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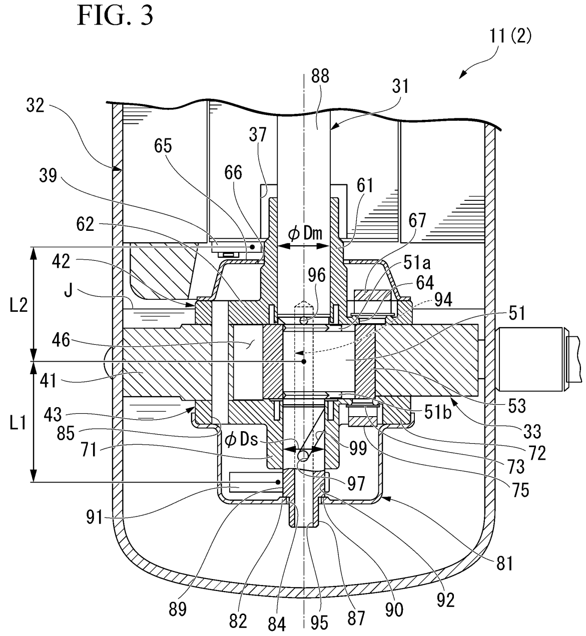
(54) ROTARY COMPRESSOR, METHOD FOR MANUFACTURING ROTARY COMPRESSOR, AND REFRIGERATION CYCLE DEVICE

(57) A rotary compressor according to an embodiment includes a case, a rotary shaft, a compression mechanism, a balancer, and a balancer cover. A through-hole is formed in the balancer cover at a position of the balancer cover facing the rotary shaft in an axial direction. The rotary shaft has a thrust sliding portion, a protruding portion, and a supply channel. The thrust sliding portion comes into contact with a seal located around the through-hole of the balancer cover, in the axial direction of the rotary shaft. The protruding portion is located on an inner peripheral side with respect to the thrust sliding portion and protrudes downward from a lower end of the through-hole through the through-hole. The supply channel is open on a lower end surface of the protruding portion to guide a lubricating oil.

FIG. 3



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Description

[Technical Field]

[0001] Embodiments of the present invention relate to a rotary compressor, a method for manufacturing a rotary compressor, and a refrigeration cycle apparatus.

[0002] Priority is claimed on Japanese Patent Application No. 2019-020870, filed on February 7, 2019, the content of which is incorporated herein by reference.

[Background Art]

[0003] A rotary compressor is used in a refrigeration cycle apparatus such as an air conditioner. In the rotary compressor, a refrigerant is compressed in such a manner that an eccentric portion of a rotary shaft is eccentrically rotated by a compression mechanism.

[0004] In this type of the rotary compressor, the rotary shaft has a supply channel for supplying a lubricating oil stored inside a case to a sliding portion between the rotary shaft and a bearing. However, when the refrigerant compressed by the compression mechanism enters the supply channel, there is a possibility that desired lubrication performance may not be obtained.

[Citation List]

[Patent Document]

[Patent Document 1]

[0005] Japanese Unexamined Patent Application, First Publication No. 2018-165502

[Summary of Invention]

[Technical Problem]

[0006] An object of the present invention is to provide a rotary compressor, a method for manufacturing a rotary compressor, and a refrigeration cycle apparatus which are capable of obtaining desired lubrication performance.

[Solution to Problem]

[0007] A rotary compressor according to an embodiment includes a case, a rotary shaft, a compression mechanism, a balancer, and a balancer cover. A lubricating oil is stored in the case. The rotary shaft is disposed inside the case, and has an eccentric portion. The compression mechanism has a cylinder, a main bearing, and an auxiliary bearing. The cylinder accommodates the eccentric portion. The main bearing rotatably supports the rotary shaft from above the cylinder. The auxiliary bearing rotatably supports the rotary shaft from below the cylinder. A through-hole is formed at a position of the balancer cover facing the rotary shaft in the axial direction. The rotary shaft has a thrust sliding portion, a protruding portion, and a supply channel. The thrust sliding portion of the rotary shaft comes into contact with a seal located around the through-hole of the balancer cover, in the axial direction. The protruding portion is located on an inner peripheral side of the thrust sliding portion, and protrudes downward from the through-hole through the through-hole. The supply channel is open on a lower end surface of the protruding portion to guide the lubricating oil.

[Brief Description of Drawings]

[0008]

Fig. 1 is a schematic configuration diagram of a refrigeration cycle apparatus including a sectional view of a rotary compressor according to a first embodiment.

Fig. 2 is a sectional view of a compression mechanism corresponding to line 11-II in Fig. 1.

Fig. 3 is an enlarged view of a main part in Fig. 1.

Fig. 4 is a partial sectional view of a rotary compressor according to a second embodiment.

Fig. 5 is a process drawing for describing an assembly process.

[Description of Embodiments]

[0009] Hereinafter, a rotary compressor according to an embodiment, a method for manufacturing a rotary compressor, and a refrigeration cycle apparatus will be described with reference to the drawings.

<First Embodiment>

[0010] First, a refrigeration cycle apparatus 1 will briefly be described. Fig. 1 is a schematic configuration diagram of the refrigeration cycle apparatus 1 including a sectional view of a rotary compressor 2 according to a first embodiment.

[0011] As shown in Fig. 1, the refrigeration cycle apparatus 1 according to the present embodiment includes the rotary compressor 2, a condenser 3 serving as a radiator connected to the rotary compressor 2, an expansion device 4 connected to the condenser 3, and an evaporator 5 serving as a heat absorber connected between the expansion device 4 and the rotary compressor 2.

[0012] The rotary compressor 2 is a so-called rotary-type compressor. The rotary compressor 2 compresses an internally fetched low-pressure gas refrigerant and obtains a high-temperature and high-pressure gas refrigerant. A specific configuration of the rotary compressor 2 will be described later.

[0013] The condenser 3 dissipates heat from the high-temperature and high-pressure gas refrigerant fed from the rotary compressor 2, and obtains a high-pressure liquid refrigerant.

[0014] The expansion device 4 lowers a pressure of the high-pressure liquid refrigerant fed from the condenser 3 and obtains a low-temperature and low-pressure liquid refrigerant.

[0015] The evaporator 5 vaporizes the low-temperature and low-pressure liquid refrigerant fed from the expansion device 4 and changes the low-temperature and low-pressure liquid refrigerant into a low-pressure gas refrigerant. In the evaporator 5, when the low-pressure liquid refrigerant vaporizes, heat of vaporization is taken from surroundings, and the surroundings are cooled. The low-pressure gas refrigerant passing through the evaporator 5 is fetched into the above-described rotary compressor 2.

[0016] In this way, in the refrigeration cycle apparatus 1 according to the present embodiment, the refrigerant serving as a working fluid circulates while changing a phase between the gas refrigerant and the liquid refrigerant. In the refrigeration cycle apparatus 1 according to the present embodiment, as the refrigerant, it is possible to use an HFC-based refrigerant such as R410A and R32, an HFO-based refrigerant such as R1234yf and R1234ze, or a natural refrigerant such as CO_2.

[0017] Next, the above-described rotary compressor 2 will be described.

[0018] The rotary compressor 2 according to the present embodiment includes a compressor body 11 and an accumulator 12.

[0019] The accumulator 12 is a so-called gas-liquid separator. The accumulator 12 is provided between the above-described evaporator 5 and the compressor body 11. The accumulator 12 is connected to the compressor body 11 through a suction pipe 21. The accumulator 12 supplies only the gas refrigerant to the compressor body 11, out of the gas refrigerant vaporized by the evaporator 5 and the liquid refrigerant not vaporized by the evaporator 5.

[0020] The compressor body 11 includes a rotary shaft 31, an electric motor unit 32, a compression mechanism 33, and a case 34 for accommodating the rotary shaft 31, the electric motor unit 32, and the compression mechanism 33. The compressor body 11 according to the present embodiment is disposed in a state where an axial direction of the rotary shaft 31 is an upward-downward direction.

[0021] The case 34 is formed in a cylindrical shape, and both end portions in the axial direction are closed. A lubricating oil J is accommodated inside the case 34. A portion of the compression mechanism 33 is immersed into the lubricating oil J.

[0022] The rotary shaft 31 is disposed coaxially with an axis line O of the case 34. In the following description, a direction extending along the axis line O will simply be referred to as the axial direction, a direction orthogonal to the axial direction will be referred to as a radial direction, and a direction turning around the axis line O will be referred to as a circumferential direction.

[0023] The electric motor unit 32 is disposed on a first side inside the case 34 in the axial direction. The compression mechanism 33 is disposed on a second side inside the case 34 in the axial direction. In the following description, the electric motor unit 32 side along the axial direction will be referred to as an upper side, and the compression mechanism 33 side will be referred to as a lower side.

[0024] The electric motor unit 32 is a so-called inner rotor type DC brushless motor. Specifically, the electric motor unit 32 includes a stator 35 and a rotor 36.

[0025] The stator 35 is fixed to an inner wall surface of the case 34 by means of shrink fitting.

[0026] The rotor 36 is fixed to an upper portion of the rotary shaft 31 in a state where an interval is formed inside the stator 35 in the radial direction.

[0027] A counter bore 37 is formed in an inner peripheral portion on a lower surface of the rotor 36. The counter bore 37 is an annular recess portion recessed upward from the lower surface of the rotor 36, and formed over an entire periphery of the rotor 36. A balancer 39 is provided in an outer peripheral portion on the lower surface of the rotor 36. For example, the balancer 39 is formed in an arc shape in a plan view when viewed in the axial direction. The balancer 39 is provided in a portion in the circumferential direction on the lower surface of the rotor 36.

[0028] The compression mechanism 33 includes a cylinder 41 having a cylindrical shape through which the rotary shaft 31 penetrates, and a main bearing 42 and an auxiliary bearing 43 which individually close both end opening portions of the cylinder 41 and rotatably support the rotary shaft 31. A space formed by the cylinder 41, the main bearing 42, and the auxiliary bearing 43 forms a cylinder chamber 46.

[0029] An eccentric portion 51 eccentric in the radial direction with respect to the axis line O is formed in a portion located inside the cylinder chamber 46 in the above-described rotary shaft 31. In the present embodiment, an eccentric direction of the eccentric portion 51 is set on a side opposite to the balancer 39 across the axis line O.

[0030] A roller 53 is externally inserted into the eccentric portion 51. The roller 53 is configured to be eccentrically rotatable with respect to the axis line O while an outer peripheral surface is in sliding contact with an inner peripheral surface of the cylinder 41 as the rotary shaft 31 is rotated.

[0031] Fig. 2 is a sectional view of the compression mechanism 33 corresponding to line II-II in Fig. 1.

[0032] As shown in Fig. 2, in the cylinder 41, a blade groove 54 recessed outward in the radial direction is formed in a portion in the circumferential direction. The blade groove 54 is formed over in the axial direction (upward-downward direction) of the cylinder 41. The blade groove 54 communicates with the inside of the case 34 in an outer end portion in the radial direction.

[0033] A blade 55 is provided in the blade groove 54. The blade 55 is configured to be slidable in the radial direction with respect to the cylinder 41. The blade 55 is biased inward in the radial direction by a biasing member (not shown). An inner end surface of the blade 55 in the radial direction is in contact with an outer peripheral surface of the roller 53 inside the cylinder chamber 46. In this manner, the blade 55 moves forward and rearward inside the cylinder chamber 46 as the roller 53 is eccentrically rotated.

[0034] The cylinder chamber 46 is divided into a suction chamber 46a and a compression chamber 46b by the roller 53 and the blade 55. In the compression mechanism 33, a compression operation is performed inside the cylinder chamber 46 by a rotation operation of the roller 53 and a forward/rearward operation of the blade 55.

[0035] In the cylinder 41, a suction hole 56 that penetrates the cylinder 41 in the radial direction is formed in a portion located on an inner side (left side of the blade groove 54 in Fig. 2) of the blade groove 54 along a rotation direction of the roller 53 (refer to an arrow in Fig. 2). The above-described suction pipe 21 (refer to Fig. 1) is connected to the suction hole 56 from an outer end portion in the radial direction. On the other hand, an inner end portion of the suction hole 56 in the radial direction is open into the cylinder chamber 46 (suction chamber 46a).

[0036] The main bearing 42 closes an upper end opening portion of the cylinder 41. The main bearing 42 rotatably supports a portion located above the cylinder 41 in the rotary shaft 31. Specifically, the main bearing 42 includes a cylinder portion 61 into which the rotary shaft 31 is inserted, and a flange portion 62 protruding outward in the radial direction from a lower end portion of the cylinder portion 61.

[0037] An upper end portion of the cylinder portion 61 is accommodated inside the above-described counter bore 37. In this manner, the rotary compressor 2 (compressor body 11) is miniaturized in the axial direction.

[0038] A main bearing discharge hole 64 that penetrates the flange portion 62 in the axial direction is formed in a portion of the flange portion 62 in the circumferential direction. The main bearing discharge hole 64 communicates with the inside of the cylinder chamber 46 (compression chamber 46b). A discharge valve mechanism 67 is disposed in the flange portion 62. The discharge valve mechanism 67 opens the main bearing discharge hole 64 as the pressure inside the cylinder chamber 46 (compression chamber 46b) increases, and discharges the refrigerant outward of the cylinder chamber 46.

[0039] The main bearing 42 is provided with a muffler 65 that covers the main bearing 42 from above. A communication hole 66 that causes the inside and the outside of the muffler 65 to communicate with each other is formed in a central portion of the muffler 65 in the radial direction. The high-temperature and high-pressure gas refrigerant discharged through the above-described discharge hole 64 is discharged into the case 34 through the communication hole 66.

[0040] The auxiliary bearing 43 closes a lower end opening portion of the cylinder 41. The auxiliary bearing 43 rotatably supports a portion located below the cylinder 41 in the rotary shaft 31. Specifically, the auxiliary bearing 43 includes a cylinder portion 71 into which the rotary shaft 31 is inserted, and a flange portion 72 protruding outward in the radial direction from the upper end portion of the cylinder portion 71.

[0041] An auxiliary bearing discharge hole 73 that penetrates the flange portion 72 in the axial direction is formed in a portion of the flange portion 72 in the circumferential direction. The auxiliary bearing discharge hole 73 communicates with the inside of the cylinder chamber 46 (compression chamber 46b). A discharge valve mechanism 75 is provided in the flange portion 72. The discharge valve mechanism 75 opens the auxiliary bearing discharge hole 73 as the pressure inside the cylinder chamber 46 (compression chamber 46b) increases and discharges the refrigerant outward of the cylinder chamber 46.

[0042] The auxiliary bearing 43 is provided with a balancer cover 81 that covers the auxiliary bearing 43 from below. The balancer cover 81 is formed in a bottomed cylindrical shape that is open upward. A seal 82 is formed in a central portion in the radial direction in a bottom portion of the balancer cover 81. The seal 82 is formed to bulge upward with respect to an outer peripheral portion in the bottom portion of the balancer cover 81. However, the seal 82 may not bulge from the bottom portion of the balancer cover 81. An upper surface of the seal 82 is formed to have a flat surface orthogonal to the axis line O. A through-hole 84 that penetrates the seal 82 in the axial direction is formed in a central portion (portion located on the axis line O) of the seal 82.

[0043] The main bearing 42, the cylinder 41, and the auxiliary bearing 43 have a communication hole 85 for causing the inside of the inside of the muffler 65 and the inside of the balancer cover 81 to communicate with each other. The communication hole 85 penetrates the main bearing 42, the cylinder 41, and the auxiliary bearing 43 in the axial direction at a position where the communication hole 85 faces the above-described discharge holes 64 and 73 across the axis line O in the radial direction.

[0044] Fig. 3 is an enlarged view of a main part in Fig. 1.

[0045] As shown in Fig. 3, the rotary shaft 31 according to the present embodiment has a thrust sliding portion 90 and a protruding portion 87 located on an inner peripheral side of the thrust sliding portion 90 and protruding downward.

[0046] The rotary shaft 31 further has the above-described eccentric portion 51, a main shaft portion 88, and an auxiliary shaft portion 89.

[0047] The main shaft portion 88 is a portion located above the eccentric portion 51 in the above-described rotary shaft 31. The main shaft portion 88 is connected to an upper side of the eccentric portion 51 via a connecting portion 51a. The main shaft portion 88 is supported by the main bearing 42, and the rotor 36 is fixed to the main shaft portion 88.

[0048] On the other hand, the auxiliary shaft portion 89 is a portion located below the eccentric portion 51 in the rotary shaft 31. The auxiliary shaft portion 89 is connected to a lower side of the eccentric portion 51 via a connecting portion 51b. The auxiliary shaft portion 89 is supported by the auxiliary bearing 43. In the present embodiment, an outer diameter φDs of the auxiliary shaft portion 89 is smaller than an outer diameter φDm of the main shaft portion 88. However, in the auxiliary shaft portion 89, at least a portion protruding downward from the auxiliary bearing 43 may have a diameter smaller than that of the main shaft portion 88. That is, a portion located inside the auxiliary bearing 43 in the auxiliary shaft portion 89 may have an outer diameter the same as that of the main shaft portion 88.

[0049] The seal 82 of the balancer cover 81 receives an axial load acting on the rotary shaft 31 and supports the thrust sliding portion 90 of the rotary shaft 31 to be slidable. The thrust sliding portion 90 and the seal 82 come into contact with each other in the axial direction, thereby blocking communication between the inside and the outside of the balancer cover 81 through the through-hole 84. The thrust sliding portion 90 according to the present embodiment is a lower end surface of the auxiliary shaft portion 89. The thrust sliding portion 90 is a flat surface orthogonal to the axial direction. It is preferable that the thrust sliding portion 90 is pressed against the seal 82 by the weight of the rotary shaft 31 and the rotor 36, or a magnetic force generated between the stator 35 and the rotor 36. In the present embodiment, the base shaft portion is configured to include the eccentric portion 51, the main bearing 88, and the auxiliary bearing 89.

[0050] A balancer 91 is attached to a portion protruding downward from the auxiliary bearing 43 in the auxiliary shaft portion 89. For example, the balancer 91 is formed in a disk shape. An attachment hole 92 that penetrates the balancer 91 in the axial direction is formed at a position eccentric with respect to the center of the balancer 91. The auxiliary shaft portion 89 of the rotary shaft 31 is fixed inside the attachment hole 92 by means of press-fitting. In this case, the center of the balancer 91 is eccentric with respect to the axis line O in a direction opposite to an eccentric direction of the eccentric portion 51 (direction the same as that of the balancer 39). That is, the balancer 91 and the eccentric portion 51 are disposed with a phase difference of 180° in the circumferential direction. The shape of the balancer 91 is not limited to the disc shape.

[0051] In this way, in the present embodiment, the balancer 91 is provided in the auxiliary shaft portion 89. Accordingly, for example, compared to a case where the balancer is provided on an upper surface of the rotor 36, a distance between the balancer 91 and the bearing (in the present embodiment, the auxiliary bearing 43) can be shortened. In this manner, it is possible to suppress bending of the rotor 36.

[0052] Here, in the compressor body 11, a centrifugal force is generated in the eccentric portion 51 and the respective balancers 39 and 91 as the rotary shaft 31 is rotated. In this case, in order to stabilize rotational balance of the rotary shaft 31, it is preferable to satisfy two Equations ((1) and (2)) below.

[0053] Specifically, a centrifugal force acting on the eccentric portion 51 is defined as F0, a centrifugal force acting on the balancer 91 is defined as F1, and a centrifugal force acting on the balancer 39 is defined as F2. In this case, it is preferable that a resultant force of the respective centrifugal forces F0, F1, and F2 becomes 0 (refer to Equation (1) below). The respective centrifugal forces F0, F1, and F2 can be calculated by $mr\omega^2$ (m: mass, r: distance in the radial direction from the axis line O, and ω: angular velocity).

$$F0\text{-}F1\text{-}F2 = 0 \ldots (1)$$

[0054] The center of action of the centrifugal force F0 is defined as a reference point, a distance in the axial direction from the reference point to the center of action of the centrifugal force F1 is defined as L1, and a distance in the axial direction from the reference point to the center of action of the centrifugal force F2 is defined as L2. In this case, it is preferable that a sum of moments acting on the rotary shaft 31 due to the centrifugal forces F1 and F2 becomes 0 (refer to Equation (2) below).

$$F1 \cdot L1\text{-}F2 \cdot L2 = 0 \ldots (2)$$

[0055] In the present embodiment, it is preferable that the distance L1 in the axial direction from the reference point to the center of action of the centrifugal force F1 is equal to or longer than the distance L2 in the axial direction from the reference point to the center of action of the centrifugal force F2 (L1≥L2). In this manner, the balancer 91 can be miniaturized, and the amount of eccentricity can be reduced. As a result, the protruding amount of the balancer 91 in the radial direction with respect to the axis line O can be particularly suppressed, and the compressor body 11 in the radial direction can be miniaturized.

[0056] The protruding portion 87 protrudes downward from an inner peripheral portion of the thrust sliding portion 90. The protruding portion 87 protrudes downward from a lower end opening edge of the through-hole 84 through the through-hole 84. Specifically, the protruding portion 87 according to the present embodiment protrudes downward from a lowest point (lower surface of the seal 82) of the balancer cover 81. The rotary shaft 31 can be displaced (backlash in the upward-downward direction) by a predetermined distance in the axial direction with respect to the compression mechanism 33, due to a difference between the height of the cylinder chamber 46 and the length in the axial direction of the connecting portions 51a and 51b provided upward and downward of the eccentric portion 51 and the eccentric portion

51. Therefore, in the present embodiment, the protruding amount from the lower end opening edge of the through-hole 84 of the protruding portion 87 is larger than the predetermined distance which is a displacement amount of the rotary shaft 31. That is, even when the rotary shaft 31 is displaced in the upward-downward direction by the amount of backlash, the protruding amount of the protruding portion 87 is set so that the protruding portion 87 always protrudes downward from the lower end opening edge of the through-hole 84 of the balancer cover 81.

[0057] The rotary shaft 31 has a supply channel 94 for supplying the lubricating oil J to each sliding portion in the compression mechanism 33 (for example, a portion between the eccentric portion 51 and the roller 53, and a portion between the rotary shaft 31 and the bearings 42 and 43). The supply channel 94 has a main flow path 95 extending coaxially with the axis line O, and sub-flow paths 96 and 97 extending in the radial direction from the main flow path 95.

[0058] A lower end portion of the main flow path 95 is open on a lower end surface of the rotary shaft 31 (protruding portion 87). In this manner, the lubricating oil J inside the case 34 can flow into the main flow path 95.

[0059] An upper end portion of the main flow path 95 is terminated in a lower end portion of the main shaft portion 88. However, the length in the axial direction of the main flow path 95 can appropriately be changed as long as the length reaches at least the cylinder 41. For example, the main flow path 95 may penetrate the rotary shaft 31 in the axial direction. A twist plate that promotes the lubricating oil J to rise as the rotary shaft 31 is rotated may be provided on an inner peripheral surface of the main flow path 95.

[0060] The first sub-flow path 96 is formed in a connecting portion (connecting portion 51a) between the main shaft portion 88 and the eccentric portion 51 in the rotary shaft 31. An inner end portion in the radial direction of the first sub-flow path 96 communicates with the inside of the above-described main flow path 95. On the other hand, an outer end portion in the radial direction of the first sub-flow path 96 is open outward in the radial direction on an outer peripheral surface of the rotary shaft 31.

[0061] The second sub-flow path 97 is formed in a portion located inside the auxiliary bearing 43 in the auxiliary shaft portion 89. An inner end portion in the radial direction of the second sub-flow path 97 communicates with the inside of the above-described main flow path 95. On the other hand, an outer end portion in the radial direction of the second sub-flow path 97 is open outward in the radial direction on the outer peripheral surface of the rotary shaft 31.

[0062] A lower circulation path 99 is formed on the outer peripheral surface of the rotary shaft 31 (auxiliary shaft portion 89). The lower circulation path 99 is formed by a spiral groove formed on the outer peripheral surface of the rotary shaft 31. A lower end portion of the lower circulation path 99 communicates with the inside of the second sub-flow path 97. On the other hand, an upper end portion of the lower circulation path 99 is located in the upper end portion of the auxiliary shaft portion 89. The lower circulation path 99 guides the lubricating oil J upward from below when the rotary shaft 31 is rotated. The lower circulation path 99 may be configured so that the lubricating oil J can be supplied between the outer peripheral surface of the auxiliary shaft portion 89 and the inner peripheral surface of the auxiliary bearing 43 (cylinder portion 71). In this case, for example, a groove may be formed on the inner peripheral surface of the cylinder portion 71. A shape or a layout of the lower circulation path 99 can appropriately be changed.

[0063] In the main bearing 42, an upper circulation path (not shown) is formed on the inner peripheral surface of the cylinder portion 61. The upper circulation path is formed in a spiral groove. The lower end portion of the upper circulation path communicates with the inside of the first sub-flow path 96. On the other hand, the upper end portion of the upper circulation path communicates with the inside of the case 34. The upper circulation path guides the lubricating oil J upward from below when the rotary shaft 31 is rotated. The upper circulation path may be formed on the outer peripheral surface of the main shaft portion 88.

[0064] Next, an operation of the above-described rotary compressor 2 will be described.

[0065] As shown in Fig. 1, when electric power is supplied to the stator 35 of the electric motor unit 32, the rotary shaft 31 is rotated around the axis line O together with the rotor 36. As the rotary shaft 31 is rotated, the eccentric portion 51 and the roller 53 are eccentrically rotated inside the cylinder chamber 46. In this case, each of the rollers 53 comes into sliding contact with the inner peripheral surface of the cylinder 41. In this manner, the gas refrigerant is fetched into the cylinder chamber 46 through the suction pipe 21, and the gas refrigerant fetched into the cylinder chamber 46 is compressed.

[0066] Specifically, in the cylinder chamber 46, the gas refrigerant is suctioned into the suction chamber 46a through the suction hole 56, and the gas refrigerant previously suctioned from the suction hole 56 is compressed in the compression chamber 46b. In the compressed gas refrigerant, the gas refrigerant discharged into the muffler 65 through the main bearing discharge hole 64 is discharged into the case 34 through the communication hole 66 of the muffler 65. On the other hand, in the compressed gas refrigerant, the gas refrigerant discharged into the balancer cover 81 through the auxiliary bearing discharge hole 73 flows into the muffler 65 through the communication hole 85, and thereafter, is discharged into the case 34 through the communication hole 66 of the muffler 65. The gas refrigerant discharged into the case 34 is fed to the condenser 3 as described above.

[0067] Incidentally, a pressure equivalent to a discharge pressure of the gas refrigerant acts on the lubricating oil J inside the case 34. Therefore, the lubricating oil J flows into the main flow path 95, and rises inside the main flow path 95 as the rotary shaft 31 is rotated. The lubricating oil J rising inside the main flow path 95 is distributed to each of the sub-flow paths 96 and 97 by the centrifugal force generated by the rotation of the rotary shaft 31.

[0068] The lubricating oil J distributed to each of the sub-flow paths 96 and 97 is discharged on the outer peripheral surface of the rotary shaft 31 and is supplied to each sliding portion. For example, the lubricating oil J discharged from the first sub-flow path 96 rises inside the upper circulation path as the rotary shaft 31 is rotated and is supplied to a portion between the main shaft portion 88 and the main bearing 42. On the other hand, the lubricating oil J discharged from the second sub-flow path 97 rises inside the lower circulation path 99 as the rotary shaft 31 is rotated and is supplied to a portion between the auxiliary shaft portion 89 and the auxiliary bearing 43 and a portion between the eccentric portion 51 and the roller 53. The lubricating oil J supplied to each sliding portion is discharged from the compression mechanism 33 through a portion between the main shaft portion 88 and the main bearing 42 and through the cylinder chamber 46.

[0069] Here, the present embodiment adopts a configuration as follows. The thrust sliding portion 90 of the rotary shaft 31 and the seal 82 of the balancer cover 81 are brought into contact with each other to seal a portion in the axial direction between the rotary shaft 31 and the balancer cover 81.

[0070] According to this configuration, the portion in the axial direction between the rotary shaft 31 and the balancer cover 81 is sealed by the seal 82. Accordingly, it is possible to suppress a possibility that the lubricating oil J accommodated inside the case 34 may enter the inside of the balancer cover 81. The possibility that the lubricating oil J may enter the inside of the balancer cover 81 is suppressed. Accordingly, even when the balancer 91 is provided in the auxiliary shaft portion 89, it is possible to suppress a possibility that the eccentric rotation of the balancer 91 may be hindered by the lubricating oil J when the rotary shaft 31 is rotated. In this manner, rotational resistance acting on the balancer 91 can be reduced when the rotary shaft 31 is rotated. As a result, the rotary shaft 31 can efficiently be rotated, and compression performance can be improved.

[0071] Incidentally, in the rotary compressor 2, when the rotary shaft 31 is displaced upward due to vibration caused by the eccentric rotation, the thrust sliding portion 90 and the seal 82 may be separated from each other in some cases. In this case, there is a possibility that the gas refrigerant discharged into the balancer cover 81 through the auxiliary bearing discharge hole 73 may leak outward of the balancer cover 81 through the through-hole 84.

[0072] Therefore, the present embodiment adopts a configuration as follows. The protruding portion 87 protrudes downward from the lower end opening edge of the through-hole 84 of the balancer cover 81 more than the predetermined distance which is the displacement amount of the rotary shaft 31. According to this configuration, when the gas refrigerant discharged into the balancer cover 81 leaks outward of the balancer cover 81 through the through-hole 84, it is possible to suppress a possibility that the gas refrigerant may flow into the main flow path 95 after turning around the protruding portion 87. In this manner, it is possible to suppress a possibility that the gas refrigerant may flow into the supply channel 94 and the lubricating oil J may not spread to the sliding portion. That is, in the rotary compressor 2 according to the present embodiment, the lubricating oil J can effectively be supplied to the sliding portion, and the desired lubrication performance can be obtained.

[0073] The refrigeration cycle apparatus 1 according to the present embodiment includes the above-described rotary compressor 2. Accordingly, it is possible to provide the refrigeration cycle apparatus 1 capable of improving operation reliability and compression performance over a long period of time.

<Second Embodiment>

[0074] Fig. 4 is a partial sectional view of a rotary compressor 200 according to a second embodiment. In the following description, the same reference numerals will be assigned to configurations the same as those of the above-described embodiment, and description thereof will be omitted.

[0075] The rotary compressor 200 according to the present embodiment is different from the above-described first embodiment in that a plurality of (for example, three) cylinders (upper cylinder 201, intermediate cylinder 202, and lower cylinder 203) are aligned in the axial direction.

[0076] In the rotary compressor 200 shown in Fig. 4, the upper cylinder 201 and the intermediate cylinder 202 abut each other in the axial direction while an upper partitioning portion 210 is interposed therebetween. The intermediate cylinder 202 and the lower cylinder 203 abut each other in the axial direction while a lower partitioning portion 211 is interposed therebetween. A configuration of each of the cylinders 201 to 203 is the same as that of the above-described embodiment. The upper cylinder 201, the lower cylinder 203, the main bearing 42, the auxiliary bearing 43, and the partitioning portions 210 and 211 form a compression mechanism 212 according to the present embodiment.

[0077] An upper end opening portion of the upper cylinder 201 is closed by the main bearing 42. A space defined by the upper cylinder 201, the main bearing 42, and the upper partitioning portion 210 forms an upper cylinder chamber 221.

[0078] A space defined by the intermediate cylinder 202 and the partitioning portions 210 and 211 forms an intermediate cylinder chamber 222.

[0079] A lower end opening portion of the lower cylinder 203 is closed by the auxiliary bearing 43. A space defined by the lower cylinder 203, the auxiliary bearing

43, and the lower partitioning portion 211 forms a lower cylinder chamber 223.

[0080] The rotary shaft 225 includes a base shaft portion 226 provided with the thrust sliding portion 90, and a supplementary shaft portion 228 fixed to the base shaft portion 226 and forming a protruding portion 227.

[0081] The base shaft portion 226 includes a plurality of eccentric portions 231 to 233 accommodated in the respective cylinder chambers 221 to 223. Specifically, the upper eccentric portion 231 is formed in a portion located inside the upper cylinder chamber 221 in the base shaft portion 226. The intermediate eccentric portion 232 is formed in a portion located inside the intermediate cylinder chamber 222 in the base shaft portion 226. The lower eccentric portion 233 is formed in a portion located inside the lower cylinder chamber 223 in the base shaft portion 226. Each of the eccentric portions 231 to 233 has the same outer shape and the same size when viewed in the axial direction. Each of the eccentric portions 231 to 233 is eccentric with respect to the axis line O by the same amount in the radial direction while having a phase difference of 120° in the circumferential direction. That is, eccentric directions of the respective eccentric portions 231 to 233 are set to be equal to each other in the circumferential direction. A roller 53 is fitted to each of the eccentric portions 231 to 233. The lower end surface of the base shaft portion 226 serves as the thrust sliding portion 90.

[0082] A base flow path 235 is formed in the base shaft portion 226. The base flow path 235 extends coaxially with the axis line O. A lower end portion of the base flow path 235 is open on a lower end surface (thrust sliding portion 90) of the base shaft portion 226. The base flow path 235 communicates with each of the sub-flow paths 96 and 97. In the base shaft portion 226, the sub-flow path may be provided at a position corresponding to each of the partitioning portions 210 and 211.

[0083] The protruding portion 227 including the supplementary shaft portion 228 is formed in a cylindrical shape extending coaxially with the axis line O. That is, the inside of the protruding portion 227 forms a protruding portion flow path 236 that penetrates the protruding portion 227 in the axial direction. An upper end portion of the protruding portion 227 is fixed inside the base flow path 235 by means of press-fitting. That is, the protruding portion 227 is fixed to the base shaft portion 226 in a state where the protruding portion 227 protrudes downward from the thrust sliding portion 90, and the base flow path 235 and the protruding portion flow path 236 communicate with each other. The base flow path 235 and the protruding portion flow path 236 form a main flow path 237 according to the present embodiment. A method of fixing the base shaft portion 226 of the protruding portion 227 may be any desired method other than the press-fitting.

[0084] A balancer cover 240 according to the present embodiment includes a cover body 241 that covers the auxiliary bearing 43 from below, and a thrust plate 242 attached to the cover body 241. Even in the present embodiment, the inside of the balancer cover 240 communicates with the inside of the muffler 65 through a communication hole (not shown).

[0085] The cover body 241 is formed in a bottomed cylindrical shape. An upper end portion of the cover body 241 is attached to the flange portion 72 of the auxiliary bearing 43. An accommodation hole 243 is formed in a bottom portion of the cover body 241. The accommodation hole 243 penetrates the bottom portion of the cover body 241 in the axial direction. A lower end portion of the base shaft portion 226 is accommodated inside the accommodation hole 243. In the illustrated example, it is preferable that the thrust sliding portion 90 and the bottom portion (lower surface) of the cover body 241 are disposed flush with each other.

[0086] The thrust plate 242 is formed in a disk shape having a diameter larger than that of the above-described accommodation hole 243. The thrust plate 242 closes the accommodation hole 243 from below in a state where an outer peripheral portion is fixed to the bottom portion of the cover body 241 by a screw 244. In the thrust plate 242, a through-hole 245 is formed in a portion that overlaps the main flow path 237 of the rotary shaft 225 when viewed in the axial direction. The inner diameter of the through-hole 245 is smaller than the inner diameter of the accommodation hole 243 and is larger than the outer diameter of the protruding portion 227. The above-described protruding portion 227 penetrates into the through-hole 245. In this manner, a lower end opening portion of the main flow path 95 communicates with the inside of the case 34 below the balancer cover 81 (lower surface of the thrust plate 242).

[0087] The above-described thrust sliding portion 90 is in contact with a portion (seal 242a) located around the through-hole 245 in the axial direction, on the upper surface of the thrust plate 242. In this manner, communication between the inside of the balancer cover 81 and the inside of the case 34 is blocked.

[0088] In the present embodiment, a gap S1 in the radial direction between the inner peripheral surface of the accommodation hole 243 and the outer peripheral surface of the base shaft portion 226 is larger than a gap S2 in the radial direction between the inner peripheral surface of the through-hole 245 and the outer peripheral surface of the protruding portion 227. The gaps S1 and S2 do may not be uniform in the entire circumferential direction due to dimensional variations. The gap S1 may be equal to or smaller than the gap S2.

[0089] Next, a method for manufacturing the rotary compressor 200 according to the present embodiment will be described. In the following description, an assembly process of assembling the thrust plate 242 to the cover body 241 in a state where the rotary shaft 225 and the cover body 241 are assembled will be described.

[0090] Fig. 5 is a process drawing for describing the assembly process.

[0091] As shown in Fig. 5, the assembly process of the thrust plate 242 according to the present embodiment includes a positioning process and a fixing process.

[0092] In the positioning process, a jig 250 is used to position the thrust plate 242 with respect to the protruding portion 227. Specifically, the jig 250 is formed in a cylindrical shape disposed coaxially with the axis line O. The jig 250 has an operation portion 251 located in a lower portion and a plate holding portion 252 located in an upper portion.

[0093] The outer diameter of the operation portion 251 is larger than the inner diameter of the through-hole 245.

[0094] The plate holding portion 252 is connected to an upper side of the operation portion 251. The plate holding portion 252 is formed in a tapered shape whose outer diameter gradually decreases upward. A minimum outer diameter of the plate holding portion 252 is smaller than the inner diameter of the through-hole 245.

[0095] The inside of the jig 250 forms an insertion hole 253 into which the protruding portion 227 can be inserted. The jig 250 is not limited to a cylindrical shape as long as a configuration has a plate holding portion for holding the inner peripheral surface of the through-hole 245 and an accommodation portion capable of accommodating the protruding portion 227.

[0096] In the positioning process, the plate holding portion 252 is inserted into the through-hole 245 of the thrust plate 242. Then, a lower end opening edge of the through-hole 245 is held by the outer peripheral surface of the plate holding portion 252. It is preferable that the plate holding portion 252 holds the thrust plate 242 in a state where the plate holding portion 252 does not protrude upward from the through-hole 245.

[0097] Subsequently, the jig 250 is disposed coaxially with the axis line O below the rotary shaft 225 (cover body 241), and the thrust plate 242 and the jig 250 are raised. Then, the thrust plate 242 moves close to the cover body 241 while the protruding portion 227 is inserted into the insertion hole 253 of the jig 250. The thrust plate 242 is raised until the thrust plate 242 abuts the lower surface of the cover body 241. In this manner, the size of the gap between the through-hole 245 of the thrust plate 242 and the outer peripheral surface of the protruding portion 227 becomes substantially uniform in the circumferential direction, and the thrust plate 242 is positioned in the radial direction with respect to the protruding portion 227. The thrust plate 242 may be rotated in the circumferential direction with respect to the cover body 241 to align a fixing portion between the thrust plate 242 and the cover body 241.

[0098] Next, in the fixing process, the thrust plate 242 is fixed to the cover body 241 by a screw 244 (refer to Fig. 4). Thereafter, the jig 250 is retreated to complete the assembly process of the thrust plate 242.

[0099] In the present embodiment, in addition to achieving operational effects the same as those of the above-described first embodiment, the following operational effects are achieved.

[0100] That is, in the present embodiment, the base shaft portion 226 and the protruding portion 227 (supplementary shaft portion 228) are separately formed. In this manner, the rotary shaft does not need to be processed into a stepped shape as in a case where the base shaft portion and the protruding portion are integrally formed. Therefore, the accurate thrust sliding portion 90 can easily be manufactured, and it is possible to provide the low cost rotary compressor 200 having excellent manufacturing efficiency. Since the base shaft portion 226 and the protruding portion 227 are separately formed, an optimum material can be selected for each component. Therefore, design can more freely be selected.

[0101] Since the base shaft portion 226 and the protruding portion 227 are separate from each other, a shaft length of each component can be shortened, and each component can accurately and easily be formed.

[0102] The present embodiment adopts a configuration as follows. The gap S1 in the radial direction between the inner peripheral surface of the accommodation hole 243 and the outer peripheral surface of the base shaft portion 226 is larger than the gap S2 in the radial direction between the inner peripheral surface of the through-hole 245 and the outer peripheral surface of the protruding portion 227. According to this configuration, since the gap S1 is enlarged, the lubricating oil J existing inside the balancer cover 240 can easily be accommodated inside the gap S1.

[0103] In this manner, the lubricating oil J is likely to be interposed between the outer peripheral surface of the base shaft portion 226 and the inner peripheral surface of the accommodation hole 243, and between the thrust sliding portion 90 and the seal 242a. Therefore, it is possible to improve lubrication performance.

[0104] On the other hand, since the gap S2 is reduced, a contact area (seal area) is likely to increase between the thrust sliding portion 90 and the seal 242a. In this manner, sealing performance can be improved, and a surface pressure acting between the thrust sliding portion 90 and the seal 242a can be reduced.

[0105] Therefore, it is possible to provide the power-saving and high-quality rotary compressor 200 excellent in operation reliability over a long period of time. When the position of the rotary shaft 225 is displaced upward, it is possible to suppress a leakage amount when the gas refrigerant discharged into the balancer cover 240 leaks outward of the balancer cover 240 through the through-hole 245.

[0106] The present embodiment adopts a configuration as follows. The jig 250 having the plate holding portion 252 for holding the inner peripheral surface of the through-hole 245 and the insertion hole 253 into which the protruding portion 227 is inserted is used so that the thrust plate 242 is positioned with respect to the protruding portion 227.

[0107] According to this configuration, it is possible to suppress contact between the protruding portion 227 and the thrust plate 242. Therefore, it is possible to suppress friction during the operation.

[0108] The gap S1 is enlarged as described above. In this manner, it is easy to avoid contact between the base shaft portion 226 having a large turning radius in the rotary shaft 225 and the cover body 241. In this manner, it is also possible to suppress the friction during the operation.

[0109] As a result, it is possible to provide the power-saving and high-quality rotary compressor 200 excellent in operation reliability over a long period of time.

[0110] In the second embodiment, a configuration having three cylinders has been described. However, a configuration having a plurality of cylinders other than three may be adopted.

[0111] In the second embodiment, a configuration in which each of the rotary shaft 225 and the balancer cover 240 is separately formed has been described. However, any one of the rotary shaft 225 and the balancer cover 240 may separately be formed.

[0112] In the second embodiment, a configuration in which the thrust plate 242 is assembled in a state where the rotary shaft 225 and the cover body 241 are assembled has been described. However, the present invention is not limited only to this configuration. For example, the cover body 241 may be assembled to the auxiliary bearing 43 in a state where the cover body 241 and the thrust plate 242 are assembled in advance.

[0113] In the above-described embodiment, a configuration in which the roller 53 and the blade 55 are separate from each other has been described. However, the present invention is not limited only to this configuration. For example, a type in which the blade and the roller are integrated with each other may be adopted.

[0114] According to at least one of the above-described embodiments, desired lubrication performance can be obtained.

[0115] Some embodiments of the present invention have been described. However, the embodiments have been described as examples, and do not intend to limit the scope of the invention. The embodiments can be implemented in various other forms, and various omissions, substitutions, and modifications can be made within the scope not departing from the concept of the invention. The embodiments or modifications thereof are included in the scope and the concept of the invention, and are also included in the scope of the invention described in the appended claims and an equivalent scope thereof.

[Reference Signs List]

[0116]

1:	Refrigeration cycle apparatus
2:	Rotary compressor
3:	Condenser
4:	Expansion device
5:	Evaporator
33:	Compression mechanism
31:	Rotary shaft
33:	Compression mechanism
34:	Case
41:	Cylinder
42:	Main bearing
43:	Auxiliary bearing
51:	Eccentric portion
81:	Balancer cover
82:	Seal
84:	Through-hole
87:	Protruding portion
90:	Thrust sliding portion
91:	Balancer
94:	Supply channel
200:	Rotary compressor
201:	Upper cylinder (Cylinder)
202:	Intermediate cylinder (Cylinder)
203:	Lower cylinder (Cylinder)
225:	Rotary shaft
226:	Base shaft portion
227:	Protruding portion
228:	Supplementary shaft portion
230:	Balancer cover
231:	Upper eccentric portion (Eccentric portion)
232:	Intermediate eccentric portion (Eccentric portion)
233:	Lower eccentric portion (Eccentric portion)
240:	Balancer cover
241:	Cover body
242:	Thrust plate
242a:	Seal
243:	Accommodation hole
245:	Through-hole
250:	Jig

Claims

1. A rotary compressor comprising:

a case configured to store a lubricating oil;
a rotary shaft disposed inside the case, and having an eccentric portion;
a compression mechanism having
a cylinder accommodating the eccentric portion,
a main bearing configured to rotatably support the rotary shaft from above the cylinder, and
an auxiliary bearing configured to rotatably support the rotary shaft from below the cylinder;
a balancer attached to the rotary shaft at a position below the auxiliary bearing; and
a balancer cover configured to cover the balancer from below,
wherein a through-hole is formed at a position of the balancer cover facing the rotary shaft in an axial direction, and
the rotary shaft includes
a thrust sliding portion configured to come into contact with a seal located around the through-

hole of the balancer cover, in the axial direction,
a protruding portion located on an inner peripheral side of the thrust sliding portion, and protruding downward from a lower end of the through-hole through the through-hole, and
a supply channel open on a lower end surface of the protruding portion to guide the lubricating oil.

2. The rotary compressor according to Claim 1,

wherein the rotary shaft is displaceable by a predetermined distance in the axial direction with respect to the compression mechanism, and
the protruding portion protrudes from the lower end of the through-hole to be longer than the predetermined distance.

3. The rotary compressor according to Claim 1 or 2, wherein the rotary shaft includes a base shaft portion provided with the thrust sliding portion, and a supplementary shaft portion fixed to the base shaft portion and forming the protruding portion.

4. The rotary compressor according to any one of Claims 1 to 3,

wherein the rotary shaft has a base shaft portion provided with the thrust sliding portion,
the balancer cover includes

a cover body attached to the auxiliary bearing, and having an accommodation hole for accommodating the base shaft portion, and
a thrust plate having the through-hole, and with which the thrust sliding portion comes into contact, and

a gap in a radial direction of the rotary shaft between an outer peripheral surface of the base shaft portion and an inner peripheral surface of the accommodation hole is wider than a gap in the radial direction between an outer peripheral surface of the protruding portion and an inner peripheral surface of the through-hole.

5. A method for manufacturing the rotary compressor according to Claim 4, comprising:

an assembly process of assembling the thrust plate to the cover body in a state where the base shaft portion is accommodated inside the accommodation hole of the cover body fixed to the auxiliary bearing,
wherein the assembly process has

a positioning process of positioning the thrust plate with respect to the protruding portion, and
a fixing process of fixing the positioned thrust plate to the cover body.

6. A refrigeration cycle apparatus comprising:

the rotary compressor according to any one of claims 1 to 4;
a radiator connected to the rotary compressor;
an expansion device connected to the radiator; and
an evaporator connected between the expansion device and the rotary compressor.

FIG. 1

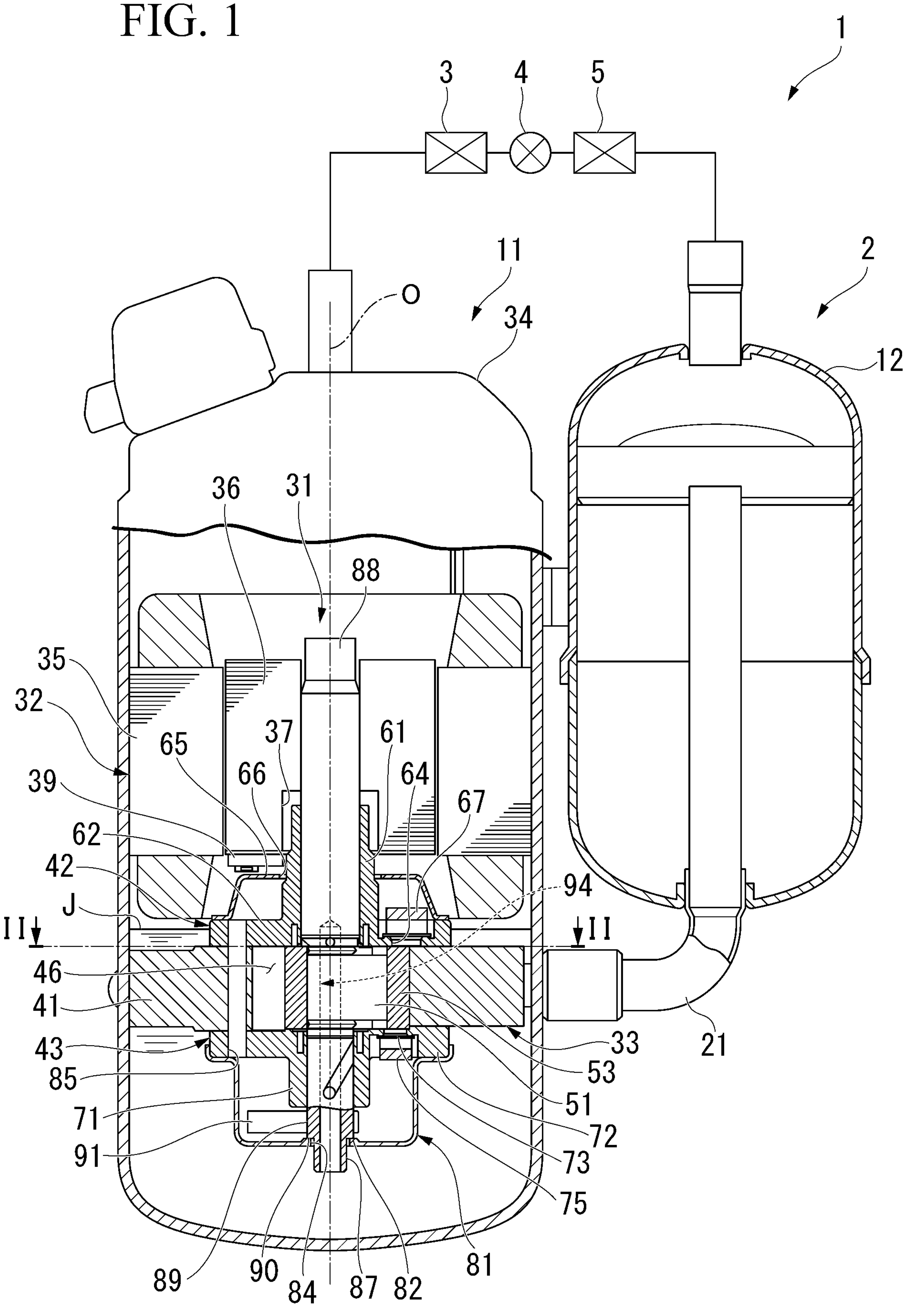
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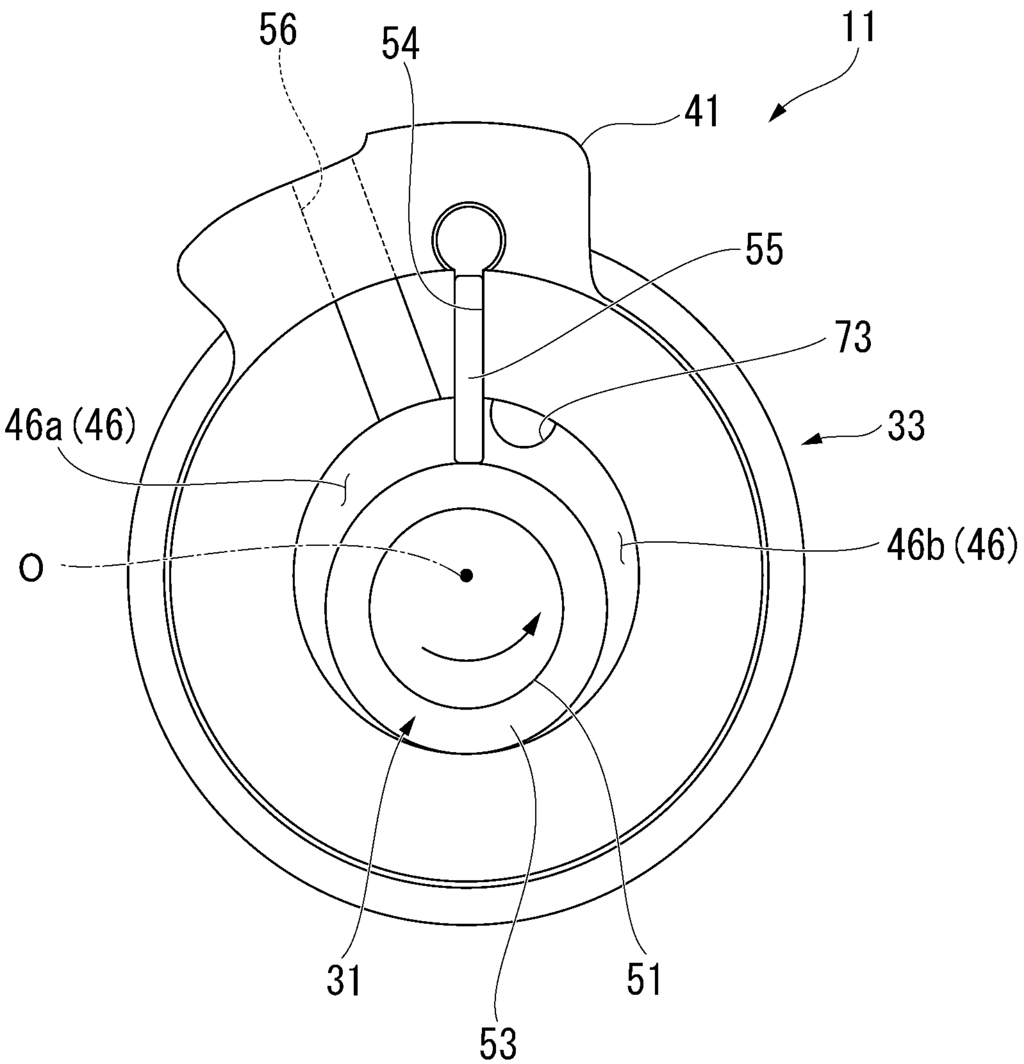
FIG. 2



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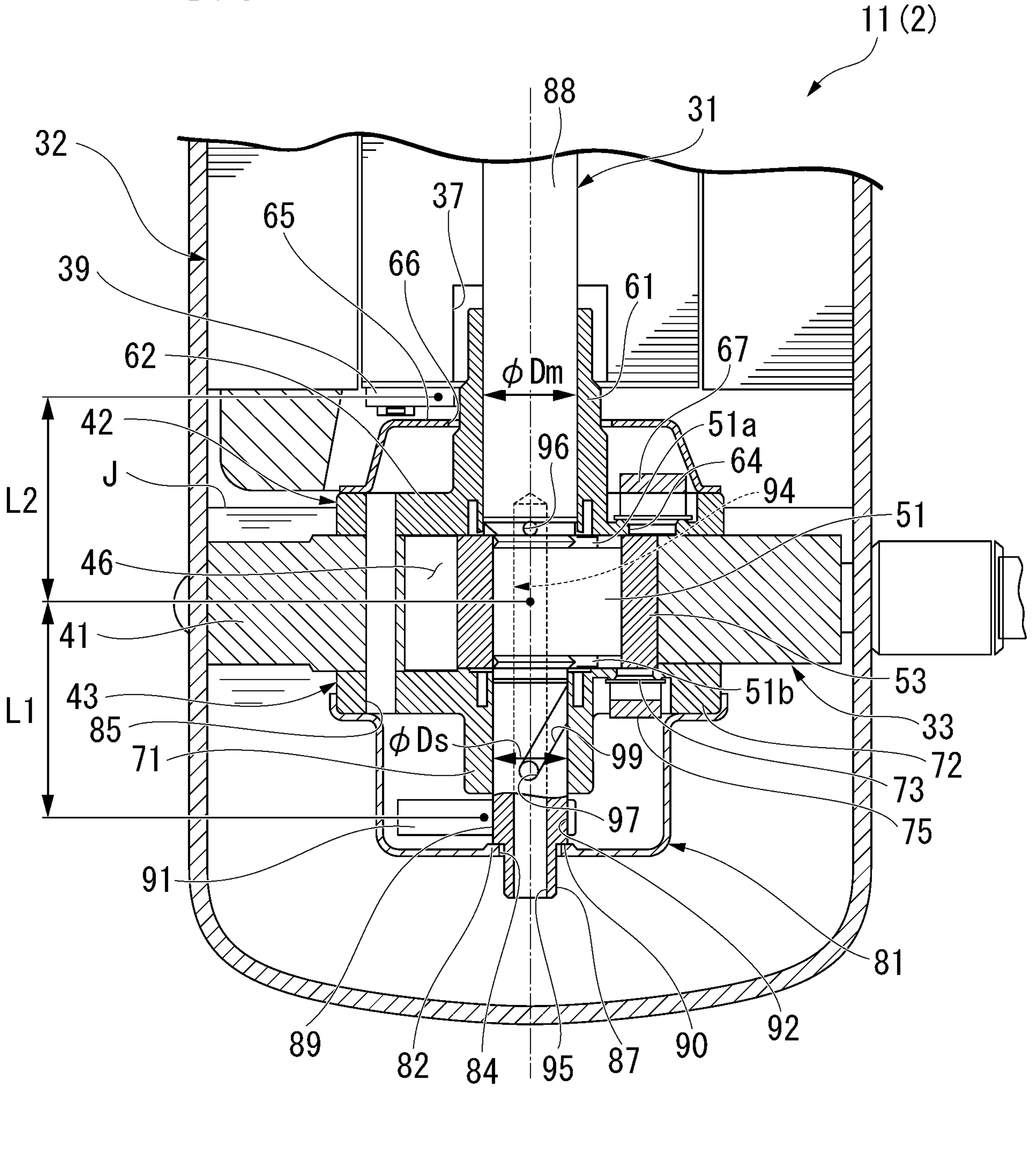
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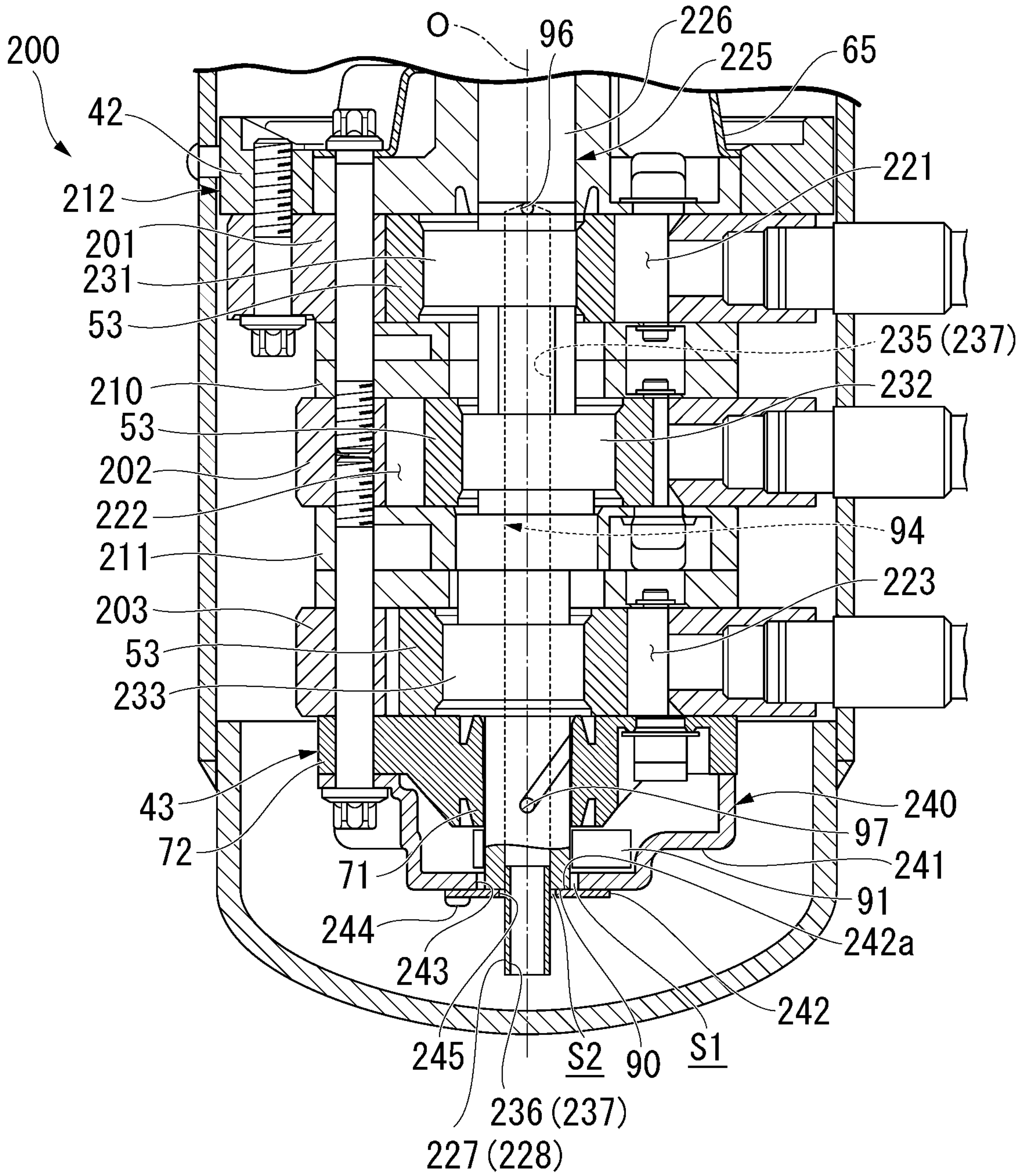
FIG. 4



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227 (228)
S2
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S1
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242a
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235 (237)
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96
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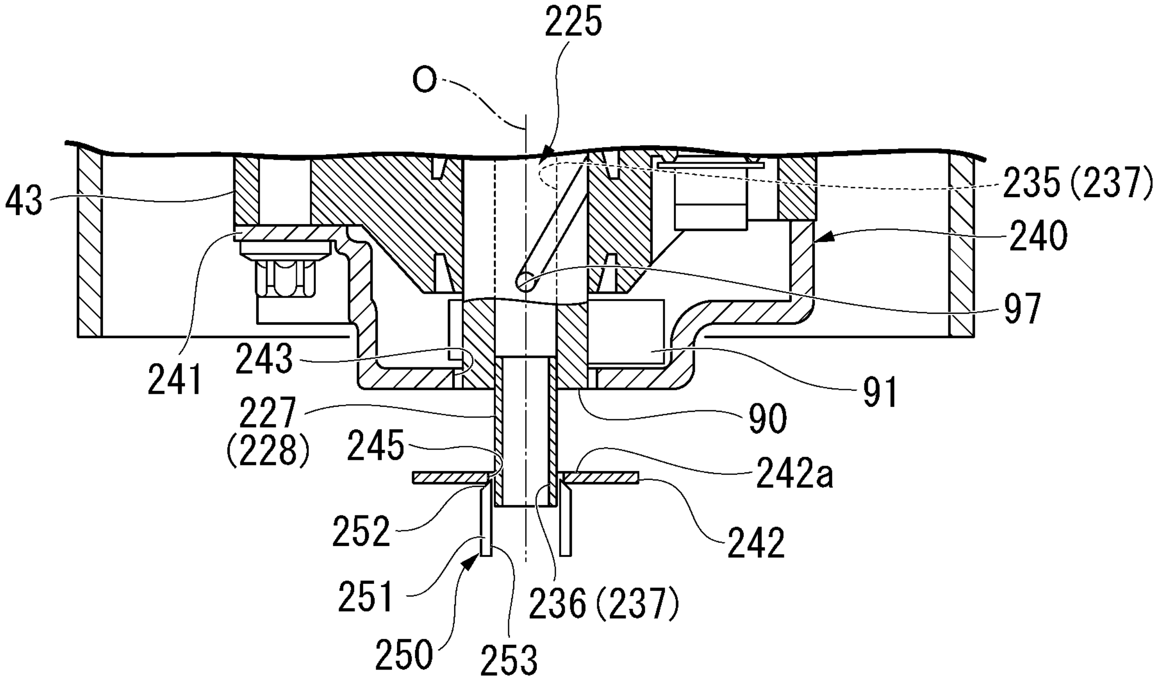
FIG. 5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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2019/041020

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F04C29/02(2006.01)i, F04C18/356(2006.01)i, F04C23/02(2006.01)i, F04C29/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. F04C29/02, F04C18/356, F04C23/02, F04C29/00

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2018-165502 A (TOSHIBA CARRIER CORP.) 25 October 2018, paragraphs [0009]-[0069], fig. 1-5 (Family: none)	1-6
Y	JP 61-171890 A (SANYO ELECTRIC CO., LTD.) 02 August 1986, page 2, upper right column, line 10 to lower right column, line 17, fig. 1, 2 (Family: none)	1-6
Y	JP 2015-197044 A (DAIKIN INDUSTRIES, LTD.) 09 November 2015, paragraphs [0036], [0082], [0083], fig. 1, 2 (Family: none)	1-6

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

* Special categories of cited documents:
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"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

Date of the actual completion of the international search	Date of mailing of the international search report
11.12.2019	24.12.2019

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2019020870 A **[0002]**
- JP 2018165502 A **[0005]**