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(72) Inventors:
• **HATAYAMA, Masahiro**
Fuji-shi, Shizuoka 416-8521 (JP)
• **Jafet Ferdhy Monasry**
Fuji-shi, Shizuoka 416-8521 (JP)

(74) Representative: **Gramm, Lins & Partner**
Patent- und Rechtsanwälte PartGmbB
Frankfurter Straße 3c
38122 Braunschweig (DE)

(71) Applicant: **Carrier Japan Corporation**
Tokyo 141-0032 (JP)

(54) ROTARY COMPRESSOR AND REFRIGERATION CYCLE DEVICE

(57) A rotary compressor and a refrigeration cycle apparatus are provided that: can reliably reduce pressure pulsation and vibration in an intermediate pipe connecting a discharge side of a low-stage compression mechanism and a suction side of a high-stage compression mechanism; and can downsize the apparatus including a muffler. A rotary compressor (2) includes: a first cylinder (55) having a first compression chamber (61) that compresses introduced low-pressure refrigerant gas to medium pressure and discharges the compressed refrigerant gas; a second cylinder (57) having a second compression chamber (62) that compresses introduced medium-pressure refrigerant gas; an upstream intermediate pipe (13u) guiding the medium-pressure refrigerant gas, discharged from the first compression chamber (61), to an outside of the sealed container (16); and an external muffler (39) connected to the upstream intermediate pipe (13u). Relationship between outlet area S1 of the upstream intermediate pipe (13u) and flow path cross-sectional area S2 of the external muffler (39) is $0.01 \leq (S1 \div S2) \leq 0.04$.

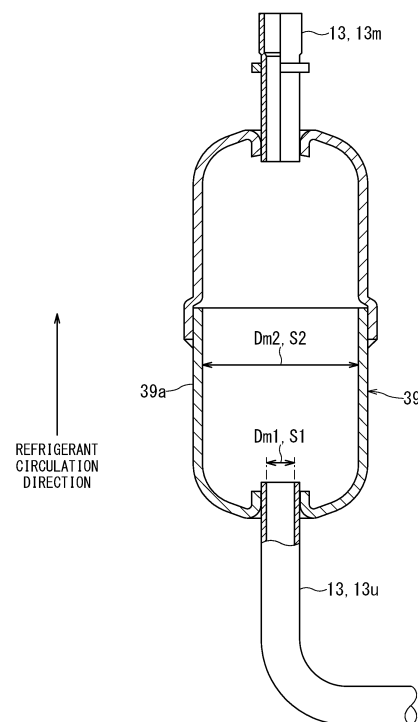


FIG. 6

Description

TECHNICAL FIELD

[0001] An embodiment of the present invention relates to a rotary compressor and a refrigeration cycle apparatus.

BACKGROUND

[0002] A compressor is known that includes an upstream intermediate pipe connecting the discharge side of a low-stage compression mechanism to an intermediate cooler, a first muffler connected to the upstream intermediate pipe, a downstream intermediate pipe connecting the intermediate cooler to the suction side of a high-stage compression mechanism, and a second muffler connected to the downstream intermediate pipe. The compressor is a two-stage compressor in which a fluid compressed by the low-stage compression mechanism is further compressed by the high-stage compression mechanism. The first muffler reduces pressure pulsation and vibration on the discharge side of the low-stage compression mechanism, preventing a decrease in operation efficiency due to pressure pulsation. The second muffler reduces pressure pulsation and vibration on the suction side of the high-stage compression mechanism, preventing a decrease in operation efficiency due to pressure pulsation.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0003] Patent Document 1
Japanese Patent Laid-Open No. 2010-065562

SUMMARY

PROBLEMS TO BE SOLVED BY INVENTION

[0004] In size and sizing of the muffler, larger is not always better. A too large muffler makes it difficult to install the compressor in the desired installation location. However, a too small muffler may not be able to sufficiently reduce the pressure pulsation in the intermediate pipe.

[0005] In addition, the effectiveness of the muffler in reducing pressure pulsation is affected not only by the size of the muffler, but also by the inner diameter of the intermediate pipe connected to the muffler.

[0006] Therefore, an object of the present invention is to provide a rotary compressor and a refrigeration cycle apparatus that: can reliably reduce pressure pulsation and vibration in an intermediate pipe connecting a discharge side of a low-stage compression mechanism and a suction side of a high-stage compression mechanism; and can downsize the apparatus including a muffler as a

whole, in a multi-stage compressor in which a fluid compressed by the low-stage compression mechanism is further compressed by the high-stage compression mechanism.

MEANS FOR SOLVING PROBLEM

[0007] In order to solve the above problems, a rotary compressor according to an embodiment of the preset invention includes: a sealed container having a center line 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, and being rotationally driven by the electric motor unit, the low-pressure side eccentric portion being eccentric from a rotation center line, the high-pressure side eccentric portion being provided below the low-pressure side eccentric portion and being eccentric from the rotation center line; a compression mechanism unit including a low-pressure side cylinder and a high-pressure side cylinder, the low-pressure side cylinder having a low-pressure side compression chamber that compresses introduced low-pressure refrigerant gas to medium pressure 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 introduced medium-pressure refrigerant gas by power of the high-pressure side eccentric portion; an upstream intermediate pipe configured to guide the medium-pressure refrigerant gas, discharged from the low-pressure side compression chamber, to an outside of the sealed container; a muffler connected to the upstream intermediate pipe; and a downstream intermediate pipe configured to guide the medium-pressure refrigerant gas, discharged from the muffler, to the high-pressure side compression chamber inside the sealed container, wherein relationship between outlet area S1 of the upstream intermediate pipe and flow path cross-sectional area S2 of the muffler is $0.01 \leq (S1 \div S2) \leq 0.04$.

[0008] The rotary compressor according to the embodiment of the present invention is preferably configured such that the muffler is provided next to the sealed container and has an elongated shape with a center line extending in an up-down direction, and a top portion of the muffler is lower than a top portion of the sealed container.

[0009] The rotary compressor according to the embodiment of the present invention is preferably configured such that a length of the muffler in an up-down direction is 1.5 times or more an inner diameter of the muffler.

[0010] The rotary compressor according to the embodiment of the present invention preferably further includes a fixing device that fixes the muffler to the sealed container.

[0011] The rotary compressor according to the embodiment of the present invention preferably further includes: an accumulator; and an outlet pipe configured

to guide the low-pressure refrigerant gas from the accumulator to the low-pressure side compression chamber inside the sealed container, wherein the muffler is tangent to or accommodated inside an imaginary circle, the imaginary circle being centered on the center line of the sealed container, encompassing the accumulator, and being circumscribed to the accumulator.

[0012] 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 refrigerant to circulate.

EFFECTS OF INVENTION

[0013] According to the present invention, it is possible to provide a rotary compressor and a refrigeration cycle apparatus that: can reliably reduce pressure pulsation and vibration in an intermediate pipe connecting a discharge side of a low-stage compression mechanism and a suction side of a high-stage compression mechanism; and can downsize the apparatus including a muffler as a whole, in a multi-stage compressor in which a fluid compressed by the low-stage compression mechanism is further compressed by the high-stage compression mechanism.

BRIEF DESCRIPTION OF DRAWINGS

[0014]

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 is a vertical cross-sectional view of an external muffler of the compressor according to the embodiment of the present invention.

Fig. 7 is a histogram showing relationship between the external muffler and an upstream intermediate pipe of the compressor according to the embodiment of the present invention.

Fig. 8 is a plan view of the compressor according to the embodiment of the present invention.

DETAILED DESCRIPTION

[0015] 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.

[0016] 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.

[0017] Fig. 2 is a cross-sectional plan view taken along a first cylinder of the compressor according to the embodiment of the present invention.

[0018] Fig. 3 is a cross-sectional plan view taken along a second cylinder of the compressor according to the embodiment of the present invention.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] 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 three-phase windings.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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 multi-stage 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.

[0031] 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.

[0032] 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.

[0033] 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)".

[0034] 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.

[0035] 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".

[0036] 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.

[0037] 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).

[0038] 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.

[0039] 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)".

[0040] 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.

[0041] 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.

[0042] 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.

[0043] 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)".

[0044] 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.

[0045] Fig. 4 is a vertical cross-sectional view of a partition plate of a compressor according to the embodiment of the present invention.

[0046] 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.

[0047] 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 t_2 of the bottom plate portion of the recessed portion 92a of the second partition plate half body 92 is thicker than the thickness t_1 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.

[0048] 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 t_2 of the bottom plate portion of the recessed portion 92a of the second partition plate half body 92 is made thicker than the thickness t_1 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.

[0049] Here, the suction pressure P_s of the first compression chamber 61, the medium pressure P_m dis-

charged 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 P_d of the second compression chamber 62 have a relationship of (suction pressure P_s) < (medium pressure P_m) < (discharge pressure P_d). During operation, the conditions $(P_d - P_m) > (P_m - P_s)$ always hold. Under these conditions, each pressure differs depending on the operating conditions. The medium pressure P_m changes according to the relationship $P_m = A / (P_d \times P_s)$.

[0050] Therefore, the surface pressure load of the differential pressure $(P_m - P_s)$ acts on the recessed portion 91a of the first partition plate half body 91, and the surface pressure load of the differential pressure $(P_d - P_m)$ acts on the recessed portion 92a of the second partition plate half body 92.

[0051] The first partition plate half body 91 and the second partition plate half body 92 have substantially the same thickness dimension while the thickness t_2 of the bottom plate portion of the second partition plate half body 92 is thicker than the thickness t_1 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.

[0052] 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.

[0053] The thickness t_3 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 t_1 . This makes it possible to reduce the volume of the hole 91b portion while ensuring the necessary rigidity against the pressure difference.

[0054] 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 $t_3 \leq t_1 < t_2$ reduces the dead volume of the hole 91b, and prevents the efficiency of the compressor 2 from lowering.

[0055] 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.

[0056] 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.

[0057] 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 eliminated; 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 provided 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.

[0058] 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.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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.

[0063] 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.

[0064] 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.

[0065] 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.

[0066] Fig. 6 is a vertical cross-sectional view of an

external muffler of a compressor according to an embodiment of the present invention.

[0067] As shown in Fig. 6 in addition to Fig. 1, the inner diameter D_{m1} of the outlet of the upstream intermediate pipe 13u of the compressor 2 according to the present embodiment is smaller than the inner diameter D_{m2} of the external muffler 39.

[0068] The upstream intermediate pipe 13u has a substantially constant inner diameter D_{m1} , and the flow path cross-sectional area of the upstream intermediate pipe 13u is equal to the outlet area $S1$ of the upstream intermediate pipe 13u.

[0069] The external muffler 39 is provided next to the sealed container 16. The shape of the external muffler 39 is longitudinal shape with a center line extending in the up-down direction, and has a shape similar to that of a cylindrical tank that defines a cylindrical space. The center line of the external muffler 39 and the center line of the sealed container 16 are parallel and extend vertically. The external muffler 39 has a body portion 39a with a substantially constant inner diameter D_{m2} . The flow path cross-sectional area $S2$ of the external muffler 39 is determined at the point of largest area in the longitudinal direction (up-down direction) of the external muffler 39.

[0070] The quotient obtained by dividing the outlet area $S1$ of the upstream intermediate pipe 13u by the flow path cross-sectional area $S2$ of the external muffler 39 is called an area ratio $S1/S2$.

[0071] Fig. 7 is a histogram showing relationship between the external muffler and the upstream intermediate pipe of the compressor according to the embodiment of the present invention.

[0072] Fig. 7 shows relationship between the area ratio $S1/S2$, pressure pulsation α in the intermediate pipe 13m on the outlet side of the external muffler 39, and vibration β of the midway pipe 13m excited by the pressure pulsation α .

[0073] A case in which the area ratio $S1/S2 = 1.0$ means a case in which the outlet area $S1$ of the upstream intermediate pipe 13u is the same as the flow path cross-sectional area $S2$ of the external muffler 39. In other words, this means a case in which there is no external muffler 39 and the upstream intermediate pipe 13u is directly connected to the intercooler 41. Fig. 5 is shown with reference to the pressure pulsation α_0 occurring in the upstream intermediate pipe 13u and the vibration β_0 of the upstream intermediate pipe 13u excited by the pressure pulsation α_0 when the area ratio $S1/S2 = 1.0$.

[0074] Here, the pressure pulsation α is the difference between the maximum value of the periodic pressure change at the inlet of the external muffler 39 and the maximum value of the periodic pressure change at the outlet of the external muffler 39. The inlet of the external muffler 39 is the connecting portion between the upstream intermediate pipe 13u and the external muffler 39, and the outlet of the external muffler 39 is the connecting portion between the intermediate pipe 13m and the external muffler 39. At the inlet of the external muffler

39 and outlet of the external muffler 39, the pressure of the refrigerant in the intermediate pipe 13 changes periodically. The amplitude of the pressure change on the outlet side of the external muffler 39 is smaller than the amplitude of the pressure change on the inlet side of the external muffler 39.

[0075] As an index, the vibration β uses the amplitude in the radial direction of the intermediate pipe 13 in the vicinity of the connecting portion between the external muffler 39 and the intermediate pipe 13m. The index of vibration β may be velocity or acceleration, in addition to amplitude. The acceleration at a predetermined point of the external muffler 39 may also be used.

[0076] The inventors have found that the vibration β of the intermediate pipe 13 (midway pipe 13m) can be reduced to 50 percent or less of the reference shown by a dashed line BL in Fig. 7, and thereby breakage or cracking of the intermediate pipe 13 is prevented and the soundness of the intermediate pipe 13 is maintained.

[0077] Therefore, setting the area ratio $S1/S2$ to 0.04 or less reliably reduces the vibration β of the intermediate pipe 13 (midway pipe 13m) to 50 percent or less of the reference. In other words, if the flow path cross-sectional area $S2$ of the external muffler 39 is 25 times or more the outlet area $S1$ of the upstream intermediate pipe 13u, the vibration β of the intermediate pipe 13 (midway pipe 13m) is reliably reduced to 50 percent or less of the reference.

[0078] Furthermore, when the area ratio $S1/S2 = 0.02$ is compared with the area ratio $S1/S2 = 0.01$, the reduction amount in the vibration β of the midway pipe 13m saturates relative to the reduction amount in the pressure pulsation α in the midway pipe 13m. In other words, when the flow path cross-sectional area $S2$ of the external muffler 39 is 100 times or more the outlet area $S1$ of the upstream intermediate pipe 13u, the effect of reducing the vibration β of the intermediate pipe 13 saturates.

[0079] Therefore, setting the area ratio $S1/S2$ to 0.01 or more and 0.04 or less effectively reduces the vibration β of the intermediate pipe 13 (midway pipe 13m). This prevents breakage or cracking of the intermediate pipe 13, maintains the soundness of the intermediate pipe 13, and avoids unnecessary increase in the size of the external muffler 39.

[0080] It is preferable that the length of the external muffler 39 in the up-down direction, that is, the height of the external muffler 39, do not exceed the top portion of the sealed container 16 to prevent the compressor 2 from getting large. In other words, it is preferable that the top portion of the external muffler 39 be lower than the top portion of the sealed container 16.

[0081] Furthermore, it is preferable that the length of the external muffler 39 in the up-down direction be 1.5 times or more the inner diameter D_{m2} of the external muffler 39. The length of the external muffler 39 contributes to relief of the pressure pulsation α of the refrigerant gas flowing from the upstream intermediate pipe 13u into the external muffler 39. Then, the length of the external muffler 39 that is 1.5 times or more the inner diameter

Dm2 of the external muffler 39 can sufficiently relieve the pressure pulsation α of the refrigerant gas flowing into the external muffler 39.

[0082] Fig. 8 is a plan view of the compressor according to the embodiment of the present invention.

[0083] As shown in Fig. 8, the accumulator 7 and external muffler 39 of the compressor 2 according to the present embodiment are disposed around the sealed container 16.

[0084] Here, an imaginary circle C1 is set that is centered on the center line of the sealed container 16, encompasses the accumulator 7, and is circumscribed to the accumulator 7. The imaginary circle C1 is drawn on a plane that is the installation plane of the compressor 2 or a plane parallel to the installation plane and is perpendicular to the center line of the sealed container 16.

[0085] The external muffler 39 is tangent to the imaginary circle C1 or is accommodated inside the imaginary circle C1. This makes it possible to prevent the area of the installation portion of the compressor 2, the so-called footprint, from getting excessively large.

[0086] However, if the external muffler 39 is cylindrical and the accommodating region of the external muffler 39 is limited to within the imaginary circle C1, the flow path cross-sectional area S2 of the external muffler 39 is limited by the inner diameter Dm2 of the external muffler 39. Therefore, from the viewpoint of ensuring a larger flow path cross-sectional area S2 of the external muffler 39, the horizontal cross-sectional shape of the external muffler 39 may be non-circular. In other words, the horizontal cross-sectional shape of the external muffler 39 may be a non-circular shape such as an ellipse, a rectangle, or a polygon, as long as the external muffler 39 can be contained within the imaginary circle C1.

[0087] The second external muffler 101 provided on the suction side of the second compression chamber 62 is preferably configured in the same manner as the external muffler 39 provided on the discharge side of the first compression chamber 61. In other words, the area ratio S1/S2 of the second external muffler 101 is preferably set to 0.01 or more and 0.04 or less. The top portion of the second external muffler 101 is preferably lower than the top portion of the sealed container 16. The length of the second external muffler 101 in the up-down direction is preferably 1.5 times or more the inner diameter Dm2 of the second external muffler 101. The second external muffler 101 is preferably tangent to the imaginary circle C1 or is accommodated inside the imaginary circle C1. The horizontal cross-sectional shape of the second external muffler 101 may be non-circular. Such a second external muffler 101 sufficiently reduces the pressure pulsation α of the refrigerant to be introduced into the second compression chamber 62, improving the compression efficiency in the second compression chamber 62.

[0088] As described above, the refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment include the upstream intermediate pipe 13u

and the external muffler 39 in which the area ratio S1/S2 is set to 0.01 or more and 0.04 or less, the area ratio S1/S2 being the quotient obtained by dividing the outlet area S1 of the upstream intermediate pipe 13u by the flow path cross-sectional area S2 of the external muffler 39. Therefore, the vibration β generated in the intermediate pipe 13 (midway pipe 13m) is reliably reduced to 50 percent or less of the reference case, which is a case in which: the external muffler 39 is not provided and the upstream intermediate pipe 13u is directly connected to the intercooler 41; and the area ratio S1/S2 is 1.0. Therefore, this prevents breakage or cracking of the intermediate pipe 13, and maintains the soundness of the intermediate pipe 13. In addition, this avoids unnecessary increase in the size of the external muffler 39.

[0089] The refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment include the external muffler 39 having the top portion placed lower than the top portion of the sealed container 16. Therefore, the refrigeration cycle apparatus 1 and the compressor 2 can simultaneously reduce the vibration β generated in the intermediate pipe 13 (midway pipe 13m) and avoid increase in the size of the compressor 2.

[0090] Furthermore, the refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment include the external muffler 39 having the longitudinal dimension (height dimension, up-down direction dimension) that is 1.5 times or more the inner diameter Dm2. Therefore, the refrigeration cycle apparatus 1 and the compressor 2 can easily reduce the pressure pulsation α and vibration β generated in the intermediate pipe 13 (midway pipe 13m), and avoid increase in the size of the compressor 2.

[0091] The refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment also include the fixing device 38 that fixes the external muffler 39 to the sealed container 16. The compressor 2 can therefore be easily handled while maintaining the external muffler 39 and the sealed container 16 in a desired relationship in placement.

[0092] Furthermore, the refrigeration cycle apparatus 1 and the compressor 2 according to the present embodiment include the external muffler 39 that is tangent to or accommodated inside the imaginary circle C1, which is centered on the center line of the sealed container 16, encompasses the accumulator 7, and is circumscribed to the accumulator 7. Therefore, the area of the installation portion of the compressor 2, the so-called footprint, does not get excessively large.

[0093] The second external muffler 101 provided on the suction side of the second compression chamber 62 can achieve the same effect as the external muffler 39 in terms of reducing the pressure pulsation α of the refrigerant to be introduced into the second compression chamber 62 and improving the compression efficiency of the second compression chamber 62.

[0094] Therefore, according to the refrigeration cycle apparatus 1 and the compressor 2 of the present embodiment

diment, in the multi-stage compressor 2 in which a fluid compressed by a low-stage compression mechanism is further compressed by a high-stage compression mechanism, it is possible to reliably reduce the pressure pulsation α and vibration β in the intermediate pipe 13 connecting the discharge side of the low-stage compression mechanism and the suction side of the high-stage compression mechanism, allowing the apparatus including the first external muffler 39 to be downsized as a whole.

[0095] 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.

[0096] 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, 21... main bearing, 22... auxiliary bearing, 22... auxiliary shaft portion, 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... first external muffler, 39a... body portion, 41... intercooler, 43... stator, 44... rotor, 45... outlet wire, 47... main shaft portion, 48... eccentric 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.

Claims

1. A rotary compressor comprising:

a sealed container having a center line 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, and being rotationally driven by the electric motor unit, the low-pressure side eccentric portion being eccentric from a rotation center line, the high-pressure side eccentric portion being provided below the low-pressure side eccentric portion and being eccentric from the rotation center line;

a compression mechanism unit including a low-pressure side cylinder and a high-pressure side cylinder, the low-pressure side cylinder having a low-pressure side compression chamber that compresses introduced low-pressure refrigerant gas to medium pressure 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 introduced medium-pressure refrigerant gas by power of the high-pressure side eccentric portion;

an upstream intermediate pipe configured to guide the medium-pressure refrigerant gas, discharged from the low-pressure side compression chamber, to an outside of the sealed container;

a muffler connected to the upstream intermediate pipe; and

a downstream intermediate pipe configured to guide the medium-pressure refrigerant gas, discharged from the muffler, to the high-pressure side compression chamber inside the sealed container,

wherein relationship between outlet area S1 of the upstream intermediate pipe and flow path cross-sectional area S2 of the muffler is

$$0.01 \leq (S1 \div S2) \leq 0.04.$$

2. The rotary compressor according to claim 1, wherein

the muffler is provided next to the sealed container and has an elongated shape with a center line extending in an up-down direction, and a top portion of the muffler is lower than a top portion of the sealed container.

3. The rotary compressor according to claim 1 or 2, wherein a length of the muffler in an up-down direction is 1.5 times or more an inner diameter of the muffler.

4. The rotary compressor according to any one of claims 1 to 3, further comprising a fixing device configured to fix the muffler to the sealed container.
5. The rotary compressor according to any one of claims 1 to 4, further comprising:
- an accumulator; and
 - an outlet pipe configured to guide the low-pressure refrigerant gas from the accumulator to the low-pressure side compression chamber inside the sealed container, wherein the muffler is tangent to or accommodated inside an imaginary circle, the imaginary circle being centered on the center line of the sealed container, encompassing the accumulator, and being circumscribed to the accumulator.
6. A refrigeration cycle apparatus comprising:
- the rotary compressor according to any one of claims 1 to 4;
 - 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 refrigerant to circulate.

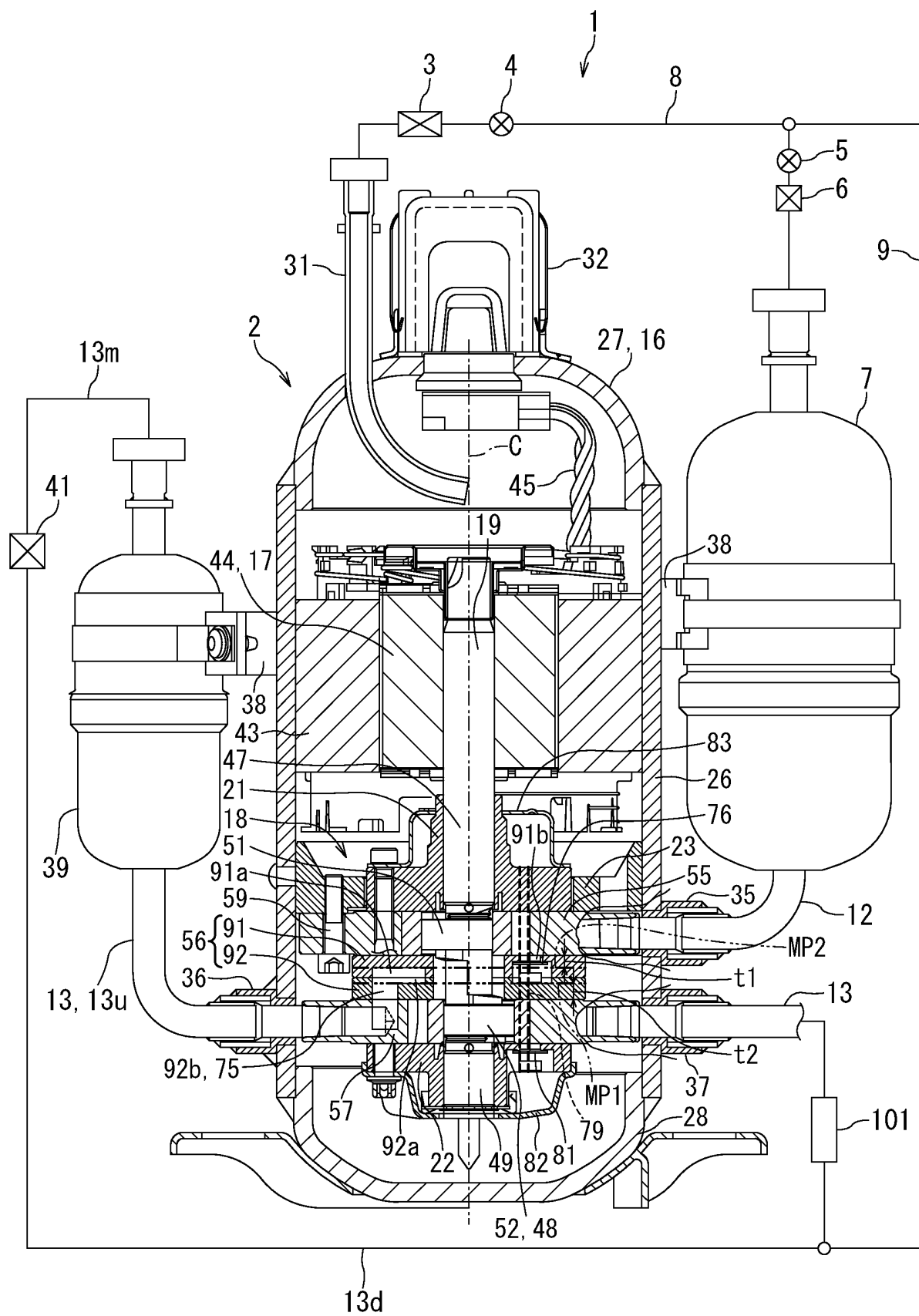


FIG. 1

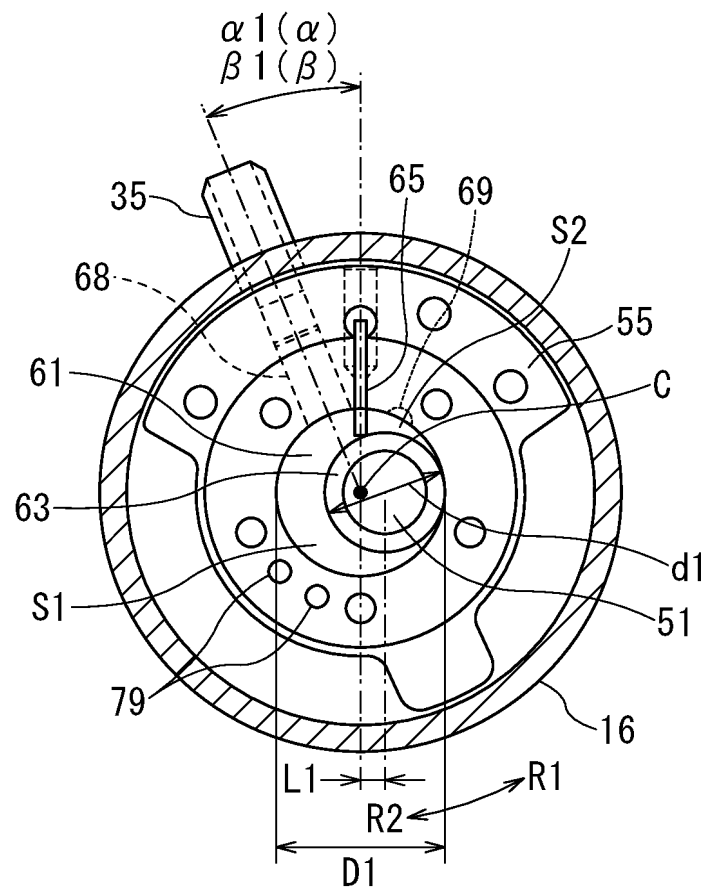


FIG. 2

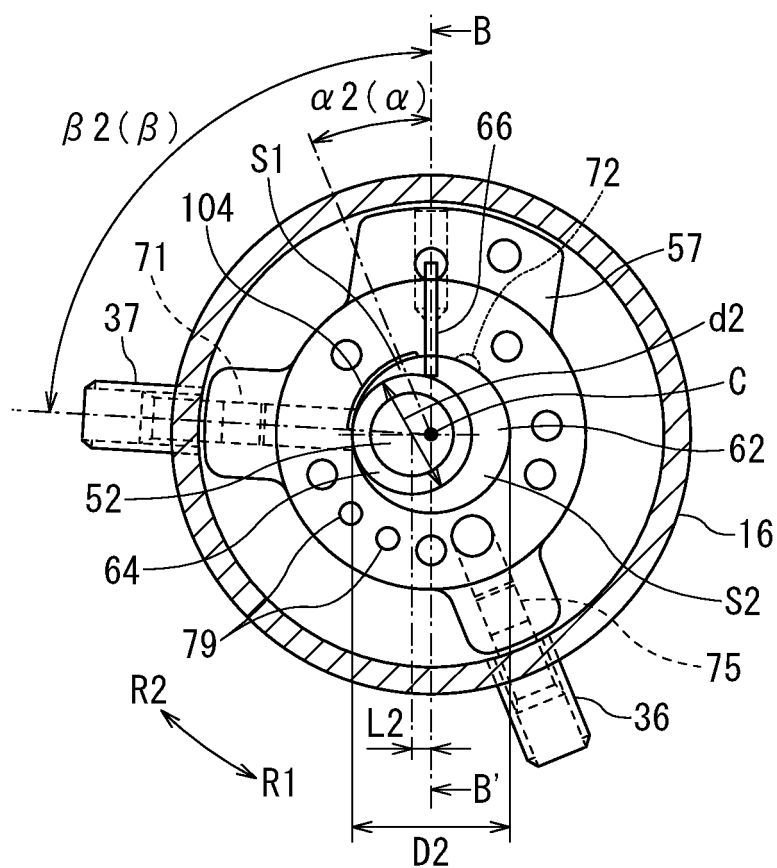


FIG. 3

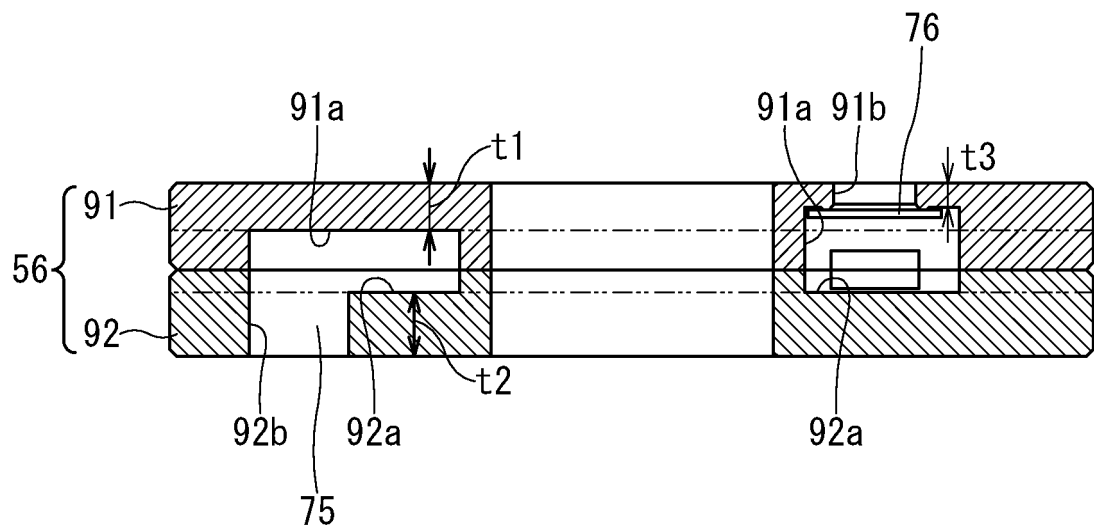


FIG. 4

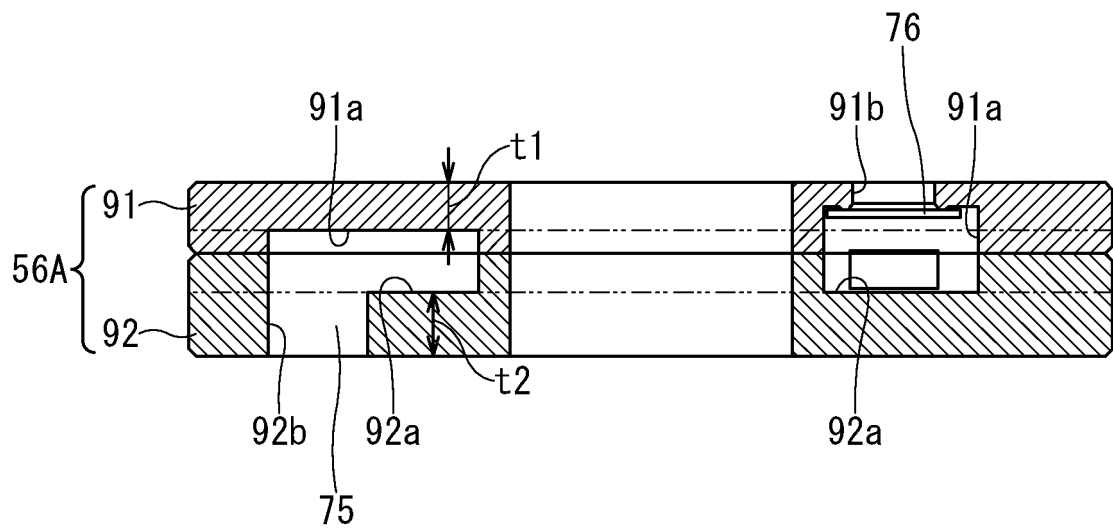


FIG. 5

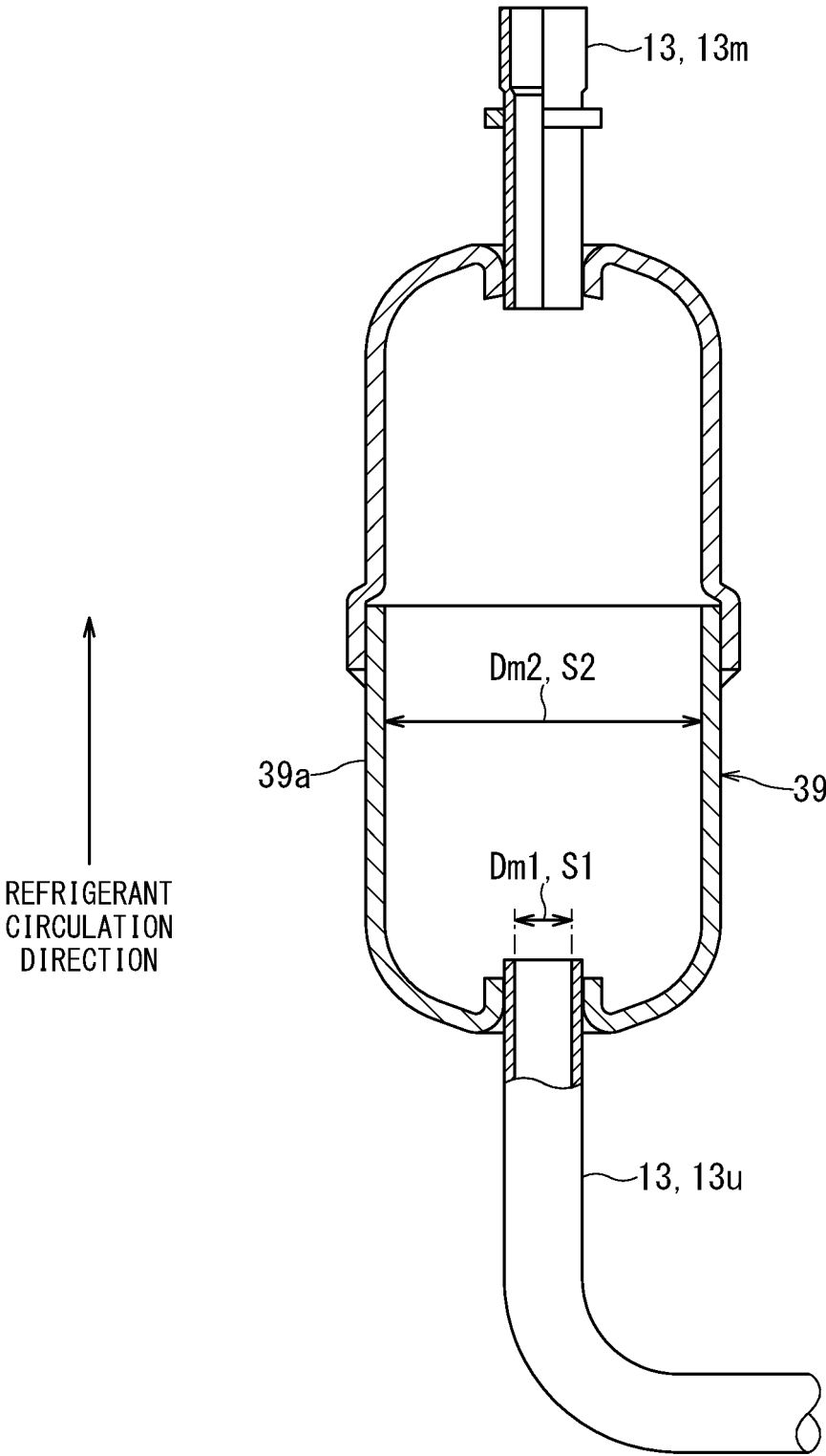


FIG. 6

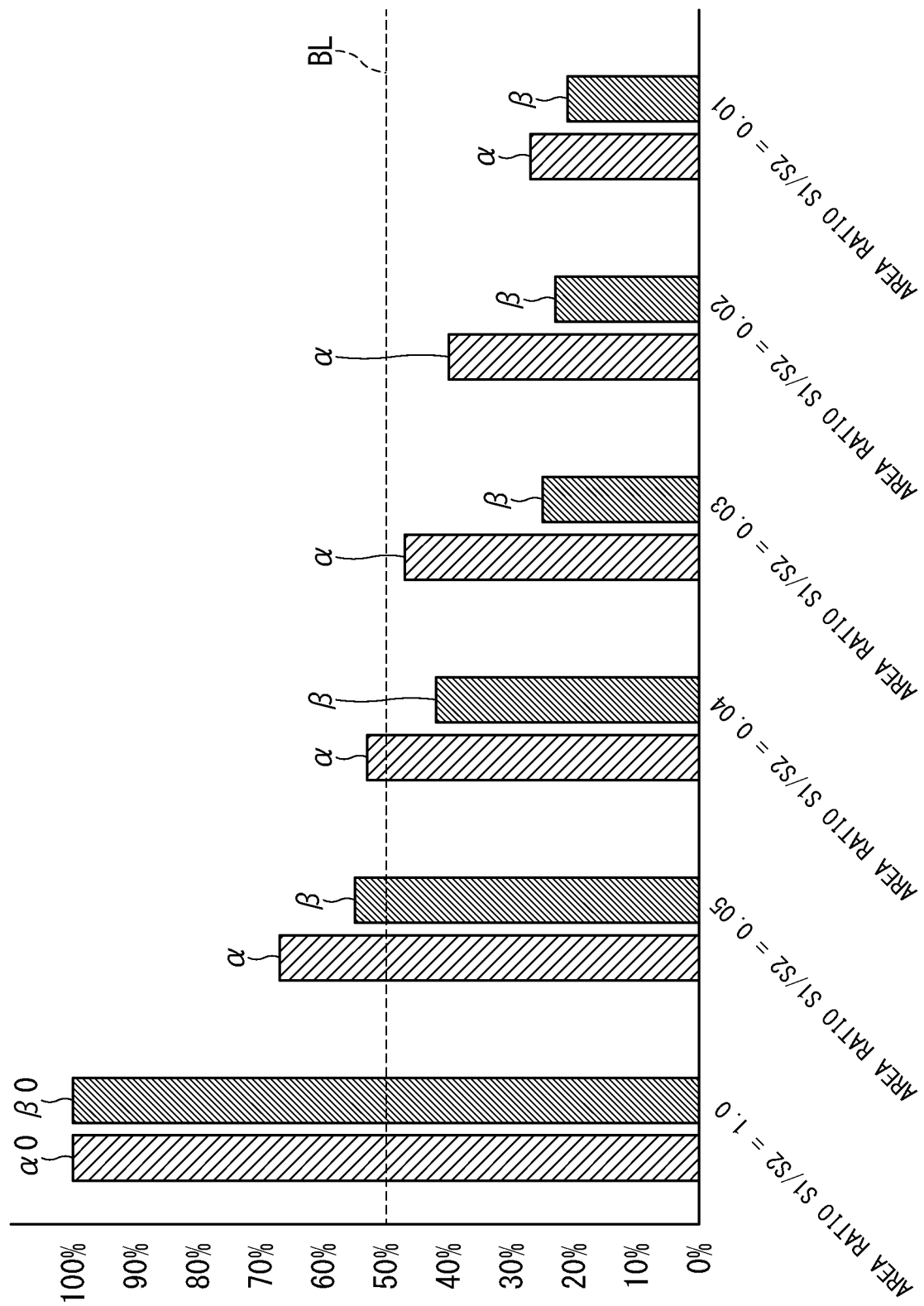


FIG. 7

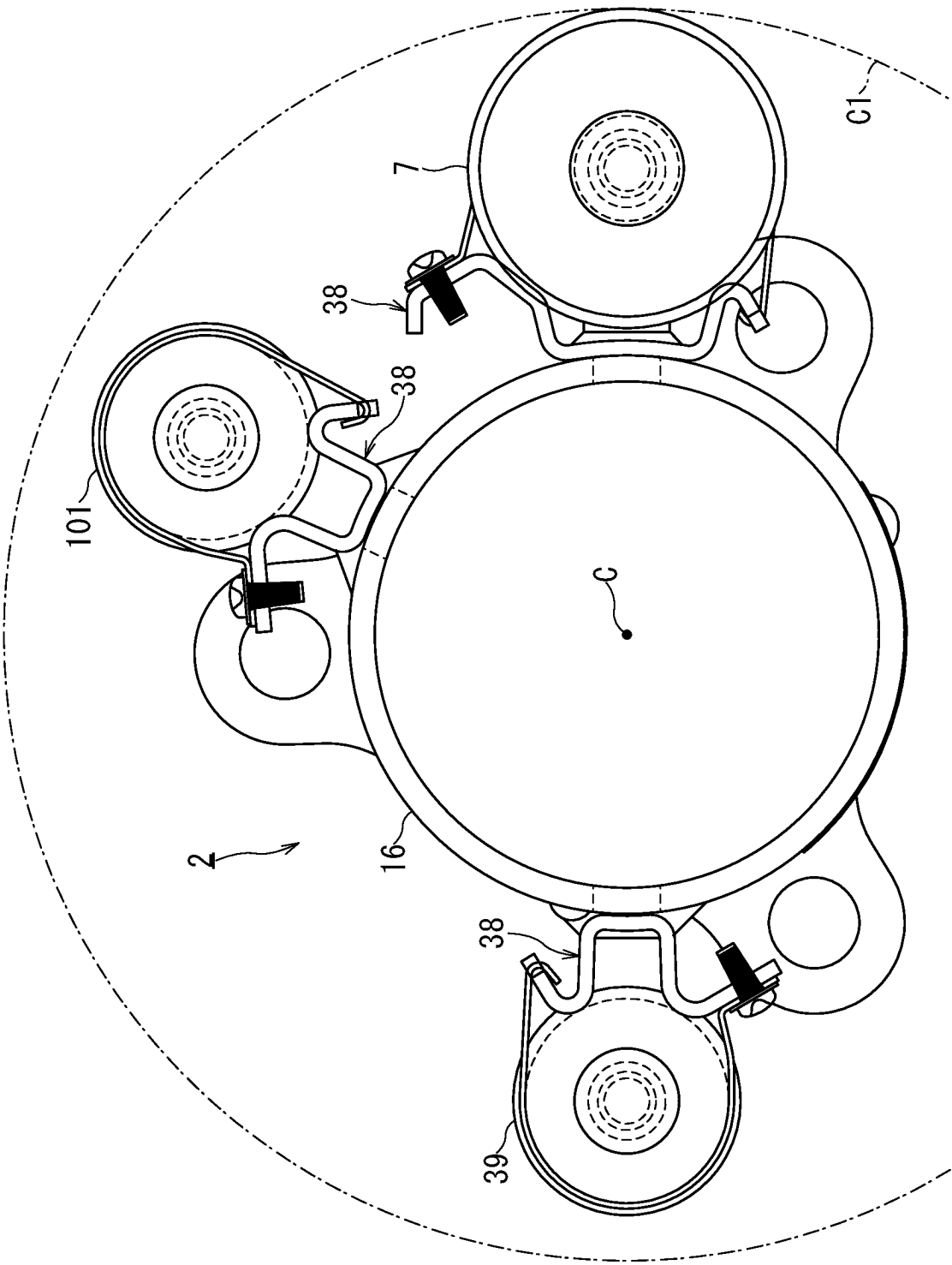


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/014449

A. CLASSIFICATION OF SUBJECT MATTER

F04C 29/06(2006.01)i; **F04C 18/356**(2006.01)i; **F04C 23/00**(2006.01)i
 FI: F04C29/06 D; F04C18/356 V; 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)

F04C29/06; 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.
Y	JP 2001-082369 A (SANYO ELECTRIC CO LTD) 27 March 2001 (2001-03-27) paragraphs [0006], [0019]-[0038], fig. 1, 3	1-6
Y	JP 2006-017024 A (MATSUSHITA ELECTRIC IND CO LTD) 19 January 2006 (2006-01-19) paragraph [0017]	1-6
Y	JP 2010-065562 A (DAIKIN IND LTD) 25 March 2010 (2010-03-25) paragraph [0046], fig. 1-3	3-4
Y	JP 2003-166472 A (SANYO ELECTRIC CO LTD) 13 June 2003 (2003-06-13) paragraphs [0042]-[0047], fig. 1-3	4-5

☐ 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

16 May 2022

Date of mailing of the international search report

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Name and mailing address of the ISA/JP

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/014449

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	2001-082369	A	27 March 2001	(Family: none)	
JP	2006-017024	A	19 January 2006	(Family: none)	
JP	2010-065562	A	25 March 2010	(Family: none)	
JP	2003-166472	A	13 June 2003	(Family: none)	

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2010065562 A [0003]