter than the first cylindrical part 33a of the first bearing 33 that rotatably supports the main shaft part 32a. Therefore, from the viewpoint of an axial length, the second cylindrical part 34a is more difficult to bend than the first cylindrical part 33a. In the embodiment, however, since the second support end portion 62 that is thinner than the first support end portion 61 of the first bearing 33 is provided at the second bearing 34, the second cylindrical part 34a can be bent as much as the first cylindrical part 33a. For this reason, a gap in the sliding portion S2 can be secured equally to that in the sliding portion S1 and these can be fully lubricated.

[0069] At that time, since the lubricating oil I that lubricates the sliding portion S2 is supplied to the gap formed by the

minute deformation of the second cylindrical part 34a (inner wall part 64a and second support end portion 62), the amount of oil can be limited to a small amount necessary for the sliding reliability of the sliding portion S2. Therefore, the amount of oil to be supplied to the sliding portion S1 and other sliding portions is not insufficient. That is, the lubricating performance of the sliding portion S1 and other sliding portions can be prevented from deteriorating, and the lubricating performance of the sliding portion S2 can be enhanced.

[0070] Thus, according to the embodiment, the lubricating performance of the bearing lubricating portion of the compression mechanism portion 12, particularly, the sliding portion S2 between the second bearing 34 (second cylindrical part 34a) and the sub-shaft part 32b, can be enhanced. In contrast, the lubricating oil I sucked up from the oil supply hole 39e into the main oil supply channel 52 may infiltrate into the cover space 42 through the sliding gap between the thrust support part 39d of the balancer cover 39 and the lower end surface 32e of the sub-shaft part 32b. In this case, for example, if the balancer 38 agitates the infiltrating lubricating oil I, excessive resistance may occur in the rotation of the rotating shaft 32 depending on the size of the resistance.

[0071] For this reason, the embodiment comprises a discharge structure for efficiently discharging the infiltrating lubricating oil I from the cover space 42. As a result, for example, a reduction in the rotational performance of the rotating shaft 32 caused by the agitation resistance of the lubricating oil of the balancer 38 can be suppressed. Such a discharge structure will be described below.

[0072] As shown in FIG. 2, the balancer cover 39 includes an inclined portion 71 which is inclined from the other end (lower end) side of the rotating shaft 32 toward the connection passage 43. The inclined portion 71 is a portion formed by inclining at least a part of the wall part 39b in the radial direction of the rotating shaft 32 with respect to the bottom part 39a. For example, the inclined portion 71 may be provided over the entire circumference of the wall part 39b or may be partially provided on the part in the circumferential direction.

[0073] FIG. 5 is a plan view showing a configuration of the balancer cover 39 from below. As shown in FIG. 5, the balancer cover 39 includes a plurality of divisional chamber parts 72 and fixing parts 73.

[0074] The divisional chamber parts 72 divide the cover space 42, avoiding the fixing parts 73 by the bolts 40. The fixing parts 73 are the fixing portion to the second bearing 34 via the bolts 40. In the configuration example shown in FIG. 5, the balancer cover 39 is fixed to the second bearing 34 by five bolts 40, and includes five fixing parts 73a to 73f corresponding thereto. For this reason, the balancer cover 39 includes five divisional chamber parts 72a to 72e, avoiding these five fixing parts 73a to 73f. These divisional chamber parts 72 and fixing parts 73 are arranged alternately in the circumferential direction at approximately equal intervals (same phase). Accordingly, the balancer cover 39 is in the form of a substantial star shape having five vertices, in planar view as shown in FIG. 5. The number of the divisional chamber parts 72, the number of the bolts 40, and the number of the fixing parts 73 are not limited to five, but may be two or more and four or less, or six or more.

[0075] These plural (for example, five) chamber parts 72 are connected by the cover space 42. In the configuration example shown in FIG. 5, the cover space 42 forms one space as a whole, in a state of being partitioned into five parts by the five divisional chamber parts 72a to 72e.

[0076] The first divisional chamber part 72a, of the five divisional chamber parts 72a to 72e, is connected with the discharge port 34d of the second bearing 34. That is, the first divisional chamber part 72a can be connected with the compression chamber of the cylinder chamber 35 via the discharge port 34d. Therefore, high-temperature and high-pressure gas-phase refrigerant is discharged from the compression chamber of the cylinder chamber 35 into the first divisional chamber part 72a, by opening the discharge port 34d by the second discharge valve mechanism 34e. The discharged high-temperature and high-pressure gas-phase refrigerant flows from the first divisional chamber part 72a to the other connected divisional chamber parts 72b to 72e.

[0077] In addition, at least one of the five divisional chamber parts 72a to 72e is connected to the connection passage 43. As described above, for example, two connection passages 431 and 432 are provided in the embodiment. As shown in FIG. 5, these connection passages 431 and 432 are arranged in the circumferential direction with a predetermined phase difference (center angle difference). More specifically, as viewed from the axial center direction, the connection passages 431 and 432 are connected with the divisional chamber parts 72b and 72c at a position of a center angle larger than a center angle (α_1) from the discharge port 34d to the fixing part (first fixing part) 73a located at the first position, in the rotational direction of the rotating shaft 32 (i.e., a direction indicated by an arrow R in FIG. 5).

[0078] That is, these connection passages 431 and 432 are arranged (with a phase difference of approximately 72°) in accordance with a predetermined phase difference (central angle difference) in the circumferential direction, that is, in accordance with an interval of arrangement of two adjacent divisional chamber parts (divided chamber parts 72b and 72c) of the five divided chamber parts 72 arranged at approximately equal intervals. As a result, the second divisional chamber part 72b is connected to the connection passage 431, and the third divisional chamber part 72c is connected to the connection passage 432. Accordingly, the second and third divisional chamber parts 72b and 72c are connected via the connection passage 431 and 432, respectively, with an upper space of a lubricating oil storage surface 1s in the sealed container 10.

[0079] In this case, the center angle (α_2) from the discharge port 34d to the connection passage 431, in the direction

of rotation of the rotating shaft 32, is larger than the center angle (α_1) to the bolt 40 of the first fixing portion 73a. In addition, a center angle (α_3) from the discharge port 34d to the connection passage 432 is further larger than the center angle (α_2) to the connection passage 431 ($\alpha_1 < \alpha_2 < \alpha_3$). The defined positions of the center angle are the position of the axial center (central axis O1) of the rotating shaft 32, the rotation center Cb of the bolt 40, the opening center C1 of the opening 34h of the discharge port 34d, and the opening centers C2 and C3 of the openings 43b of the connection passages 431 and 432.

[0080] Inclined portions 71 are provided in the second divisional chamber part 72b and the third divisional chamber part 72c, respectively. The inclined portion 71 of the second divisional chamber part 72b has an inclined surface 74b that is closer to the connection passage 431 toward the outside in the radial direction of the rotating shaft 32 (sub-shaft part 32b). In addition, the inclined portion 71 of the third divisional chamber part 72c has an inclined surface 74c that is closer to the connection passage 432 toward the outside in the radial direction of the rotating shaft 32 (sub-shaft part 32b).

[0081] In the embodiment, the rotation of the rotating shaft 32 causes the roller 37 to rotate eccentrically in the cylinder chamber 35. The high-temperature and high-pressure gas-phase refrigerant compressed in the compression chamber of the cylinder chamber 35 is thereby discharged from the discharge port 34d into the cover space 42 of the balancer cover 39. In addition, as described above, the lubricating oil I sucked up from the oil supply hole 39e into the main oil supply channel 52 may infiltrate into the cover space 42 through the sliding gap between the thrust support part 39d of the balancer cover 39 and the lower end surface 32e of the sub-shaft part 32b.

[0082] In this case, a retraction force into the cover space 42 acts on the lubricating oil I due to the flow rate of the high-temperature and high-pressure gas-phase refrigerant discharged from the discharge port 34d (hereinafter referred to as a discharge gas). In addition, the centrifugal force from the balancer 38 acts on the lubricating oil I infiltrating into the cover space 42, and the retraction force caused by the discharge gas continuously acts.

[0083] For this reason, the lubricating oil I rises on the inclined surfaces 74b and 74c and is led from the opening 43b to the connection passage 43 (431 and 432) as indicated by an arrow A2 in FIG. 2. The lubricating oil I led to the connection passage 43 (431 and 432) is discharged from the opening 43a into the muffler 41 and is discharged into the upper space of the lubricating oil storage surface 1s inside the sealed container 10.

[0084] At that time, the lubricating oil I is misted and rises on the inclined surfaces 74b and 74c. FIG. 6 shows the conditions for particles P of the misted lubricating oil I to rise on the inclined surface SS whose inclination angle to the horizontal surface GS is θ . As shown in FIG. 6, the following relational expression (1) need to be satisfied for the particles P of the misted lubricating oil I to rise on the inclined surface SS by the centrifugal force.

$$F \cos \theta > \mu \times F \sin \theta, \text{ i.e., } \tan \theta < 1/\mu \quad . . . (1)$$

[0085] F is a centrifugal force acting on the particles P of the misted lubricating oil I, and θ is an angle of inclination of the inclined surface SS relative to the horizontal surface GS, which defines the value of the inclined angle θ_1 of the inclined surfaces 74b and 74c shown in FIG. 2. μ is a friction coefficient between the particles P of the misted lubricating oil I and the inclined surface SS.

[0086] The value of the friction coefficient (μ) depends on various conditions for the lubricating oil I and the inclined surface SS. In the embodiment, when the value is estimated to be approximately 0.25 to 0.3 as a general value, the particles P of the lubricating oil I can rise on the inclined surface SS by the centrifugal force if the inclination angle (θ) is 70° or less. Therefore, in the embodiment, the inclination angle (angle θ_1 shown in FIG. 2) of the inclined surfaces 74b and 74c is set to be, for example, 70° or less with respect to the horizontal plane.

[0087] According to such a structure for discharging the lubricating oil I, even when the lubricating oil I infiltrates into the cover space 42, the lubricating oil I can be guided to the inclined surfaces 74b and 74c by the centrifugal force of the balancer 38 and the retraction force of the discharge gas. Since the inclination angle (θ_1) of the inclined surfaces 74b and 74c is a predetermined angle, the lubricating oil I can be raised on the inclined surfaces 74b and 74c. As a result, the lubricating oil I can be discharged from the cover space 42 through the connection passages 431 and 432, on the inclined surfaces 74b and 74c. As a result, the atmosphere around the balancer 38 can be maintained with the discharge gas. For this reason, for example, the agitation resistance of the lubricating oil of the balancer 38 can be reduced and the rotational performance of the rotating shaft 32 can be suppressed.

[0088] For example, the inclined surfaces 74b and 74c are set to 70° or less with respect to the horizontal plane. For this reason, when the friction coefficient (μ) between the oil droplets (mist) of the lubricating oil I scattered in the cover space 42 and the inclined surfaces 74b and 74c is relatively high, the lubricating oil I can be discharged from the cover space 42 on the inclined surfaces 74b and 74c even if the friction coefficient is, for example, approximately 0.25 to 0.3.

[0089] In addition, the inclined surfaces 74b and 74c are provided in the divisional chamber parts 72 (72b and 72c) arranged avoiding the fixing portions 73 of the bolts 40. Therefore, not only can the balancer cover 39 be firmly fixed to the second bearing 34 by the bolts 40, but also the lubricating oil I can be efficiently discharged from the cover space 42.

[0090] That is, in the embodiment, the connection passages 431 and 432 are arranged in connection with the minute

chamber parts 72b and 72c avoiding the fixing portions 73 of the bolts 40. For this reason, the connection passages 431 and 432 can be arranged close to the outer periphery of the divisional chamber parts 72b and 72c, that is, close to the inclined surfaces 74b and 74c, such that they can be opened. Not only the centrifugal force from the balancer 38, but the propulsive force in the tangential direction of the rotation of the rotating shaft 32 (sub-shaft part 32b) act on the particles of the misted lubricating oil I and the discharge gas from the discharge port 34d. Therefore, larger centrifugal force and propulsive force can be made to act on the lubricating oil I and the discharge gas by arranging the connection passages 431 and 432 close to the inclined surfaces 74b and 74c. For this reason, the lubricating oil I can be discharged from the cover space 42 more efficiently by putting the lubricating oil I on the discharge gas.

[0091] In addition, the center angles (α_2 and α_3) from the discharge port 34d to the connection passages 431 and 432 are both larger than the center angle (α_1) to the bolt 40 of the first fixing part 73a. For this reason, the centrifugal force and propulsive force can be made to act on the particles of the lubricating oil I and the discharge gas, and the lubricating oil I can be led to the connection passages 431 and 432 without fail. At the same time, the fixing parts 73 can be arranged at predetermined intervals and the fixing position of the stable balancer cover 39 can be secured by the bolts 40.

[0092] Thus, according to the embodiment, the lubricating performance for the bearing lubricating portion can be improved and the lubricating oil I can be efficiently discharged from the cover space 42, thereby further improving the reliability of the hermetic compressor 2.

[0093] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

[0094] For example, in the above-described embodiment, the hermetic compressor 2 is a single-cylinder rotary compressor model with one cylinder 31, but may be a multi-cylinder rotary compressor model with two or more cylinders. In this case, each cylinder may have an equal or different volume of the cylinder chamber. Moreover, the sealed compressor may be a swing type, in which the vanes and rollers are integrated.

Reference Signs List

[0095] 1... refrigeration cycle device (air conditioner), 2... hermetic compressor, 3... condenser, 4... expansion device, 5... evaporator, 6... accumulator, 7... circulation circuit, 10... sealed container, 10c... oil reservoir, 11... motor, 12... compression mechanism, 31... cylinder, 32 ... rotating shaft, 32a... main shaft part, 32b... sub-shaft part, 32c... eccentric part, 32e... lower end surface, 32f and 32g... outer peripheral surface, 33 ... first bearing, 33a... first cylindrical part, 33b... first flange part, 34... second bearing, 34a... second cylindrical part, 34b... second flange part, 34d... second discharge hole (discharge port), 34h... opening, 35... cylinder chamber, 35a... upper surface, 35b... lower surface, 38... balancer, 39 ... balancer cover, 39a... bottom part, 39b... wall part, 39c... flange part, 39e... oil supply hole, 40... bolt, 42... cover space, 43 (431 and 432)... connection passage, 43a and 43b... openings, 51... oil supply channel, 52... main oil supply channel, 53a... first sub oil supply channel, 53b... second sub oil supply channel, 53c and 53d... openings, 54... oil passage groove, 54a... base end, 61... first support end portion, 62... second support end portion, 63 and 64... grooves, 63a and 64a... inner wall parts, 63b and 64b... outer wall parts, 63c and 64c... bottom parts, 65... thin portion, 71... inclined portion, 72 (72a to 72f)... divisional chamber parts, 73 (73a to 73f)... fixing parts, 74b and 74c... inclined surfaces, C1, C2, and C3... opening centers, Cb... bolt rotation center, I... lubricating oil, Is... lubricating oil storage surface, O1... central axis of sealed container, S1 and S2... sliding parts, T1... thickness of second support end portion.

Claims

1. A hermetic compressor accommodating a compression mechanism unit comprising:

a cylinder forming a cylinder chamber;
a rotating shaft including an eccentric portion arranged in the cylinder chamber; and
a first bearing defining an end surface on one axial end side of the rotating shaft in the cylinder chamber and
a second bearing defining an end surface on an other end side, the first bearing and the second bearing rotatably supporting the rotating shaft,
the hermetic compressor comprising a sealed container where a lubricating oil for lubricating a sliding portion of the compression mechanism unit is stored,
the rotating shaft having a main shaft portion supported by the first bearing on one axial end side with respect

to the eccentric portion, and a sub-shaft portion supported by the second bearing on the other end side, the sub-shaft portion including on an outer peripheral surface an oil passage groove of the lubricating oil, which is spirally continues to one axial end side along the rotation direction of the rotating shaft, with one end side rather than the other axial end used as a base end,

the second bearing including a flange part and a cylindrical part protruding from the flange part, a thickness of the other axial end portion of the cylindrical part, which is a portion lapping over the base end of the oil passage groove as viewed from the radial direction of the rotating shaft, being smaller than thicknesses of other portions of the cylindrical part.

2. The hermetic compressor of claim 1, wherein the portion lapping over the base end of the oil passage groove as viewed from the radial direction of the rotating shaft is an inner wall part of a circumferentially continuous groove provided at an other axial end of the cylindrical part, or a circumferentially continuous thin portion provided at the other axial end of the cylindrical part.

3. The hermetic compressor of claim 1, further comprising:

a balancer provided at an other axial end part of the rotating shaft; and
a balancer cover covering the balancer,
wherein

the second bearing includes a discharge hole through which a working fluid compressed in the cylinder chamber is discharged into a cover space of the balancer cover, and a connection passage connecting the cover space with an upper space of a lubricating oil storage surface inside the sealed container, and
the balancer cover includes an inclined portion inclined from an other end side of the rotating shaft toward the connection passage.

4. The hermetic compressor of claim 3, wherein the balancer cover is fixed to the second bearing with bolts, and includes a plurality of divisional chamber parts dividing the cover space while avoiding fixing parts of the bolts, and connecting with each other in the cover space,

at least one of the plurality of divisional chamber parts is connected with the connection passage, and
the inclined portion having an inclined plane closer to the connection passage toward an outer side of the rotating shaft in a radial direction is provided in the divisional chamber part connected with the connection passage.

5. The hermetic compressor of claim 4, wherein an inclination angle to a horizontal plane, on the inclined surface, is 70° or less.

6. The hermetic compressor of claim 4 or 5, wherein as viewed from the axial center direction, a center angle to an axial center of the rotating shaft, from an opening center of the discharge hole to the opening center of the connection passage in the rotating direction of the rotating shaft, is larger than a center angle to the axial center, from the opening center of the discharge hole to an opening center of the bolt located at a first position.

7. A refrigeration cycle device comprising:

the hermetic compressor of any one of claims 1 to 6;
a condenser connected to the hermetic compressor;
an expansion device connected to the condenser; and
an evaporator connected to the expansion device.

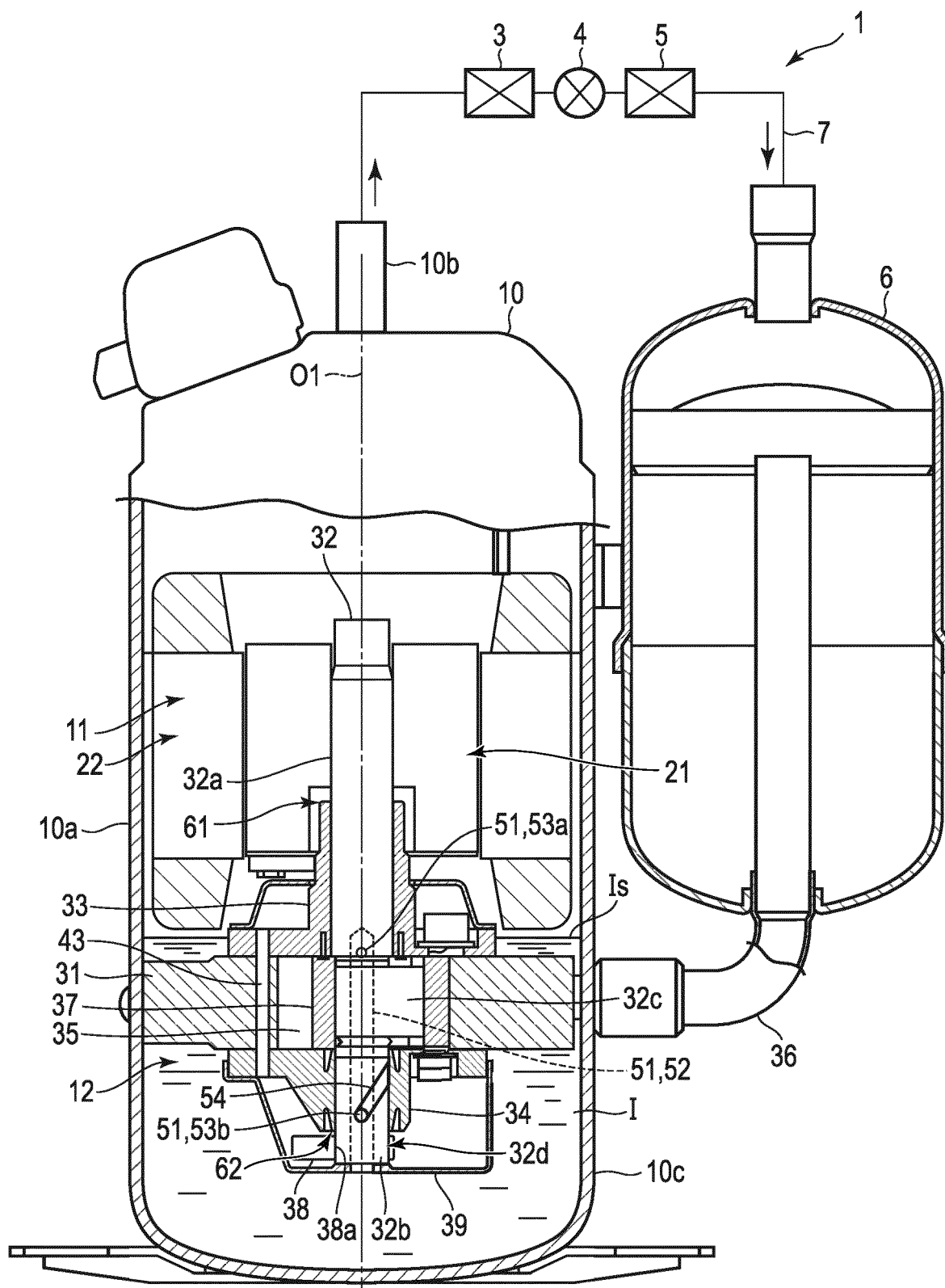


FIG. 1

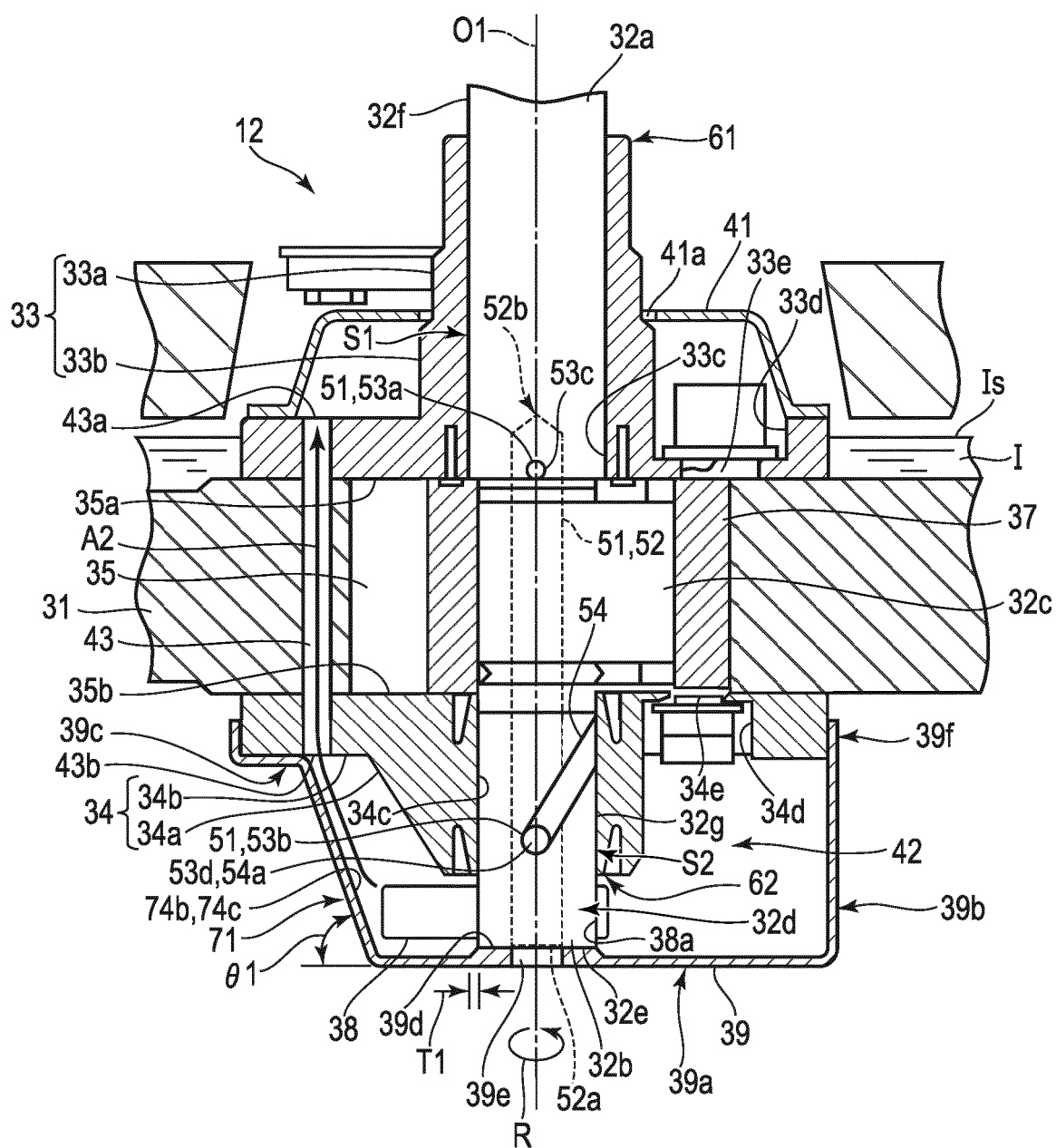


FIG. 2

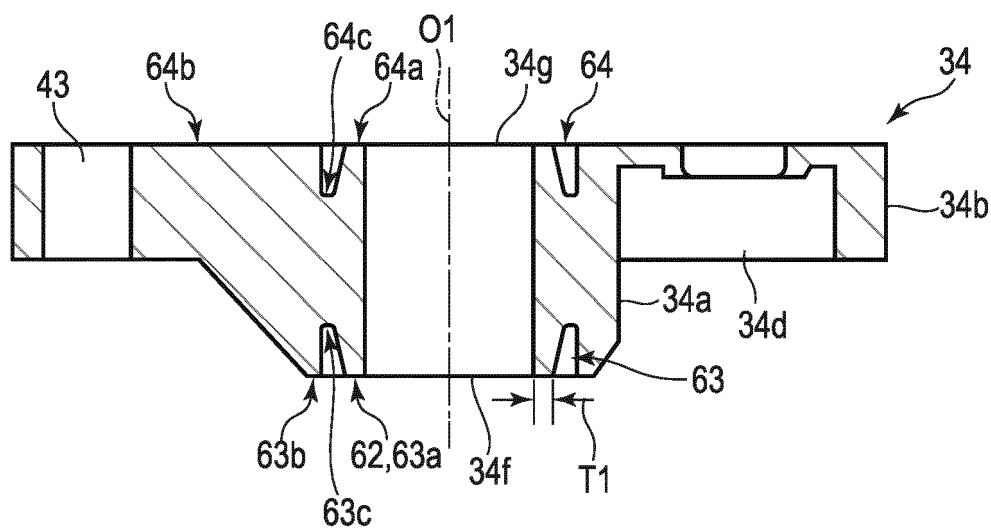


FIG. 3

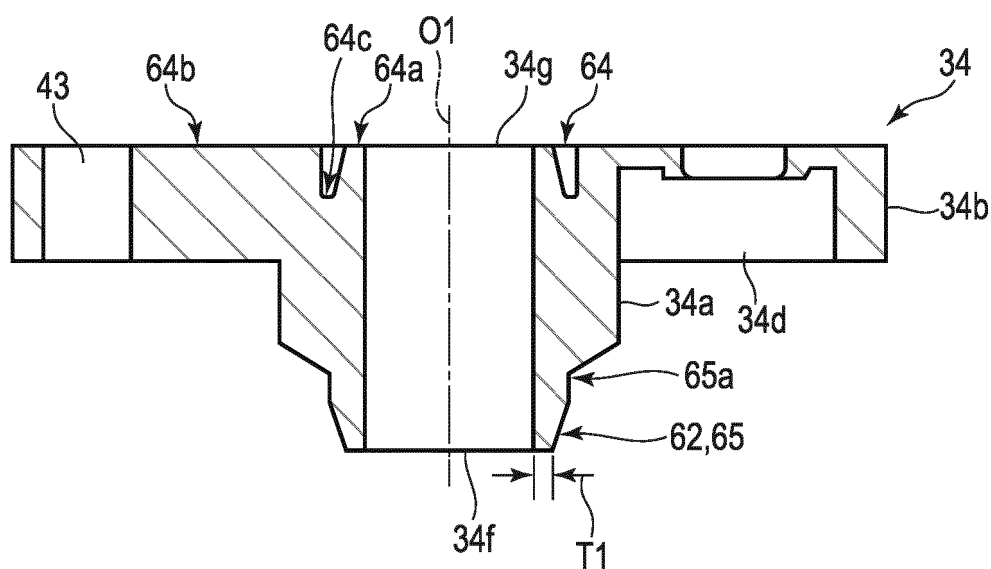


FIG. 4

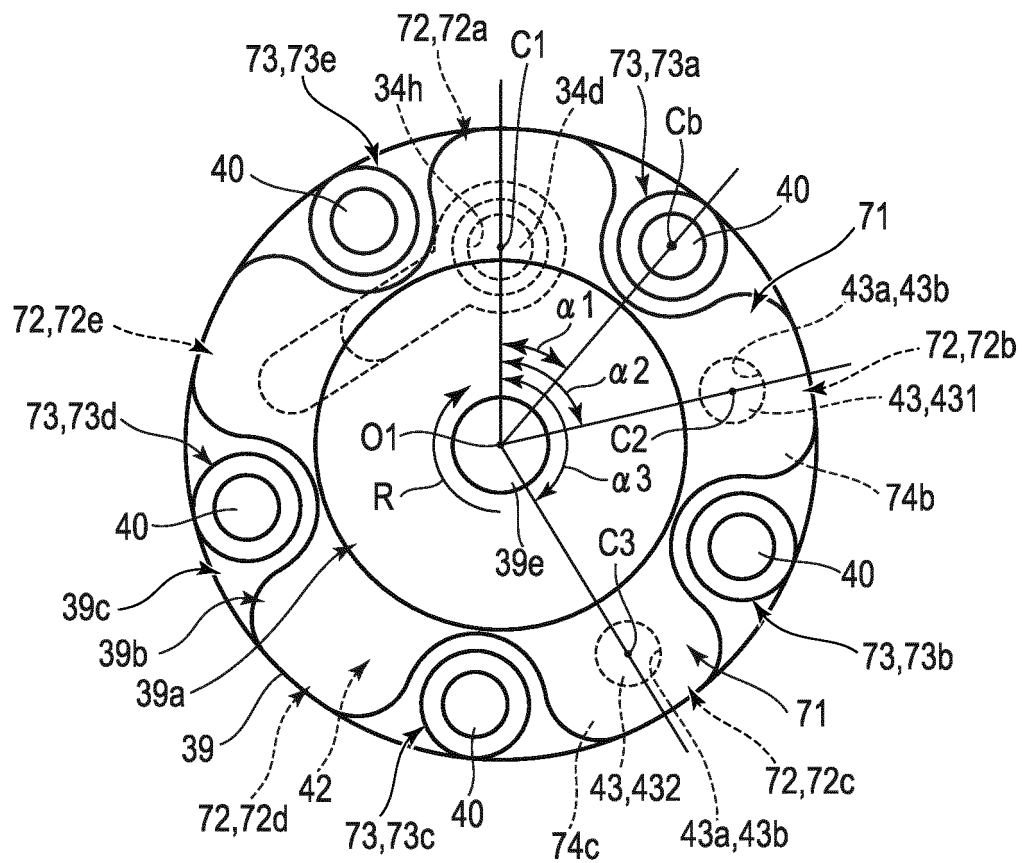


FIG. 5

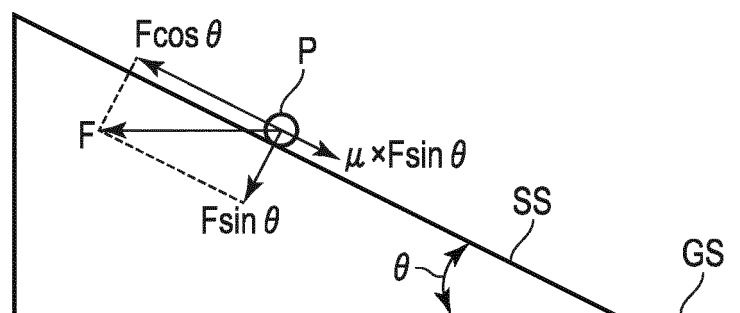


FIG. 6

5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/030101

10

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F04C29/02 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

15

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F04C29/02

20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2019
Registered utility model specifications of Japan 1996-2019
Published registered utility model applications of Japan 1994-2019

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

25

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2018-165502 A (TOSHIBA CARRIER CORPORATION) 25 October 2018, paragraphs [0009]-[0058], [0069], fig. 1-4 (Family: none)	1-2, 7 3-6
Y	JP 9-250483 A (MITSUBISHI ELECTRIC CORPORATION) 22 September 1997, paragraphs [0002]-[0004], fig. 8, 9 (Family: none)	3-6
A	KR 10-2005-0053371 A (LG ELECTRONICS INC.), 08 June 2005, fig. 3, 4 (Family: none)	1

40

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

45

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

50

Date of the actual completion of the international search
04.10.2019

Date of mailing of the international search report
15.10.2019

55

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP S6145079 A [0004]
- JP S6194296 U [0004]
- JP 2018165502 A [0004]