(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 502 384 A1

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

(43) Date of publication:
05.02.2025 Bulletin 2025/06

(21) Application number: **22933501.3**

(22) Date of filing: **25.03.2022**

(51) International Patent Classification (IPC):
F04C 18/356 *(2006.01)* ***F04C 23/00*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F04C 18/356; F04C 23/00

(86) International application number:
PCT/JP2022/014438

(87) International publication number:
WO 2023/181362 (28.09.2023 Gazette 2023/39)

(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

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(54) ROTARY COMPRESSOR AND REFRIGERATION CYCLE DEVICE

(57) A rotary compressor is provided that can prevent decrease in reliability of a multi-stage compression mechanism unit and can be downsized. A compression mechanism unit 18 of a compressor 2 includes: a low-pressure side cylinder 55 having a low-pressure side compression chamber 61 that compresses introduced gaseous refrigerant and discharges the compressed refrigerant gas by power of a low-pressure side eccentric portion 51; a high-pressure side cylinder 57 having a high-pressure side compression chamber 62 that compresses the refrigerant discharged from the low-pressure side compression chamber 61 by power of a high-pressure side eccentric portion 52; and a partition plate 56 provided between the low-pressure side cylinder 55 and the high-pressure side cylinder 57, wherein a height of the low-pressure side compression chamber 61 is the same as a height of the high-pressure side compression chamber 62, and an inner diameter dimension of the low-pressure side compression chamber 61 is larger than an inner diameter dimension of the high-pressure side compression chamber 62.

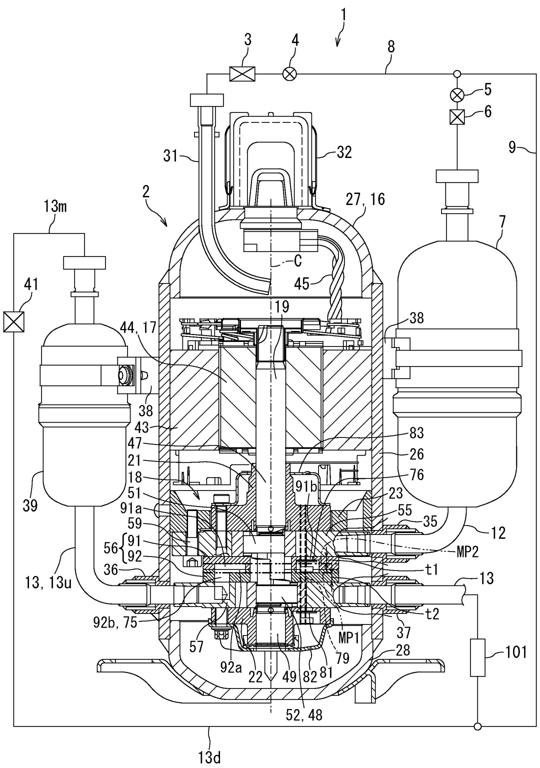

FIG. 1

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Description

TECHNICAL FIELD

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

BACKGROUND

[0002] A rotary compressor is known that includes: a cylindrical sealed container that is vertically mounted; a compression mechanism unit disposed at a lower part within the sealed container; a motor disposed within the sealed container and above the compression mechanism unit, as an electric motor unit that drives the compression mechanism unit; and a rotating shaft. The rotating shaft extends along the center line that extends in the up-down direction through the sealed container. The compression mechanism unit is connected to the motor via the rotating shaft. The compression mechanism unit compresses refrigerant gas that flows in from outside the sealed container using power of the rotating shaft.

[0003] The compression mechanism unit has a first compression chamber, an annular first roller fitted into a first eccentric portion of the rotating shaft, a first blade dividing an internal space of the first compression chamber, a second compression chamber connected to the first compression chamber, an annular second roller fitted into a second eccentric portion of the rotating shaft, and a second blade dividing an internal space of the second compression chamber. The first roller revolves along the inner wall surface of the first compression chamber, and the second roller revolves along the inner wall surface of the second compression chamber. The first compression chamber compresses refrigerant gas flowing in from the outside and discharges the compressed refrigerant gas, by the revolution of the first roller. This discharged refrigerant gas is further compressed in the second compression chamber by the revolution of the second roller.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0004] Patent Document 1
International Publication No. WO 2021/033283

SUMMARY

PROBLEMS TO BE SOLVED BY INVENTION

[0005] Here, the volume of a space through which the roller moves for one rotation is called an excluded volume. In a conventional rotary compressor, the excluded volume of the first compression chamber is set larger than the predetermined excluded volume of the second compression chamber because refrigerant gas discharged from the first compression chamber is further pressurized into higher pressure in the second compression chamber, and a predetermined amount of refrigerant gas is highly pressurized.

[0006] In order to increase the internal volume of the first cylinder related to the excluded volume of the first compression chamber, for example, the height of the first compression chamber is set larger than the height of the second compression chamber. The height of the first blade disposed in the first compression chamber is larger than the height of the second blade disposed in the second compression chamber.

[0007] However, when the height of the first compression chamber is larger than the height of the second compression chamber, the height of the first blade is larger than the height of the second blade. In general, increasing the height of the blades increases the load on the blades from, for example, the refrigerant gas, causing the reliability of operation of the blade to be likely to decrease. In addition, making the height of the first compression chamber larger than the height of the second compression chamber encourages increase in the size of the compression mechanism unit, which in turn encourages increase in the size of the compressor.

[0008] Therefore, an object of the present invention is to provide a rotary compressor that can prevent decrease in reliability of a multi-stage compression mechanism unit and can be downsized.

MEANS FOR SOLVING PROBLEM

[0009] In order to solve the above problems, a rotary compressor according to an embodiment of the present invention includes: a sealed container having a central axis extending in an up-down direction; an electric motor unit provided within the sealed container; a crankshaft, having a low-pressure side eccentric portion and a high-pressure side eccentric portion, configured to be rotationally driven around the central axis by the electric motor unit, the low-pressure side eccentric portion being eccentric from the central axis of the sealed container by a first eccentric length, the high-pressure side eccentric portion being provided below the low-pressure side eccentric portion and being eccentric from the central axis by a second eccentric length; and a compression mechanism unit having a low-pressure side cylinder, a high-pressure side cylinder, and a partition plate provided between the low-pressure side cylinder and the high-pressure side cylinder, the low-pressure side cylinder having a low-pressure side compression chamber that compresses introduced gaseous refrigerant and discharges the compressed refrigerant gas by power of the low-pressure side eccentric portion, the high-pressure side cylinder having a high-pressure side compression chamber that compresses the refrigerant discharged from the low-pressure side compression chamber by power of the high-pressure side eccentric portion, wherein a height of the low-pressure side compression chamber is a same as a height of the high-pressure side compression chamber, and an inner diameter dimension of the low-pressure side compression chamber is larger than an inner diameter dimension of the high-pressure side compression chamber.

[0010] The rotary compressor according to the embodiment of the present invention is preferably configured such that the first eccentric length is larger than the second eccentric length.

[0011] The rotary compressor according to the embodiment of the present invention is preferably configured such that a compression start angle of the high-pressure side compression chamber is larger than a compression start angle of the low-pressure side compression chamber.

[0012] The rotary compressor according to the embodiment of the present invention is preferably configured such that the high-pressure side cylinder has a groove, the groove being provided on a wall surface defining the high-pressure side compression chamber, the groove being connected to a suction portion of the high-pressure side compression chamber.

[0013] The rotary compressor according to the embodiment of the present invention is preferably configured such that the partition plate and the high-pressure side cylinder have a medium-pressure flow path, and the medium-pressure flow path connects a discharge portion of the low-pressure side compression chamber and a suction portion of the high-pressure side compression chamber.

[0014] The rotary compressor according to the embodiment of the present invention is preferably configured such that the partition plate has a first partition plate half body and a second partition plate half body stacked below the first partition plate half body, and part of the medium-pressure flow path is provided on a mating surface of the first partition plate half body and the second partition plate half body, and the second partition plate half body has a larger thickness than the first partition plate half body, the second partition plate half body having a lower part of the part of the medium-pressure flow path, the first partition plate half body having an upper part of the part of the medium-pressure flow path.

[0015] The rotary compressor according to the embodiment of the present invention preferably further includes an intermediate pipe provided outside the sealed container, wherein the medium-pressure flow path is connected to a suction portion of the high-pressure side compression chamber via the intermediate pipe.

[0016] In order to solve the above problems, a refrigeration cycle apparatus according to an embodiment of the present invention includes: the rotary compressor; a heat radiator; an expansion device; a heat absorber; and a refrigerant pipe that connects the rotary compressor, the heat radiator, the expansion device, and the heat absorber, to allow the refrigerant to circulate.

EFFECTS OF INVENTION

[0017] According to the present invention, it is possible to provide a rotary compressor that can prevent decrease in reliability of a multi-stage compression mechanism unit and can be downsized.

BRIEF DESCRIPTION OF DRAWINGS

[0018]

Fig. 1 is a schematic diagram of a refrigeration cycle apparatus and a compressor according to an embodiment of the present invention.

Fig. 2 is a cross-sectional plan view taken along a first cylinder of the compressor according to the embodiment of the present invention.

Fig. 3 is a cross-sectional plan view taken along a second cylinder of the compressor according to the embodiment of the present invention.

Fig. 4 is a vertical cross-sectional view of a partition plate of the compressor according to the embodiment of the present invention.

Fig. 5 is a vertical cross-sectional view of another embodiment of the partition plate of the compressor according to the embodiment of the present invention.

Fig. 6(a) is a cross-sectional view taken along a line B-B' in Fig. 3, and Fig. 6(b) is a partial cross-sectional view taken along a line D-D' in Fig. 6(a).

Fig. 7(a) is a cross-sectional view showing a modified embodiment of a groove in the embodiment of the present invention, and Fig. 7(b) is a partial cross-sectional view taken along a line E-E' in Fig. 7(a).

Fig. 8(a) is a cross-sectional view showing a modified embodiment of the groove in the embodiment of the present invention, and Fig. 8(b) is a partial cross-sectional view taken along a line F-F' in Fig. 8 (a) .

Fig. 9(a) is a cross-sectional view showing a modified embodiment of the groove in the embodiment of the present invention, and Fig. 9(b) is a partial cross-sectional view taken along a line G-G' in Fig. 9 (a) .

DETAILED DESCRIPTION

[0019] Embodiments of a compressor and a refrigeration cycle apparatus according to the present invention will be described with reference to Figs. 1 to 6. Note that the same or corresponding components are denoted by the same reference numerals and characters in the drawings.

[0020] Fig. 1 is a schematic diagram of the refrigeration cycle apparatus and the compressor according to an embodiment of the present invention. In Fig. 1, the compressor is shown in vertical cross section.

[0021] Fig. 2 is a cross-sectional plan view taken along a first cylinder of the compressor according to the embodiment of the present invention.

[0022] Fig. 3 is a cross-sectional plan view taken along a second cylinder of the compressor according to the embodiment of the present invention.

[0023] A refrigeration cycle apparatus 1 according to the present embodiment is, for example, an air conditioner. The refrigeration cycle apparatus 1 includes: a sealed rotary compressor 2 (hereinafter simply referred to as a "compressor 2") that compresses gaseous refrigerant, such as carbon dioxide (CO2), which is a working fluid; a heat radiator 3 (condenser) that cools the high-temperature, high-pressure refrigerant discharged from the compressor 2; a first expansion device 4 (expansion valve) and a second expansion device 5 (expansion valve) that decompress the cooled refrigerant; a heat absorber 6 (evaporator) that evaporates the decompressed refrigerant; an accumulator 7 that separates the refrigerant into gas and liquid; a first refrigerant pipe 8; and a second refrigerant pipe 9.

[0024] The first refrigerant pipe 8 sequentially connects the compressor 2, the heat radiator 3, the first expansion device 4, the second expansion device 5, the heat absorber 6, and the accumulator 7 to circulate the refrigerant. The accumulator 7 has an outlet pipe 12 connected to the compressor 2 and allowing the refrigerant to flow into the compressor 2. One end of the second refrigerant pipe 9 is connected to the first refrigerant pipe 8 between the first expansion device 4 and the second expansion device 5. The other end of the second refrigerant pipe 9 is connected to the intermediate pipe 13 of the compressor 2. The second refrigerant pipe 9 allows the refrigerant, which has been decompressed to, for example, a medium pressure in the first expansion device 4, to flow into the compressor 2 via the intermediate pipe 13.

[0025] The compressor 2 includes: a cylindrical sealed container 16 mounted vertically; an electric motor unit 17 housed in the upper half portion of the sealed container 16; a compression mechanism unit 18 housed in the lower half portion of the sealed container 16; a crankshaft 19 that transmits the rotational driving force of the electric motor unit 17 to the compression mechanism unit 18; a main bearing 21 provided below the electric motor unit 17 and rotatably supporting the crankshaft 19; an auxiliary bearing 22 provided below the main bearing 21 and cooperating with the main bearing 21 to rotatably support the crankshaft 19; a frame 23 fixed to the sealed container 16 and supporting the compression mechanism unit 18; and an intermediate pipe 13 provided outside the sealed container 16.

[0026] The center line of the sealed container 16 mounted vertically extends in the up-down direction. The compressor 2 is installed with the center line of the sealed container 16 vertical. The sealed container 16 includes a cylindrical body portion 26 extending in the up-down direction, a head plate 27 covering the upper end portion of the body portion **26,** and a bottom plate 28 covering the lower end portion of the body portion 26**.** The sealed container 16 stores lubricating oil for lubricating the compression mechanism unit 18. The lubricating oil is supplied to the compression mechanism unit 18 through an oil supply mechanism provided in a lower end portion of the crankshaft 19.

[0027] The head plate 27 of the sealed container 16 includes a discharge pipe 31 that discharges the high-temperature, high-pressure refrigerant to the outside of the sealed container 16, the high-temperature, high-pressure refrigerant having been discharged from the compression mechanism unit 18 into the sealed container 16. The discharge pipe 31 is connected to the first refrigerant pipe 8. The head plate 27 also includes a terminal block 32 having sealed terminals that conduct electric power from an external power source to the electric motor unit 17. The sealed terminals of the terminal block 32 are provided across the outside and inside of the head plate 27.

[0028] The body portion 26 of the sealed container 16 includes: a suction end portion 35 connected to the outlet pipe 12 of the accumulator 7; an intermediate discharge end portion 36 connected to one end of the intermediate pipe 13; and an intermediate suction end portion 37 connected to the other end of the intermediate pipe 13. The suction end portion 35, intermediate discharge end portion 36, and intermediate suction end portion 37 each have a central portion fixed to the sealed container 16, an inner end placed inside the sealed container 16, and an outer end placed outside the sealed container 16. The body portion 26 of the sealed container 16 is also provided with a fixing device 38 such as a holder that fixes the accumulator 7 to the outer surface of the body portion 26.

[0029] The intermediate pipe 13 circulates the refrigerant compressed to medium pressure by the compression mechanism unit 18 to the outside of the sealed container 16. The intermediate pipe 13 is connected to a cylindrical external muffler 39 and an intercooler 41. The intermediate pipe 13 sequentially connects the intermediate discharge end portion 36, the external muffler 39, the intercooler 41, and the intermediate suction end portion 37 to circulate the refrigerant. The external muffler 39 has a cylindrical shape extending in the up-down direction, and is fixed to the outer surface of the sealed container 16 by a fixing device 38 such as a holder provided on the body portion 26 of the sealed container 16. The intermediate pipe 13 circulates the refrigerant compressed to medium pressure by the compression mechanism unit 18.

[0030] The electric motor unit 17 generates a driving force to rotate the compression mechanism unit 18. The electric motor unit 17 includes: a cylindrical stator 43 fixed to the inner surface of the sealed container 16; a rotor 44 disposed inside the stator 43 and generating a rotational driving force for the compression mechanism unit 18; and a plurality of outlet wires 45 drawn from the stator 43 and electrically connected to sealed terminals of the terminal block 32. The electric motor unit 17 may be an open-end winding motor, a star-connected motor, or a motor with a plurality of systems, for example, two systems of threephase windings.

[0031] The rotor 44 includes a rotor core (not shown) having magnet accommodating holes, and a permanent magnet (not shown) accommodated in the magnet accommodating holes. The rotor 44 is fixed to the crankshaft 19. The rotation center line C of the rotor 44 and the crankshaft 19 substantially coincide with the center line of the stator 43. The rotation center line C of the rotor 44 and the crankshaft 19 substantially coincide with the center line of the sealed container 16.

[0032] The plurality of outlet wires 45 are power-line wires that supply electric power to the stator 43, and are so-called lead wires. The plurality of outlet wires 45 are wired depending on the type of the electric motor unit 17, that is, open-end winding type or star-connected type.

[0033] The crankshaft 19 connects the electric motor unit 17 and the compression mechanism unit 18. The crankshaft 19 rotates integrally with the rotor 44 and extends downward from the rotor 44. The crankshaft 19 has a main shaft portion 47 located in the middle part, a plurality of eccentric portions 48 located below the main shaft portion 47, and an auxiliary shaft portion 49 located below the plurality of eccentric portions 48. The main shaft portion 47 is rotatably supported by the main bearing 21, and the auxiliary shaft portion 49 is rotatably supported by the auxiliary bearing 22. The main bearing 21 and the auxiliary bearing 22 are also part of the compression mechanism unit 18. In other words, the crankshaft 19 is disposed to penetrate the compression mechanism unit 18. Each eccentric portion 48 is a so-called crank pin. The plurality of eccentric portions 48 include, for example, a first eccentric portion 51 and a second eccentric portion 52. The first eccentric portion 51 and the second eccentric portion 52 are disk-shaped or cylindrical with centers that do not coincide with the rotation center line C of the crankshaft 19.

[0034] The compression mechanism unit 18 sucks and compresses gaseous refrigerant from the outlet pipe 12 and intermediate pipe 13 by rotational drive of the crankshaft 19, and discharges the refrigerant compressed to a high temperature and high pressure into the sealed container 16. The compression mechanism unit 18 is a multistage rotary compression mechanism. The compression mechanism unit 18 includes: a first cylinder 55 disposed below the main bearing 21; a partition plate 56 disposed below the first cylinder 55; and a second cylinder 57 disposed between the partition plate 56 and the auxiliary bearing 22.

[0035] The main bearing 21, the first cylinder 55, the partition plate 56, the second cylinder 57, and the auxiliary bearing 22 are disposed one above the other in the up-down direction. The main bearing 21 covers the upper surface of the first cylinder 55. The auxiliary bearing 22 covers the lower surface of the second cylinder 57. The partition plate 56 covers the lower surface of the first cylinder 55 and the upper surface of the second cylinder 57.

[0036] The first cylinder 55 is fixed by fastening members 59 such as bolts to the frame 23 fixed by welding at a plurality of points to the body portion 26 of the sealed container 16. The main bearing 21, the first cylinder 55, the partition plate 56, the second cylinder 57, and the auxiliary bearing 22 are fixed to each other by a plurality of fastening members 59 such as bolts. The main bearing 21, the first cylinder 55, the partition plate 56, the second cylinder 57, and the auxiliary bearing 22 are fixed to the inside of the sealed container 16 via the frame 23.

[0037] The first cylinder 55 has a first compression chamber 61 penetrating the first cylinder 55 in the up-down direction. The second cylinder 57 has a second compression chamber 62 penetrating the second cylinder 57 in the up-down direction. The first compression chamber 61 and the second compression chamber 62 are disk-shaped spaces that overlap each other in the up-down direction via the partition plate 56. The centers of the first compression chamber 61 and the second compression chamber 62 are placed on the rotation center line C. The compression mechanism unit 18 compresses the low-pressure gas refrigerant, which flows therein from the accumulator 7, to medium pressure in the first compression chamber 61 and discharges the compressed refrigerant gas. The compression mechanism unit 18 compresses the medium-pressure gas refrigerant, which is discharged from the first compression chamber 61, to high pressure in the second compression chamber 62 and discharges the compressed refrigerant gas. The first cylinder 55 and the second cylinder 57 may be collectively referred to as "cylinders 55 and 57" or "cylinder 55 (57)" in which the former represents all of them and the latter represents each of them. The same applies to all of the following collective terms. The first compression chamber 61 and the second compression chamber 62 may be collectively referred to as "compression chambers 61 and 62" or "compression chamber 61 (62)".

[0038] The compression mechanism unit 18 also includes: an annular first roller 63 disposed in the first compression chamber 61; an annular second roller 64 disposed in the second compression chamber 62; a first blade 65 placed in the first cylinder 55 in the radial direction of the first compression chamber 61; and a second blade 66 placed in the second cylinder 57 in the radial direction of the second compression chamber 62. The first roller 63 and the second roller 64 may be collectively referred to as "rollers 63 and 64" or "roller 63 (64)", and the first blade 65 and the second blade 66 may be collectively referred to as "blades 65 and 66" or "blade 65 (66)". The rollers 63 and 64 are so-called rolling pistons, and the blades 65 and 66 are so-called vanes.

[0039] The first roller 63 is fitted to the first eccentric portion 51 of the crankshaft 19. The second roller 64 is fitted to the second eccentric portion 52 of the crankshaft 19. The crankshaft 19 rotates counterclockwise in plan view of the compressor 2. When the crankshaft 19 rotates, the two eccentric portions 48 rotate counterclockwise, seen from above the crankshaft 19, around the rotation center line C (see Fig. 1) as indicated by a solid arrow R1 in Fig. 2, the two eccentric portions 48 being the first eccentric portion 51 and the second eccentric portion 52, and the first roller 63 and the second roller 64. The rotational direction of the crankshaft 19 and the rollers 63, 64 is sometimes called a "rotational direction R1", and the counter-rotational direction of the rotational direction R1 is sometimes called a "counter-rotational direction R2".

[0040] The roller 63 (64) rotates eccentrically with respect to the central axis of the cylinder 55 (57) and the rotational center line C of the crankshaft 19 while being in contact with the inner wall of the cylinder 55 (57), by the rotation of the crankshaft 19.

[0041] The blades 65 and 66 are placed on a straight line in the up-down direction. In other words, the two blades 65 and 66 are disposed at substantially the same position in the circumferential direction of the cylinders 55 and 57. The blade 65 (66) is pressed against the roller 63 (64) by a blade spring (not shown). Therefore, the blade 65 (66) reciprocates in the radial direction of the compression chamber 61 (62) while being pressed by the roller 63 (64), by the rotation of the crankshaft 19. As shown in Figs. 2 and 3, the blade 65 (66) divides the space between the cylinder 55 (57) and the roller 63 (64) into a suction space S1 (not shown in **Fig.** 2) and a compression space S2. The height of the first blade 65 is the same as the height of the second blade 66. The blade 65 (66) has a height that is substantially the same as the compression chamber 61 (62).

[0042] The first cylinder 55 has a first suction portion 68 and a first discharge portion 69 connected to the first compression chamber 61. The first suction portion 68 extends outward from the inner wall surface of the first compression chamber 61, and has an outer end connected to the inner end of the suction end portion 35 of the sealed container 16. The first discharge portion 69 is recessed outward from the inner wall surface of the first compression chamber 61, for example, and opens to the lower surface of the first cylinder 55. The first suction portion 68 is disposed adjacent to the first blade 65 on the side in the rotational direction R1, and the first discharge portion 69 is disposed adjacent to the first blade 65 on the side in the counter-rotational direction R2.

[0043] The second cylinder 57 has a second suction portion 71 and a second discharge portion 72 connected to the second compression chamber 62. The second suction portion 71 extends outward from the inner wall surface of the second compression chamber 62, and has an outer end connected to the inner end of the intermediate suction end portion 37 of the sealed container 16. The second discharge portion 72 is recessed outward from the inner wall surface of the second compression chamber 62, for example, and opens to the lower surface of the second cylinder 57. The second suction portion 71 is disposed next to the second blade 66 on the side in the rotational direction R1, and the second discharge portion 72 is disposed adjacent to the second blade 66 on the side in the counter-rotational direction R2. The first suction portion 68 and the second suction portion 71 may be collectively referred to as the "suction portions 68 and 71" or "suction portion 68 (71)", and the first discharge portion 69 and the second discharge portion 72 may be collectively referred to as the "discharge portions 69 and 72" or "discharge portion 69 (72)".

[0044] The partition plate 56 and the second cylinder 57 have a medium-pressure flow path 75 that connects with the first discharge portion 69 of the first compression chamber 61. The medium-pressure flow path 75 is a flow path for the refrigerant compressed to medium pressure in the first compression chamber 61. The medium-pressure flow path 75 of the partition plate 56 includes flow path provided within the partition plate 56 and extending along the upper and lower surfaces of the partition plate 56. The medium-pressure flow path 75 of the second cylinder 57 includes a crank-shaped flow path provided outside the second compression chamber 62 and bent from the upper side to the outside. The medium-pressure flow path 75 of the partition plate 56 is connected to the first discharge portion 69 of the first compression chamber 61, and the medium-pressure flow path 75 of the second cylinder 57 is connected to the inner end of the intermediate discharge end portion 36 of the sealed container 16.

[0045] The partition plate 56 includes a first discharge valve 76 that discharges the refrigerant compressed in the first compression chamber 61 to the medium-pressure flow path 75. When the pressure difference between the pressure of the first compression chamber 61 and the pressure of the medium-pressure flow path 75 reaches a predetermined value by the compression operation of the compression mechanism unit 18, the first discharge valve 76 opens a discharge port (not shown) to discharge the refrigerant compressed to medium pressure to the medium-pressure flow path 75 of the partition plate 56. The refrigerant discharged to the medium-pressure flow path 75 of the partition plate 56 is guided to the outside of the sealed container 16 from the intermediate discharge end portion 36 through the medium-pressure flow path 75 of the second cylinder 57. The refrigerant guided to the outside of the sealed container 16 circulates through the intermediate pipe 13, is guided from the intermediate suction end portion 37 to the inside of the sealed container 16, and flows into the second compression chamber 62 from the second suction portion 71 of the second cylinder 57.

[0046] The main bearing 21, the first cylinder 55, the partition plate 56, the second cylinder 57, and the auxiliary bearing 22 have a high-pressure flow path 79 penetrating in the up-down direction and connecting them to each other. The high-pressure flow path 79 is a flow path for high-pressure gas refrigerant that extends linearly in the up-down direction across the main bearing 21, the first cylinder 55, the partition plate 56, the second cylinder 57, and the auxiliary bearing 22.

[0047] The compression mechanism unit 18 includes: a second discharge valve 81 that is provided at the auxiliary bearing 22 and discharges the refrigerant compressed in the second compression chamber 62; and a first discharge muffler 82 that covers the second discharge valve 81 and the high-pressure flow path 79. When the pressure difference between the pressure in the second compression chamber 62 and the pressure in the first discharge muffler 82 reaches a predetermined value by the compression action of the compression mechanism unit 18, the second discharge valve 81 opens a discharge port (not shown) to discharge the refrigerant compressed to high pressure into the first discharge muffler 82. The refrigerant discharged from the second discharge valve 81 into the first discharge muffler 82 is guided to the upper side of the compression mechanism unit 18 through the high-pressure flow path 79. The first discharge valve 76 and the second discharge valve 81 may be collectively referred to as the "discharge valves 76 and 81" or "discharge valve 76 (81)".

[0048] The compression mechanism unit 18 includes a second discharge muffler 83 provided at the main bearing 21 and covering the high-pressure flow path 79. The second discharge muffler 83 defines the space into which the high-pressure refrigerant is discharged from the high-pressure flow path 79. The second discharge muffler 83 has a discharge hole (not shown) that connects the inside and outside of the second discharge muffler 83. The high-pressure refrigerant discharged into the second discharge muffler 83 is discharged into the sealed container 16 through the discharge hole.

[0049] Fig. 4 is a vertical cross-sectional view of a partition plate of a compressor according to the embodiment of the present invention.

[0050] As shown in Figs. 1 and 4, the partition plate 56 is a stack body composed of a plurality of plates stacked in the up-down direction. The partition plate 56 includes a first partition plate half body 91 and a second partition plate half body 92 that are stacked in the up-down direction. The first partition plate half body 91 and the second partition plate half body 92 have a shape of substantially circular disk with substantially the same thickness. The first partition plate half body 91 disposed on the upper side has a recessed portion 91a (recess, groove) that opens to the lower surface of the first partition plate half body 91. The second partition plate half body 92 disposed on the lower side has a recessed portion 92a (recess, groove) that opens to the upper surface of the second partition plate half body 92. The medium-pressure flow path 75 of the partition plate 56 is a space defined by the recessed portion 91a (recess, recessed portion) of the first partition plate half body 91 and the recessed portion 92a (recess, recessed portion) of the second partition plate half body 92. The first partition plate half body 91 has a hole 91b that connects the recessed portion 91a to the first compression chamber 61. The first discharge valve 76 is provided on the recessed portion 91a of the first partition plate half body 91 and opens and closes the hole 91b. The second partition plate half body 92 has a hole 92b that connects the recessed portion 92a to the medium-pressure flow path 75 of the second cylinder 57.

[0051] The plate thickness of the first partition plate half body 91 and the plate thickness of the second partition plate half body 92 are substantially the same in the up-down direction, while the depth of the recessed portion 92a of the second partition plate half body 92 is shallower than the depth of the recessed portion 91a of the first partition plate half body 91. In other words, the thickness t2 of the bottom plate portion of the recessed portion 92a of the second partition plate half body 92 is thicker than the thickness t1 of the bottom plate portion of the recessed portion 91a of the first partition plate half body 91. The bottom plate portion of the recessed portion 91a of the first partition plate half body 91 covers the first compression chamber 61, and the bottom plate portion of the recessed portion 92a of the second partition plate half body 92 covers the second compression chamber 62.

[0052] The multi-stage compression mechanism unit 18 compresses low-pressure refrigerant into medium-pressure refrigerant in the first compression chamber 61, and compresses the medium-pressure refrigerant into high-pressure refrigerant in the second compression chamber 62. In other words, the second partition plate half body 92 bears a higher pressure load than the first partition plate half body 91. Accordingly, the thickness t2 of the bottom plate portion of the recessed portion 92a of the second partition plate half body 92 is made thicker than the thickness t1 of the bottom plate portion of the recessed portion 91a of the first partition plate half body 91. This optimizes the rigidity of the first partition plate half body 91 stacked on the first cylinder 55 and the rigidity of the second partition plate half body 92 stacked on the second cylinder 57. In other words, this optimizes the rigidity of the partition plate 56, which is the stack body of the first partition plate half body 91 and the second partition plate half body 92. The partition plate 56 with optimized rigidity appropriately prevents refrigerant leakage from both the mating surface between the first compression chamber 61 and the partition plate 56 and the mating surface between the second compression chamber 62 and the partition plate 56.

[0053] Here, the suction pressure Ps of the first compression chamber 61, the medium pressure Pm discharged from the first compression chamber 61 and supplied to the second compression chamber 62 through the medium-pressure flow path 75, and the discharge pressure Pd of the second compression chamber 62 have a relationship of (suction pressure Ps) < (medium pressure Pm) < (discharge pressure Pd). During operation, the conditions (Pd - Pm) > (Pm - Ps) always hold. Under these conditions, each pressure differs depending on the operating conditions. The medium pressure Pm changes according to the relationship $Pm = \sqrt{(Pd \times Ps)}$.

[0054] Therefore, the surface pressure load of the differential pressure (Pm - Ps) acts on the recessed portion 91a of the first partition plate half body 91, and the surface pressure load of the differential pressure (Pd - Pm) acts on the recessed portion 92a of the second partition plate half body 92.

[0055] The first partition plate half body 91 and the second partition plate half body 92 have substantially the same thickness dimension while the thickness t2 of the bottom plate portion of the second partition plate half body 92 is thicker than the thickness t1 of the bottom plate portion of the first partition plate half body 91. These dimensional relationships optimize the rigidity required for the partition plate 56.

[0056] The first partition plate half body 91 has the same thickness dimension as the second partition plate half body 92, making it possible to use the same material for the first partition plate half body 91 and the second partition plate half body 92. Furthermore, the recessed portions are provided in both the first partition plate half body 91 and the second partition plate half body 92, which face each other in the up-down direction. This makes it possible to maintain the passage area of the medium-pressure flow path 75, and improve the rigidity of the partition plate 56 as a whole without reducing performance. Improvement in the rigidity of the partition plate 56 as a whole suppresses deformation of the partition plate 56, and prevents refrigerant leakage from the medium-pressure flow path 75.

[0057] The thickness t3 in the vicinity of the valve seat where the hole 91b and the first discharge valve 76 are disposed may be equal to or smaller than t1. This makes it possible to reduce the volume of the hole 91b portion while ensuring the necessary rigidity against the pressure difference.

[0058] The refrigerant in the volume portion of the hole 91b is not discharged from the first cylinder 55. As a result, the hole 91b becomes a dead volume, which reduces the volumetric efficiency and reduces the efficiency of the compressor. Then, setting the range of $t3 \leq t1 < t2$ reduces the dead volume of the hole 91b, and prevents the efficiency of the compressor 2 from lowering.

[0059] In addition, the medium-pressure flow path 75 made by the recessed portions 91a and 92a is placed on the mating surface of the partition plate 56, improving the degree of freedom in the flow path placement inside and outside the compressor 2.

[0060] If the plate thickness of the first partition plate half body 91 and the second partition plate half body 92 are the same, the mating surface between the first partition plate half body 91 and the second partition plate half body 92 is located substantially in the center in the up-down direction of the partition plate 56. Here, the mating surface between the first partition plate half body 91 and the second partition plate half body 92 may be placed below the substantial center in the up-down direction of the partition plate 56, as shown by a two-dot chain line MP1 in Figs. 1 and 4. For example, there may be a configuration such that: the plate thickness of the second partition plate half body 92 is thinned in the up-down direction so that the thickness is uniform and the recessed portion 92a is eliminated; while the plate thickness of the first partition plate half body 91 is thickened in the up-down direction so that a deeper recessed portion 91a is provided only in the first partition plate half body 91. In this case, the depth of the recessed portion 91a just needs to be equal to the depth of the recessed portions 91a plus 92a when recessed portions 91a and 92a are respectively provided in the first partition plate half body 91 and the second partition plate half body 92.

[0061] Alternatively, the rigidity of the second partition plate half body 92 can be further improved by placing the mating surface between the first partition plate half body 91 and the second partition plate half body 92 above the substantial center of the partition plate 56 in the up-down direction, as shown by a two-dot chain line MP2 in Figs. 1 and 4. For example, there may be a configuration such that: the plate thickness of the first partition plate half body 91 is thinned in the up-down direction so that the thickness is uniform and the recessed portion 91a is eliminate; while the plate thickness of the second partition plate half body 92 is thickened in the up-down direction so that a deeper recessed portion 92a is provide only in the second partition plate half body 92. In this case, the depth of the recessed portion 92a just needs to be equal to the depth of the recessed portions 91a plus 92a when recessed portions 91a and 92a are respectively provided in the first partition plate half body 91 and the second partition plate half body 92. This further improves the rigidity of the second partition plate half body 92 that closes the second compression chamber 62.

[0062] In other words, the partition plate 56 just needs to have a recessed portion that defines the medium-pressure flow path 75 in at least one of the first partition plate half body 91 and the second partition plate half body 92. In other words, the partition plate 56 just needs to have at least one of the recessed portions 91a and 92a.

[0063] Fig. 5 is a vertical cross-sectional view of another embodiment of a partition plate of a compressor according to the embodiment of the present invention.

[0064] As shown in Fig. 5, the partition plate 56A may include a second partition plate half body 92 thicker than the first partition plate half body 91, and may have a recessed portion 92a of the second partition plate half body 92 recessed deeper than the recessed portion 91a of the first partition plate half body 91. The partition plate 56A configured in this manner can have sufficient rigidity even when the pressure on the high stage side is higher.

[0065] Note that the compression mechanism and its components including the first cylinder 55, first eccentric portion 51, first roller 63, and first blade 65 disposed on the upper side may be called with "low-pressure side" instead of "first". Contrarily, the compression mechanism and its components including the second cylinder 57, second eccentric portion 52, second roller 64, and second blade 66 disposed on the lower side may be called with "high-pressure side" instead of "second". For example, the first cylinder 55 is called the low-pressure side cylinder 55, and the second cylinder 57 is called the high-pressure side cylinder 57. The compression mechanism disposed above may be called a low-stage side compression mechanism, and the compression mechanism disposed below may be called a high-stage side compression mechanism.

[0066] The intermediate pipe 13 includes an upstream intermediate pipe 13u connecting the first compression chamber 61 to the external muffler 39, a midway pipe 13m connecting the external muffler 39 to the intercooler 41, and a downstream intermediate pipe 13d connecting the intercooler 41 to the second compression chamber 62.

[0067] The upstream intermediate pipe 13u guides the medium-pressure refrigerant gas discharged from the first compression chamber 61 to the outside of the sealed container 16.

[0068] The downstream intermediate pipe 13d joins the second refrigerant pipe 9 outside the sealed container 16. The pipe downstream of the junction of the downstream intermediate pipe 13d and the second refrigerant pipe 9 doubles as the second refrigerant pipe 9 and the downstream intermediate pipe 13d. The downstream intermediate pipe 13d guides the medium-pressure refrigerant gas discharged from the external muffler 39 and passing through the intercooler 41 to the second compression chamber 62 inside the sealed container 16.

[0069] The compressor 2 may include a second external muffler 101 provided on the suction side of the second compression chamber 62 in addition to the external muffler 39 provided on the discharge side of the first compression chamber 61. The external muffler 39 reduces pressure pulsation of the medium-pressure refrigerant gas discharged from the first compression chamber 61. The reduction in pressure pulsation reduces vibration of the intermediate pipe 13 excited by the refrigerant gas flowing downstream from the external muffler 39. The second external muffler 101 is connected to the pipe that doubles as the second refrigerant pipe 9 and the downstream intermediate pipe 13d. The second external muffler 101 reduces pressure pulsation of the medium-pressure refrigerant gas sucked into the second compression chamber 62. The reduction in pressure pulsation reduces vibration of the intermediate pipe 13 and the compressor 2, as well as ambient noise, ensuring reliability.

[0070] The cylinders 55 and 57, rollers 63 and 64, and eccentric portion 48 of the crankshaft 19 will be further described below.

[0071] The height of the first cylinder 55 is substantially the same as the height of the first compression chamber 61. The height of the second cylinder 57 is substantially the same as the height of the second compression chamber 62. The heights of the first compression chamber 61 and the second compression chamber 62 are the same. The inner diameter dimension D1 of the first compression chamber 61 is larger than the inner diameter dimension D2 of the second compression chamber 62. The volume of the first compression chamber 61 is larger than the volume of the second compression chamber 62.

[0072] In plan view, the inner wall surface of the first compression chamber 61 with inner diameter dimension D1 and the inner wall surface of the second compression chamber 62 with inner diameter dimension D2 are provided inside the inner wall surface of the medium-pressure flow path 75 provided in the partition plate 56. The inner wall surface of the medium-pressure flow path 75 provided in the partition plate 56 includes, for example, a surface parallel to the rotation center line C.

[0073] As shown in Fig. 2, the first eccentric portion 51 of the crankshaft 19 is eccentric from the rotation center line C by a first eccentric length L1. In other words, the first eccentric length L1 of the first eccentric portion 51 is the length from the rotation center line C to the center of the first eccentric portion 51. As shown in Fig. 3, the second eccentric portion 52 of the crankshaft 19 is eccentric from the rotation center line C by a second eccentric length L2. In other words, the second eccentric length L2 of the second eccentric portion 52 is the length from the rotation center line C to the center of the second eccentric portion 52. The second eccentric length L2 is preferably smaller than the first eccentric length L1. The first eccentric portion 51 and the second eccentric portion 52 are eccentric with a phase difference of 180 degrees, and Figs. 2 and 3 show the state of the eccentric portions at the same timing.

[0074] The center of the first roller 63 coincides with the center of the first eccentric portion 51. The first roller 63 rotates with an eccentricity of the first eccentric length L1 from the rotation center line C. The center of the second roller 64 coincides with the center of the second eccentric portion 52. The second roller 64 rotates with an eccentricity of the second eccentric length L2 from the rotation center line C.

[0075] The suction space S1 of the compression chamber 61 (62) defined by the blade 65 (66) and the roller 63 (64) is a space from the surface of the blade 65 (66) on the rotational direction R1 side to the contact point between the roller 63 (64) and the inner wall surface of the compression chamber 61 (62). The compression space S2 is a space from the surface of the blade 65 (66) on the counter-rotational direction R2 side to the contact point between the roller 63 (64) and the inner wall surface of the compression chamber 61 (62). In other words, in the spaces defined by the blade 65 (66) and the roller 63 (64) in the cylinder 55 (57), the space connected to the suction portion 68 (71) is the suction space S1, and the space connected to the discharge portion 69 (72) is the compression space S2. For example, when the roller 63 (64) is positioned toward the blade 65 (66), the spaces connected to the suction portion 68 (71) and the discharge portion 69 (72) have no distinction between the suction space S1 and the discharge space S2.

[0076] Fig. 6(a) is a cross-sectional view taken along a line B-B' in Fig. 3, and Fig. 6(b) is a partial cross-sectional view taken along a line D-D' in Fig. 6(a). Fig. 6(a) omits the second eccentric portion 52, the second roller 64, and the second blade 66.

[0077] As shown in Fig. 3 and Fig. 6, the second cylinder 57 has a groove 104 between the second blade 66 and the second suction portion 71. The groove 104 is placed to be adjacent to the second blade 66 on the side in the rotational direction R1. The groove 104 extends along the inner wall surface of the second compression chamber 62 from the rotational direction R1 side of the second blade 66 to the counter-rotational direction R2 side of the second suction portion 71. The edge of the groove 104 on the rotational direction side is connected to the second suction portion 71. The groove 104 is provided by recessing the upper part of the inner wall surface of the second compression chamber 62 toward the outside.

[0078] The suction operation and compression operation of the refrigerant in the compression chambers 61 and 62 will be described below.

[0079] The roller 63 (64) of the compression mechanism unit 18 rotates within the compression chamber 61 (62) of the cylinder 55 (57) by the rotational power of the electric motor unit 17. The suction space S1 of the compression chamber 61 (62) is expanded when the roller 63 (64) located at the orientation of the blade 65 (66) starts rotating in the rotational direction R1, and the refrigerant flows in from the suction portion 68 (71). When the roller 63 (64) located at the orientation of the blade 65 (66) starts rotating in the rotational direction R1, the compression space S2 is reduced to compress the refrigerant within the compression space S2 and discharge the compressed refrigerant gas from the discharge portion 69 (72).

[0080] The suction start angle α at which the suction of the refrigerant starts in the suction space S1 is a displacement angle from when the roller 63 (64) located at the orientation of the blade 65 (66) starts rotating in the rotational direction R1 to when the refrigerant starts flowing in from the suction portion 68 (71). The suction start angle $\alpha 1$ of the first compression chamber 61 is the angle between the center line of the first blade 65 and the center line of the first suction portion 68 when the first compression chamber 61 is viewed from above. The suction start angle $\alpha 2$ of the second compression chamber 62 is the angle between the center line of the second blade 66, and a line connecting the end portion of the groove 104 on the second blade 66 side and the rotation center line C, when the second compression chamber 62 is viewed from above. The suction start angle $\alpha 1$ of the first compression chamber 61 and the suction start angle $\alpha 2$ of the second compression chamber 62 are substantially the same.

[0081] While the roller 63 (64) rotates from the orientation of the suction portion 68 (71) in the rotational direction R1 to the orientation of the discharge portion 69 (72), the refrigerant flows into the suction space S1 communicating with the suction portion 68 (71).

[0082] In other words, in the first cylinder 55, while the roller 63 rotates from the orientation of the blade 65 to the suction start angle $\alpha 1$ - $\beta 1$, there is no distinction between the suction space S1 and the discharge space S2. While the roller 63 rotates in the rotational direction R1 from the position at the angle $\alpha 1$ (= $\beta 1$), which is the orientation of the suction portion 68, to the discharge portion 69, the refrigerant flows into the suction space S1, which communicates with the suction portion 68.

[0083] In addition, in the second cylinder 57, while the roller 64 rotates from the orientation of the blade 66 to the compression start angle $\beta 2$, there is no distinction between the suction space S1 and the discharge space S2. While the roller 64 rotates in the rotational direction R1 from the position at the angle $\beta 2$, which is the orientation of the suction portion 71, to the discharge portion 72, the refrigerant flows into the suction space S1, which communicates with the suction portion 71.

[0084] The compression start angle β at which the compression of the refrigerant starts in the compression space S2 is a central angle between the following two radiuses: a radius connecting the rotational center line C and the center position of the roller 63 (64) at the orientation of the blade 65 (66); and a radius connecting the rotational center line C and the center position of the roller 63 (64) when having rotated in the rotational direction R1 to start compression of the refrigerant. The compression start angle $\beta 1$ of the first compression chamber 61 is the angle between the center line of the first blade 65 and the center line of the first suction portion 68 when the first compression chamber 61 is viewed from above. The compression start angle $\beta 2$ of the second compression chamber 62 is the angle between the center line of the second blade 66 and the center line of the second suction portion 71 when the second compression chamber 62 is viewed from above. The compression start angle $\beta 2$ of the second compression chamber 62 is larger than the compression start angle $\beta 1$ of the first compression chamber 61.

[0085] While the roller 63 (64) rotates from the orientation of the blade 65 (66) to the compression start angle β, that is, while the roller 63 (64) rotates β degrees from the orientation of the blades 65 (66), the compression space S2 is connected to the suction portion 68 (71). Here, in the compression space S2 of the second compression chamber 62, the compression space S2 is connected to the second suction portion 71 and groove 104. Therefore, the refrigerant flows out to the suction portion 68 (71) and is not compressed substantially. Here, in the compression space S2 of the second compression chamber 62, the refrigerant flows out to the second suction portion 71 and the groove 104. While the roller 63 (64) rotates from the orientation of the suction portion 68 (71) to the orientation of the blade 65 (66), that is, while the roller 63 (64) rotates (360 - β) degrees from the suction portion 68 (71), the compression space S2 is not connected to the suction portion 68 (71). Here, in the compression space S2 of the second compression chamber 62, the compression space S2 is not connected to the second suction portion 71 and the groove 104. Therefore, the refrigerant is compressed. At this time, when the pressure in the compression space S2 rises to a predetermined pressure, the discharge hole of the discharge valve 76 (81) is opened and the refrigerant at the predetermined pressure is discharged from the discharge portion 69 (72).

[0086] When the roller 63 (64) have rotated (360 - β) degrees in this way and are positioned in the orientation of the blade 65 (66), the volume of the compression space S2 becomes zero and the discharge of all the refrigerant within the compression space S2 is completed. The excluded volume of refrigerant discharged from the discharge portion 69 (72) of the compression space S2 when the roller 63 (64) in the orientation of the blade 65 (66) has made one rotation is set by the volume of the compression chamber 61 (62), the outer diameter dimension d1 (d2) of the roller 63 (64), the height of the cylinder 55 (57), and the compression start angle β. For this reason, the excluded volume of the first compression chamber 61 is set larger than the excluded volume of the second compression chamber 62, effectively improving the compression efficiency of the compressor 2.

[0087] As shown in Fig. 6(a) and Fig. 6(b), the groove 104 is provided by recessing only the upper part of the inner wall surface of the second compression chamber 62 toward the outside. However, the groove 104 is not limited to this as long as it is connected to the second suction portion 71.

[0088] Fig. 7(a) is a cross-sectional view showing a modified embodiment of the groove in the embodiment of the present invention, and Fig. 7(b) is a partial cross-sectional view taken along a line E-E' in Fig. 7 (a) .

[0089] Fig. 8(a) is a cross-sectional view showing a modified embodiment of the groove in the embodiment of the present invention, and Fig. 8(b) is a partial cross-sectional view taken along a line F-F' in Fig. 8 (a) .

[0090] Fig. 9(a) is a cross-sectional view showing a modified embodiment of the groove in the embodiment of the present invention, and Fig. 9(b) is a partial cross-sectional view taken along a line G-G' in Fig. 9(a). Fig. 7(a), Fig. 8(a), and Fig. 9(a) are cross-sectional views of the same portion as Fig. 6(a), omitting the second eccentric portion 52, the second roller 64, and the second blade 66.

[0091] As shown in Fig. 7(a) and Fig. 7(b), a groove 104e, which is a modified embodiment of the groove 104, may be provided by recessing at least one of the upper and lower parts of the inner wall surface of the second compression chamber 62 toward the outside. As shown in Fig. 8(a) and Fig. 8(b), a groove 104f, which is a modified embodiment of the groove 104, may be provided by recessing only the intermediate part between the upper and lower parts of the inner wall surface of the second compression chamber 62 toward the outside. Furthermore, the cross-sectional shapes of these grooves 104, 104e, and 104f are each a stepped shape in which the inner wall surface of the second compression chamber 62 is recessed toward the outside, but are not limited to this. For example, as shown in Fig. 9(b), the cross-sectional shape of groove 104g, which is a modified embodiment of the groove 104, may be tapered.

[0092] Furthermore, the groove 104 extends along the inner wall surface of the second compression chamber 62 from the rotational direction R1 side of the second blade 66 to the second suction portion 71, but is not limited to this. It is sufficient that the groove 104 be connected to the second suction portion 71 and the compression start angle $\beta2$ can be set larger than the compression start angle $\beta1$ of the first compression chamber 61. For example, the groove 104 may extend along at least one of the rotational direction R1 side and the counter-rotational direction R2 side of the second suction portion 71. In this case, it is preferable to set the suction start angle $\alpha2$ to substantially the same angle as suction start angle $\alpha1$ of the first compression chamber 61. To realize that, it is sufficient that, for example, the second suction portion 71 be disposed to be adjacent to the second blade 66 on the rotational direction side, and the groove 104 be disposed to be adjacent to the second suction portion 71 on the rotational direction side and extend in the rotational direction R1.

[0093] As described above, the refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment include the compression mechanism unit 18 having the low-pressure side cylinder 55 including the low-pressure side compression chamber 61 and the high-pressure side cylinder 57 including the high-pressure side compression chamber 62. The height of the low-pressure side compression chamber 61 is the same as the height of the high-pressure side compression chamber 62, and the inner diameter dimension D1 of the low-pressure side compression chamber 61 is larger than the inner diameter dimension D2 of the high-pressure side compression chamber 62. Therefore, the volume of the high-pressure side compression chamber 62 is smaller than the volume of the low-pressure side compression chamber 61, and the excluded volume of the high-pressure side compression chamber 62 is smaller than the excluded volume of the low-pressure side compression chamber 61. This improves the compression efficiency of the compressor 2 of multi-stage compression. The heights of the cylinders 55 and 57 are the same, and the difference in volume between the cylinders 55 and 57 is not set by the difference in height. The difference in volume is set by the difference in the inner diameter dimensions of the compression chambers 61 and 62. Therefore, the height dimensions of the blades 65 and 66 are substantially uniform. The operation of the blades 65 and 66, which have a uniform height, is easier to stabilize. Furthermore, the compression mechanism unit 18 is downsized mainly in the height direction.

[0094] The refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment include the crankshaft 19 having: the low-pressure side eccentric portion 51 eccentric from the central axis of the sealed container 16 by the first eccentric length L1; and the high-pressure side eccentric portion 52 eccentric from the central axis of the sealed container 16 by the second eccentric length L2. The first eccentric length L1 of the low-pressure side eccentric portion 51 is larger than the second eccentric length L2 of the high-pressure side eccentric portion 52. Therefore, the outer diameter of the low-pressure side roller 63 that fits into the low-pressure side eccentric portion 51 is smaller, and the excluded volume of the low-pressure side compression chamber 61 is larger. The outer diameter of the high-pressure side roller 64 that fits into the high-pressure side eccentric portion 52 is larger, and the excluded volume of the high-pressure side compression chamber 62 is smaller. Therefore, the compression efficiency of the compressor 2 is further improved, and the compression mechanism unit 18 is prevented from expansion.

[0095] Furthermore, in the refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment, the compression start angle β2 of the high-pressure side compression chamber 62 is set larger than the compression start angle β1 of the low-pressure side compression chamber 61. Therefore, the excluded volume of the high-pressure side compression chamber 62 is smaller. This further improves the compression efficiency of the compressor 2, and the compression mechanism unit 18 is prevented from expansion.

[0096] The refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment include the high-pressure side cylinder 57 having the groove 104 that is provided on the wall surface defining the high-pressure side compression chamber 62 and is connected to the high-pressure side suction portion 71 of the high-pressure side compression chamber 62. This allows the suction start angle α2 of the suction space S1 of the high-pressure side compression chamber 62 to be set small, and the compression start angle β2 of the compression space S2 thereof to be set large. This further improves the compression efficiency of the compressor 2, and the compression mechanism unit 18 is prevented from expansion.

[0097] Furthermore, the refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment include the compression mechanism unit 18 having the partition plate 56 provided between the low-pressure side cylinder 55 and the high-pressure side cylinder 57 of the compression mechanism unit 18. The partition plate 56 and the high-pressure side cylinder 57 have the medium-pressure flow path 75. The medium-pressure flow path 75 connects the low-pressure side discharge portion 69 of the low-pressure side compression chamber 61 to the high-pressure side suction portion 71 of the high-pressure side compression chamber 62. Therefore, the compression mechanism unit 18 is prevented from expansion by efficiently providing the medium-pressure flow path 75.

[0098] Furthermore, the partition plate 56 of the refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment has the first partition plate half body 91 and the second partition plate half body 92 that is stacked under the first partition plate half body 91. The partition plate 56 is provided with part of the medium-pressure flow path 75, that is, recessed portions 91a and 92a, on the mating surface between the first partition plate half body 91 and the second partition plate half body 92. Therefore, part of the medium-pressure flow path 75 is efficiently formed in the partition plate 56, improving the degree of freedom in flow path placement. In addition, the second partition plate half body 92, which has a lower part of the part of the medium-pressure flow path 75, has a larger thickness than the first partition plate half body 91, which has an upper part of the part of the medium-pressure flow path 75. This optimizes the rigidity of the partition plate 56 and suppresses refrigerant leakage.

[0099] In the refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment, the medium-pressure flow path 75 of the partition plate 56 is connected to the discharge portion 69 of the low-pressure side compression chamber 61, and the medium-pressure flow path 75 of the high-pressure side cylinder is connected to the medium-pressure flow path 75 of the partition plate 56 and is disposed outside the high-pressure side compression chamber 62. Therefore, the compression mechanism unit 18 is prevented from expansion by efficiently providing the medium-pressure flow path 75.

[0100] Furthermore, the refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment include the intermediate pipe 13 provided outside the sealed container 16. The medium-pressure flow path 75 is connected to the high-pressure side suction portion 71 of the high-pressure side compression chamber 62 via the intermediate pipe 13. Therefore, the medium-pressure flow path 75 can be connected to the high-pressure side suction portion 71 of the high-pressure side compression chamber 62 through the intermediate pipe 13.

[0101] Therefore, according to the refrigeration cycle apparatus 1 and the compressor 2 of the present embodiment, the multi-stage compression mechanism unit 18 can be prevented from decrease in the reliability and can be downsized.

[0102] Although several embodiments of the present invention have been described, these embodiments are presented as examples and are not intended to limit the scope of the invention. These novel embodiments can be embodied in various other forms, and various omissions, substitutions, and modifications can be made without departing from the gist of the invention. These embodiments and their modifications are included within the scope and gist of the invention, and are included in the scope of the invention and its equivalents as set forth in the claims.

REFERENCE SIGNS LIST

[0103] 1... refrigeration cycle apparatus, 2... compressor, 3... heat radiator, 4... first expansion device, 5... second expansion device, 6... heat absorber, 7... accumulator, 8... first refrigerant pipe, 9... second refrigerant pipe, 12... outlet pipe, 13... intermediate pipe, 13u... upstream intermediate pipe, 13m... midway pipe, 13d... downstream intermediate pipe, 16... sealed container, 17... electric motor unit, 18... compression mechanism unit, 19... crankshaft, 21... main bearing, 22... auxiliary bearing, 23... frame, 26... body portion, 27... head plate, 28... bottom plate, 31... discharge pipe, 32... terminal block, 35... suction end portion, 36... intermediate discharge end portion, 37... intermediate suction end portion, 38... fixing device, 39... external muffler, 41... intercooler, 43... stator, 44... rotor, 45... outlet wire, 47... main shaft portion, 48... eccentric portion, 49... auxiliary shaft portion, 51... first eccentric portion, 52... second eccentric portion, 55... first cylinder, 56... partition plate, 57... second cylinder, 59... fastening member, 61... first compression chamber, 62... second compression chamber, 63... first roller, 64... second roller, 65... first blade, 66... second blade, 68... first suction portion, 69... first discharge portion, 71... second suction portion, 72... second discharge portion, 75... medium-pressure flow path, 76... first discharge valve, 79... high-pressure flow path, 81... second discharge valve, 82... first discharge muffler, 83... second discharge muffler, 91... first partition plate half body, 91a... recessed portion, 91b... hole, 92... second partition plate half body, 92a... recessed portion, 92b... hole, 101... second external muffler, 104, 104e, 104f, 104g... groove, d1, d2... outer diameter dimension, D1, D2... inner diameter dimension, S1... suction space, S2... compression space, t1, t2... thickness.

Claims

1. A rotary compressor comprising:

> a sealed container having a central axis extending in an up-down direction;
> an electric motor unit provided within the sealed container;
> a crankshaft, having a low-pressure side eccentric portion and a high-pressure side eccentric portion, configured to be rotationally driven around the central axis by the electric motor unit, the low-pressure side eccentric portion being eccentric from the central axis of the sealed container by a first eccentric length, the high-pressure side eccentric portion being provided below the low-pressure side eccentric portion and being eccentric from the central axis by a second eccentric length; and
> a compression mechanism unit having a low-pressure side cylinder, a high-pressure side cylinder, and a partition plate provided between the low-pressure side cylinder and the high-pressure side cylinder, the low-pressure side cylinder having a low-pressure side compression chamber that compresses introduced gaseous refrigerant and discharges the compressed refrigerant gas by power of the low-pressure side eccentric portion, the high-pressure side cylinder having a high-pressure side compression chamber that compresses the refrigerant discharged from the low-pressure side compression chamber by power of the high-pressure side eccentric portion, wherein
> a height of the low-pressure side compression chamber is a same as a height of the high-pressure side compression chamber, and
> an inner diameter dimension of the low-pressure side compression chamber is larger than an inner diameter dimension of the high-pressure side compression chamber.

2. The rotary compressor according to claim 1, wherein the first eccentric length is larger than the second eccentric length.

3. The rotary compressor according to claim 1 or 2, wherein a compression start angle of the high-pressure side compression chamber is larger than a compression start angle of the low-pressure side compression chamber.

4. The rotary compressor according to any one of claims 1 to 3, wherein the high-pressure side cylinder has a groove, the groove being provided on a wall surface defining the high-pressure side compression chamber, the groove being connected to a suction portion of the high-pressure side compression chamber.

5. The rotary compressor according to any one of claims 1 to 4, wherein

> the partition plate and the high-pressure side cylinder have a medium-pressure flow path, and the medium-pressure flow path connects a discharge portion of the low-pressure side compression chamber and a suction portion of the high-pressure side compression chamber.

6. The rotary compressor according to claim 5, wherein

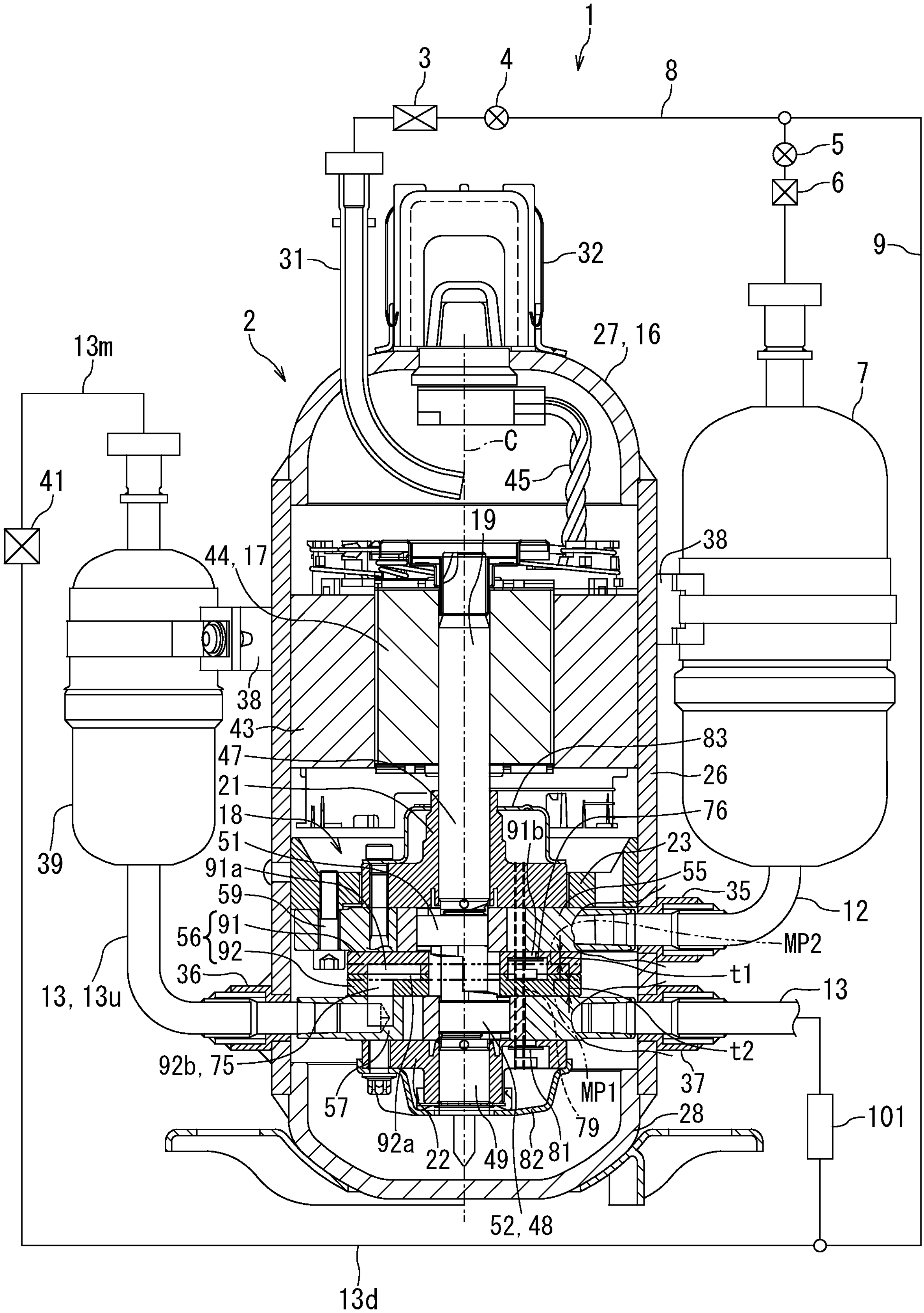
> the partition plate has a first partition plate half body and a second partition plate half body stacked below the first partition plate half body, and part of the medium-pressure flow path is provided on a mating surface of the first partition plate half body and the second partition plate half body, and
> the second partition plate half body has a larger thickness than the first partition plate half body, the second partition plate half body having a lower part of the part of the medium-pressure flow path, the first partition plate half body having an upper part of the part of the medium-pressure

flow path.

7. The rotary compressor according to claim 5 or 6, further comprising an intermediate pipe provided outside the sealed container,
wherein the medium-pressure flow path is connected to a suction portion of the high-pressure side compression chamber via the intermediate pipe.

8. A refrigeration cycle apparatus comprising:

a rotary compressor according to any one of claims 1 to 7;
a heat radiator;
an expansion device;
a heat absorber; and
a refrigerant pipe that connects the rotary compressor, the heat radiator, the expansion device, and the heat absorber, to allow the refrigerant to circulate.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101
C
MP1
MP2
t1
t2

FIG. 1

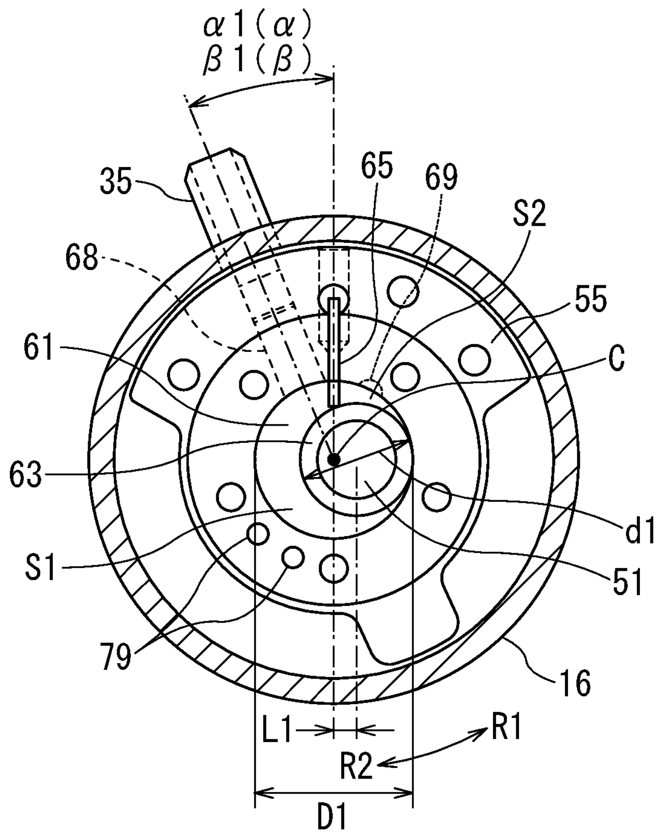

α1(α)
β1(β)
35
65
69
S2
68
55
61
C
63
d1
S1
51
79
16
L1
R1
R2
D1

FIG. 2

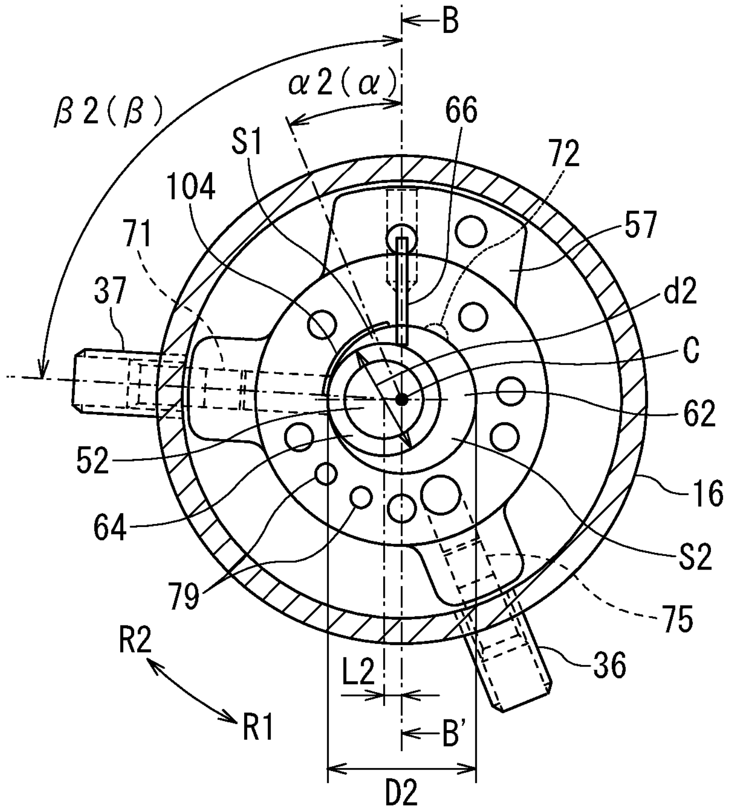

B
β2(β)
α2(α)
66
S1
72
104
57
71
d2
37
C
62
52
16
64
S2
79
75
R2
36
L2
R1
B'
D2

FIG. 3

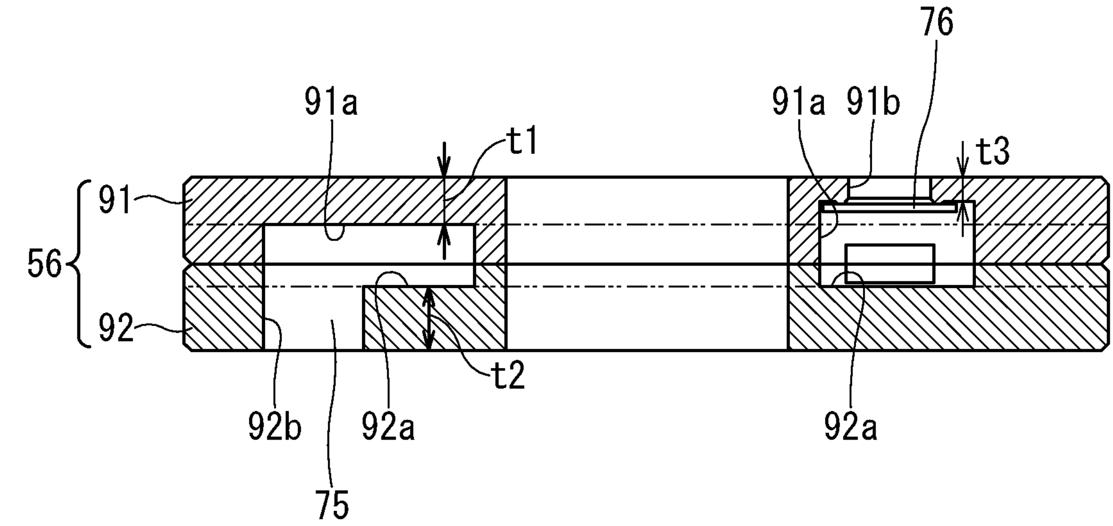

76
91a
91a 91b
t1
t3
91
56
92
t2
92b
92a
92a
75

FIG. 4

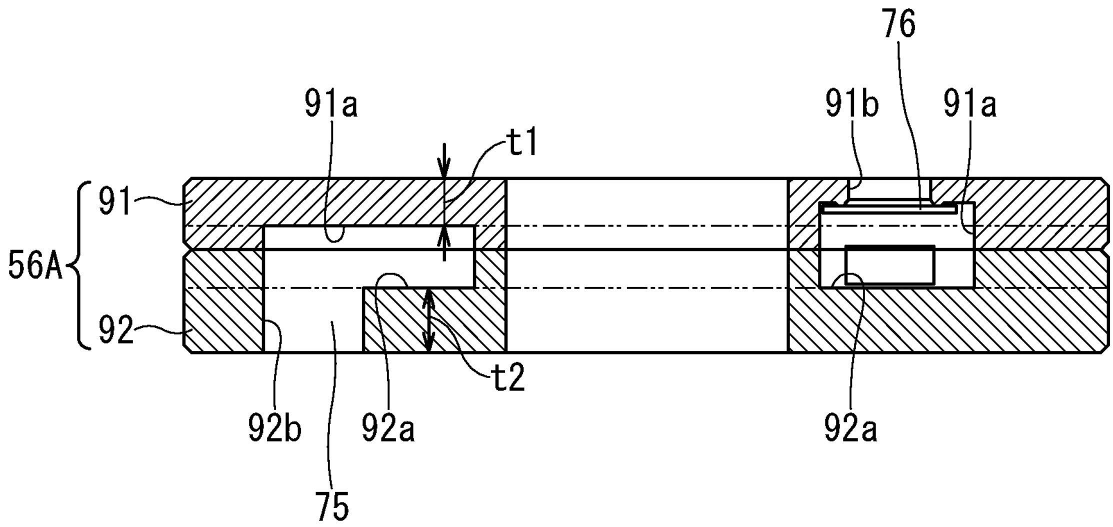

76
91a
91b
91a
t1
91
56A
92
t2
92b
92a
92a
75

FIG. 5

FIG. 6A

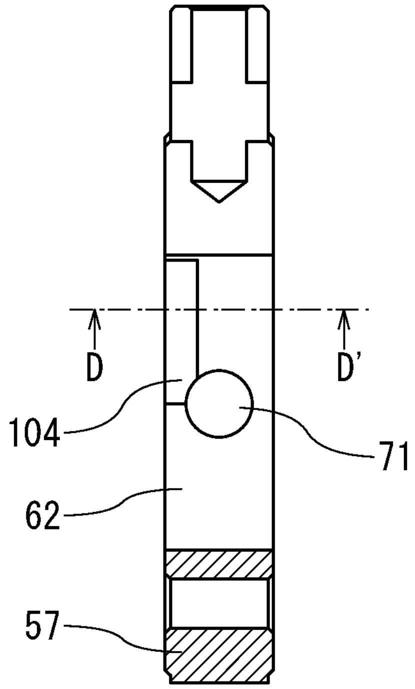


FIG. 6B

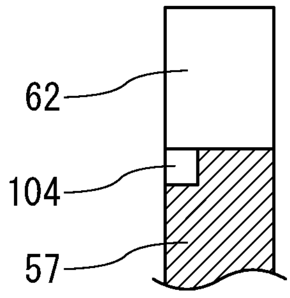


FIG. 7A

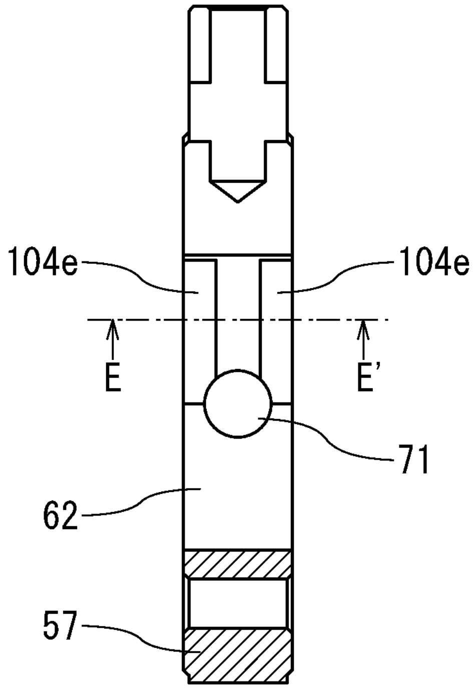


FIG. 7B

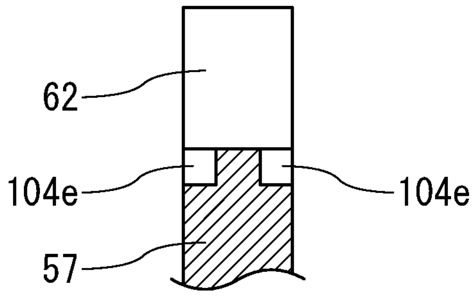


FIG. 8A

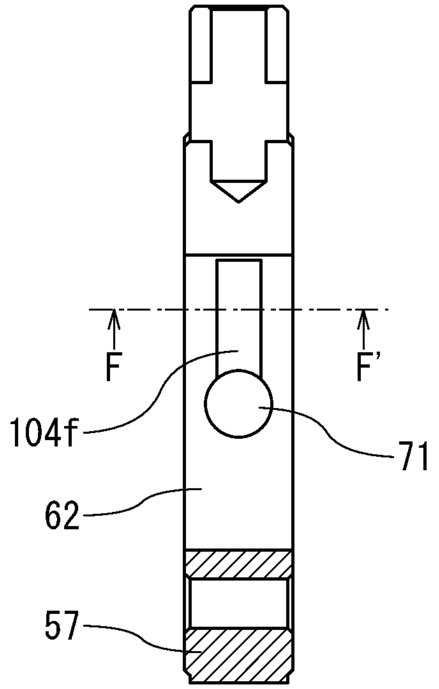


FIG. 8B

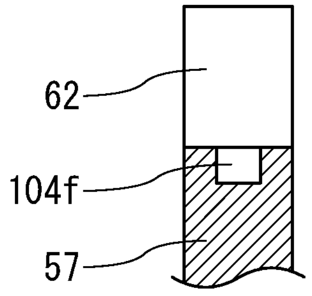


FIG. 9A

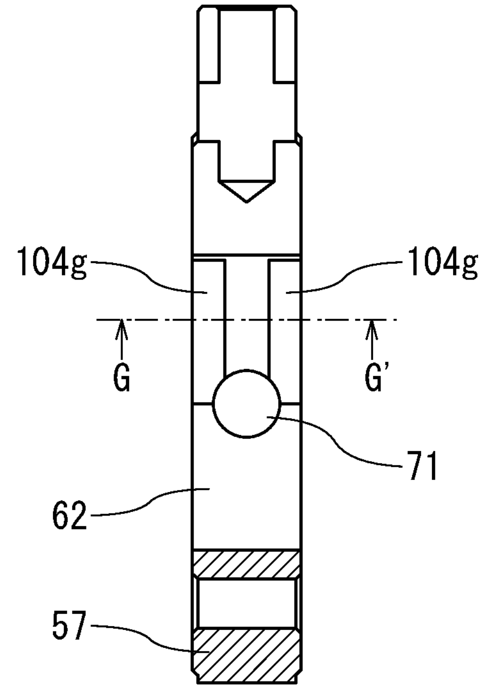
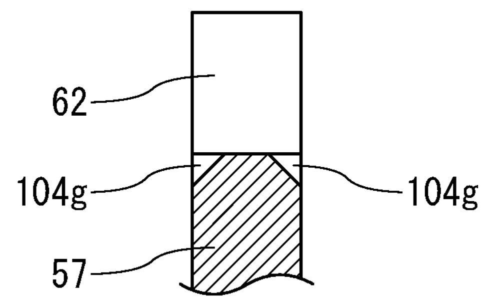


FIG. 9B



INTERNATIONAL SEARCH REPORT

International application No. **PCT/JP2022/014438**

A. CLASSIFICATION OF SUBJECT MATTER

F04C 18/356(2006.01)i; ***F04C 23/00***(2006.01)i
FI: F04C18/356 H; F04C23/00 F

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)

F04C18/356; F04C23/00

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 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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.
X Y	JP 2006-226179 A (SANYO ELECTRIC CO., LTD.) 31 August 2006 (2006-08-31) paragraphs [0015]-[0053], fig. 1-5	1 2-8
Y	JP 2004-084568 A (SANYO ELECTRIC CO., LTD.) 18 March 2004 (2004-03-18) paragraphs [0003], [0021]-[0025], fig. 4, 5	2–4
Y	WO 2021/033283 A1 (TOSHIBA CARRIER CORP.) 25 February 2021 (2021-02-25) paragraphs [0010], [0050]-[0052], [0094], fig. 1, 5	5-8
A	JP 63-272988 A (TOSHIBA CORP.) 10 November 1988 (1988-11-10) p. 3, upper right column, line 18 to lower left column, line 20, fig. 1, 2	1

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

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Date of the actual completion of the international search	Date of mailing of the international search report
19 April 2022	**10 May 2022**

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

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/014438

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2006-226179 A	31 August 2006	US 2006/0182646 A1 paragraphs [0021]-[0059], fig. 1-5 EP 1703134 A2 KR 10-2006-0092045 A CN 1821576 A ES 2384502 T3 TW 200630540 A	
JP 2004-084568 A	18 March 2004	US 2004/0071576 A1 paragraphs [0019], [0121]-[0125], fig. 12, 13 EP 1429030 A2 KR 10-2004-0019251 A CN 1487199 A ES 2387822 T3	
WO 2021/033283 A1	25 February 2021	(Family: none)	
JP 63-272988 A	10 November 1988	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2021033283 A **[0004]**