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(72) Inventors:
• **YAMAMOTO, Takahiro**
Fuji-shi, Shizuoka 416-8521 (JP)
• **YAMAZAKI, Tadayuki**
Fuji-shi, Shizuoka 416-8521 (JP)
• **TOMINAGA, Takeshi**
Fuji-shi, Shizuoka 416-8521 (JP)
• **KAWASHIMA, Yuzuki**
Fuji-shi, Shizuoka 416-8521 (JP)

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

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

(54) **ACCUMULATOR, COMPRESSOR, AND REFRIGERATION CYCLE DEVICE**

(57) Provided are an accumulator that can achieve both a gas-liquid separation capability of reliably preventing an outflow of a liquid refrigerant (i.e., a gas-liquid separation capability of reliably preventing liquid compression of the compressor) and easy adjustment of pipe length of a suction piping system suitable for obtaining the supercharging effect of the compressor, a compressor including this accumulator, and a refrigeration cycle apparatus including this accumulator. An accumulator (7) includes a container (61); a partition plate (62) provided within the container (61) and dividing an internal space of the container (61) into a refrigerant inlet chamber IR and a refrigerant outlet chamber OR; an inlet pipe (63) fixed to the container (61) and having an inlet passage IP communicating with the refrigerant inlet chamber IR; at least one communication pipe (65) penetrating the partition plate (62) and having a communication passage CP that

places the refrigerant inlet chamber IR in communication with the refrigerant outlet chamber OR; and at least one outlet pipe (66) fixed to the container (61) and having an outlet flow passage OP that communicates with the refrigerant outlet chamber OR. The at least one communication pipe (65) has an outlet opening (65o) positioned in the refrigerant outlet chamber OR. The at least one outlet pipe (66) has an inlet opening (66i) positioned in the refrigerant outlet chamber OR. The accumulator (7) can be installed in such a manner that the inlet opening (66i) of the at least one outlet pipe (66) is positioned above the outlet opening (65o) of the at least one communication pipe (65) and the inlet opening (66i) of the at least one outlet pipe (66) does not overlap with the outlet opening (65o) of the at least one communication pipe (65) in a vertical direction.

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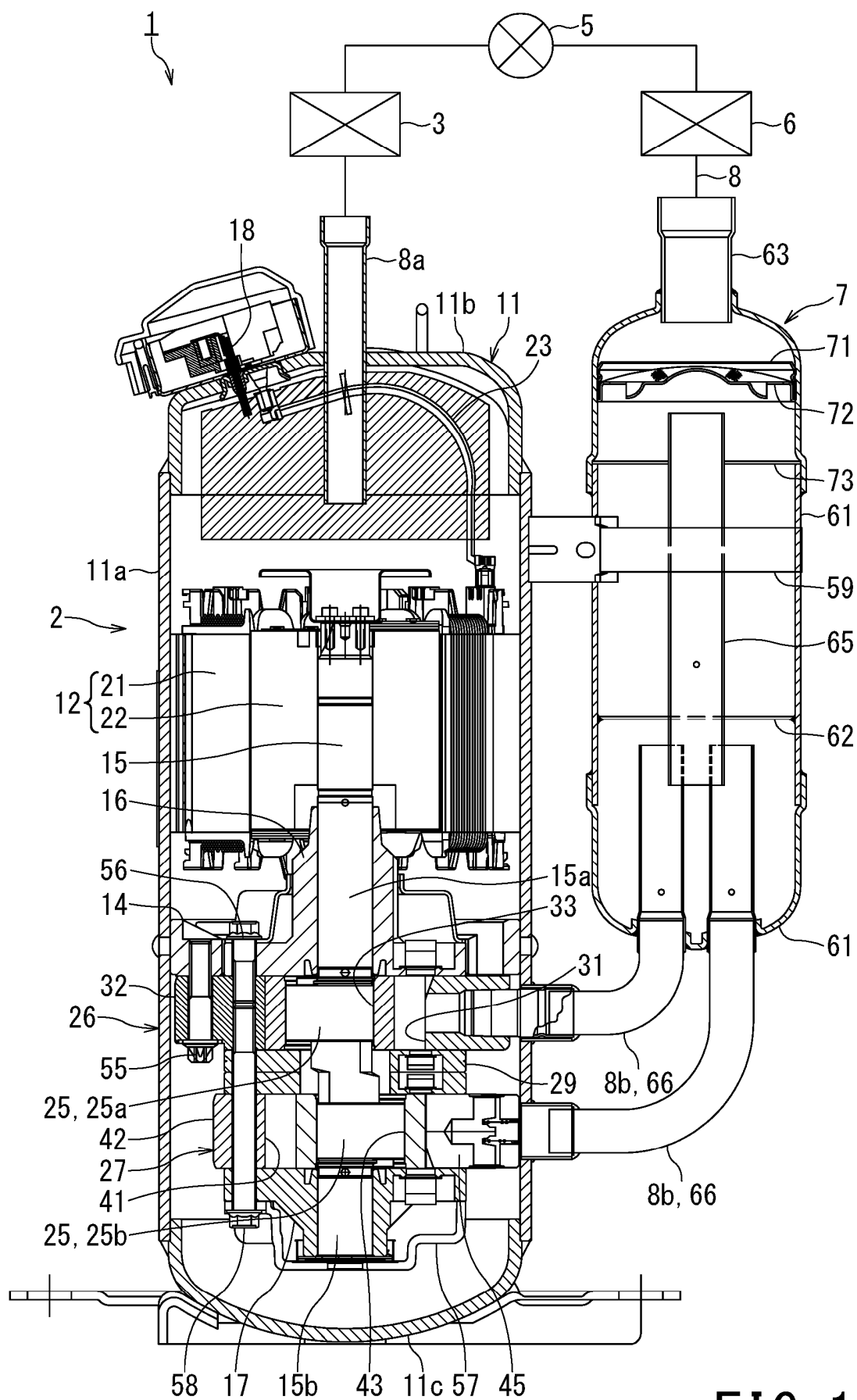


FIG. 1

Description

TECHNICAL FIELD

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

BACKGROUND

[0002] In order to prevent so-called liquid compression in which a liquid refrigerant is supplied into a cylinder of a compressor and is compressed, an accumulator (i.e., a gas-liquid separator or a liquid separator) to be provided on a suction side of a compressor is known.

[0003] In order to ensure a gas-liquid separation capability, a conventional accumulator includes: a container; a partition plate that divides an internal space of the container into an upper space and a bottom space; a straight pipe that vertically penetrates the partition plate and opens into the bottom space; and an outlet pipe that opens into the bottom space and is led out from a bottom surface of the container.

[0004] A lower end of the straight pipe, i.e., an outlet end of the straight pipe, is disposed in the vicinity of the partition plate, and an upper end of the outlet pipe, i.e., an inlet end of the outlet pipe, is disposed in the vicinity of a bottom plate of the container. In other words, the outlet end of the straight pipe is disposed above the inlet end of the outlet pipe.

PRIOR ART Document

PATENT DOCUMENT

[0005] [Patent Document 1] JP H04-350479 A

SUMMARY

PROBLEM TO BE SOLVED BY INVENTION

[0006] In a conventional accumulator, when a liquid refrigerant flows into the bottom space of the container through the straight pipe, the liquid refrigerant easily flows into the outlet pipe having the inlet end located in the vicinity of the bottom plate of the container. In such a case, the compressor falls into a state of liquid compression.

[0007] In a design of a rotary compressor, a high-load condition in which a circulating amount of a refrigerant is large is extremely important for designing a theoretical suction volume, a maximum rotational speed, and a motor capacity. Utilization of a supercharging effect, in which the circulating amount of the refrigerant increases at a specific rotational speed due to air-column resonance in a suction piping system of the compressor, is effective in designing the rotary compressor.

[0008] Accordingly, an object of the present invention

is to provide: an accumulator that can achieve both a gas-liquid separation capability of reliably preventing an outflow of a liquid refrigerant (i.e., a gas-liquid separation capability of reliably preventing liquid compression of the compressor) and easy adjustment of pipe length of a suction piping system suitable for obtaining the supercharging effect of the compressor; a compressor including this accumulator; and a refrigeration cycle apparatus including this accumulator.

MEANS FOR SOLVING PROBLEM

[0009] To resolve the above problems, an accumulator includes: a container; a partition plate that is provided within the container and divides an internal space of the container into a refrigerant inlet chamber and a refrigerant outlet chamber; an inlet pipe that is fixed to the container and has an inlet passage communicating with the refrigerant inlet chamber; at least one communication pipe that penetrates the partition plate and has a communication passage placing the refrigerant inlet chamber in communication with the refrigerant outlet chamber; and at least one outlet pipe that is fixed to the container and has an outlet flow passage communicating with the refrigerant outlet chamber. The at least one communication pipe has an outlet opening positioned in the refrigerant outlet chamber. The at least one outlet pipe has an inlet opening positioned in the refrigerant outlet chamber. The accumulator can be installed in such a manner that (i) the inlet opening of the at least one outlet pipe is positioned above the outlet opening of the at least one communication pipe and (ii) the inlet opening of the at least one outlet pipe does not overlap with the outlet opening of the at least one communication pipe in a vertical direction.

[0010] To resolve the above problems, a compressor includes: a sealed container; a compression mechanism that is accommodated in the sealed container; an electric motor that is accommodated in the sealed container and generates driving force of the compression mechanism; and the accumulator disposed outside the sealed container and connected to a suction side of the compression mechanism.

[0011] To resolve the above problems, a refrigeration cycle apparatus includes: the compressor; a radiator; an expansion device; a heat absorber; and refrigerant piping that connects the compressor, the heat radiator, the expansion device, and the evaporator to circulate a refrigerant.

EFFECTS OF INVENTION

[0012] The present invention provides: an accumulator that can achieve both a gas-liquid separation capability of reliably preventing an outflow of a liquid refrigerant (i.e., a gas-liquid separation capability of reliably preventing liquid compression of the compressor) and easy adjustment of pipe length of a suction piping system suitable for

obtaining the supercharging effect of the compressor; a compressor including this accumulator; and a refrigeration cycle apparatus including this accumulator.

BRIEF DESCRIPTION OF DRAWINGS

[0013]

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

Fig. 2 is a first longitudinal cross-sectional view of the accumulator according to the embodiment of the present invention.

Fig. 3 is a second longitudinal cross-sectional view of the accumulator according to the embodiment of the present invention.

Fig. 4 is a cross-sectional view of the accumulator according to the embodiment of the present invention.

Fig. 5 is a schematic diagram illustrating comparison of a supercharging effect between the accumulator according to the present embodiment and a conventional accumulator.

Fig. 6 is a schematic diagram illustrating relationship between a cross-sectional area of a communication passage and a cross-sectional area of an outlet passage in the accumulator according to the present embodiment.

DETAILED DESCRIPTION

[0014] Embodiments of an accumulator, a compressor, and a refrigeration cycle apparatus according to the present invention will be described by referring to Figs. 1 to 6. The same reference signs are given to identical or equivalent components in each figure.

[0015] Fig. 1 is a schematic diagram of a refrigeration cycle apparatus, a compressor, and an accumulator according to embodiments of the present invention.

[0016] As shown in Fig. 1, the refrigeration cycle apparatus 1 according to the present embodiment includes a rotary compressor 2, a radiator 3, an expansion device 5, a heat absorber 6, an accumulator 7, and refrigerant piping 8. The rotary compressor 2 is hereinafter simply referred to as the compressor 2. The refrigerant piping 8 sequentially connects the compressor 2, the radiator 3, the expansion device 5, the heat absorber 6, and the accumulator 7 to circulate a refrigerant. The refrigerant circulating in the refrigeration cycle apparatus 1 may be various refrigerants, such as carbon dioxide, R32, and a mixed refrigerant including R32. The radiator 3 may also be referred to as a condenser. The heat absorber 6 may also be referred to as an evaporator.

[0017] The compressor 2 includes: a cylindrical sealed container 11 disposed vertically; an electric motor 12 accommodated in an upper half of the sealed container 11; a compression mechanism 13 accommodated in a

lower half of the sealed container 11; a crankshaft 15 configured to transmit rotational driving force of the electric motor 12 to the compression mechanism 13; and a main bearing 16 and an auxiliary bearing 17, both of which rotatably support the crankshaft 15 in cooperation.

[0018] The sealed container 11 is cylindrical. The sealed container 11 includes a cylindrical body 11a extending in the vertical direction, a hemispherical or elliptical upper end plate 11b closing the upper end portion of the body 11a, and a hemispherical or elliptical lower end plate 11c closing the lower end portion of the body 11a.

[0019] The body 11a supports a plurality of suction pipes 8b that guide the refrigerant to the compressor 2. The plurality of suction pipes 8b are connected to the accumulator 7. The plurality of suction pipes 8b constitute part of the refrigerant piping 8.

[0020] The upper end plate 11b supports a discharge pipe 8a that discharges the refrigerant compressed by the compressor 2. The discharge pipe 8a is connected to the refrigerant piping 8. The upper end plate 11b includes a sealed terminal portion 18 configured to supply electric power to the electric motor 12.

[0021] The electric motor 12 generates driving force that rotates the compression mechanism 13. The electric motor 12 is, for example, a permanent magnet synchronous motor (PMSM). The electric motor 12 includes: a cylindrical stator 21 fixed to the inner wall of the sealed container 11; a rotor 22 disposed within the stator 21 and fixed to the crankshaft 15; and a plurality of lead wires 23 drawn from the stator 21 and connected to the sealed terminal portion 18.

[0022] The rotor 22 includes a rotor core having magnet receiving holes and permanent magnets housed in the magnet receiving holes. The rotor 22 is rotatable with respect to the stator 21 and is fixed to the crankshaft 15 so as to rotate integrally with the crankshaft 15. The rotational centerline of the rotor 22 and the crankshaft 15 substantially coincides with the centerline of the stator 21.

[0023] The plurality of lead wires 23 are wirings that supply power to the stator 21 through the sealed terminal portion 18. The lead wires 23 are wired in a plurality of number depending on the type of the electric motor 12. When the lead wires 23 are used in an open winding type, two lead wires are wired for each of the U-phase, the V-phase, and the W-phase, and thus, a total of six lead wires 23 are wired. When the electric motor 12 is used in a star connection, one lead wire 23 is connected to each of the U-phase, the V-phase, and the W-phase, i.e., a total of three lead wires 23 are wired.

[0024] The crankshaft 15 connects the electric motor 12 and the compression mechanism 13. The crankshaft 15 transmits the driving force generated by the electric motor 12 to the compression mechanism 13.

[0025] A middle portion 15a of the crankshaft 15 connects the electric motor 12 and the compression mechanism 13 and is rotatably supported by the main bearing 16. The lower end portion 15b of the crankshaft 15 is rota-

tably supported by the auxiliary bearing 17. The main bearing 16 and the auxiliary bearing 17 are also part of the compression mechanism 13. In other words, the crankshaft 15 penetrates through the compression mechanism 13.

[0026] The crankshaft 15 has a plurality of eccentric portions 25a and 25b between the middle portion 15a supported by the main bearing 16 and the lower end portion 15b supported by the auxiliary bearing 17. Of the plurality of eccentric portions 25, the side closer to the main bearing 16 is referred to as the first eccentric portion 25a, and the side closer to the auxiliary bearing 17 is referred to as the second eccentric portion 25b. Each of the eccentric portions 25a and 25b is a disk or a column having a center that does not coincide with the center of the crankshaft 15. The centers of the respective eccentric portions 25a and 25b are eccentric around the crankshaft 15 with a phase difference of approximately 180°. The first eccentric portion 25a is disposed on the upper side closer to the electric motor 12, and the second eccentric portion 25b is disposed on the lower side farther from the electric motor 12.

[0027] The upper main bearing 16 is fixed to a frame 14 via the first cylinder 32 by a plurality of fastening members, such as bolts 55 and 56. The frame 14 is fixed to the sealed container 11 at a plurality of locations by welding, such as spot welding. In other words, the frame 14 supports the compression mechanism 13, the crankshaft 15, and the rotor 22 of the electric motor 12 in the sealed container 11.

[0028] When the electric motor 12 connected to the compression mechanism 13 via the crankshaft 15 is driven to rotate, the compression mechanism 13 draws in a gaseous refrigerant through the plurality of suction pipes 8b, compresses the drawn refrigerant, and discharges the compressed refrigerant into the sealed container 11. The lower portion of the sealed container 11 is filled with refrigeration oil, and most of the compression mechanism 13 is immersed in this refrigeration oil.

[0029] The compression mechanism 13 has a plurality of, for example, two cylinder units 26 and 27. In other words, the compressor 2 is a multi-cylinder rotary compressor. The compression mechanism 13 includes the first cylinder unit 26 provided within the sealed container 11, the second cylinder unit 27 provided within the sealed container 11, and a partition plate 29 provided between the first cylinder unit 26 and the second cylinder unit 27.

[0030] The compressor 2 may be a multi-cylinder rotary compressor with three or more cylinders or may be a single-cylinder rotary compressor. The compressor 2 and the accumulator 7 are connected via the suction pipes 8b, number of which is the same as the number of cylinders.

[0031] The first cylinder unit 26 includes a first cylinder 32 having a circular first cylinder chamber 31 and an annular first rolling piston 33 disposed within the first cylinder chamber 31. Hereinafter, the first rolling piston 33 is simply referred to as the first piston 33.

[0032] The second cylinder unit 27 includes a second cylinder 42 having a circular second cylinder chamber 41 and an annular second rolling piston 43 disposed within the second cylinder chamber 41. Hereinafter, the second rolling piston 43 is simply referred to as the second piston 43.

[0033] Each of the cylinder units 26 and 27 is provided with a vane 45. Each vane 45 performs a reciprocating motion toward and away from the rotational centerline of the crankshaft 15 while remaining in contact with the outer peripheral surface of the corresponding piston 33 or 43, thereby dividing the corresponding cylinder chamber 31 or 41 into a suction chamber and a compression chamber. Each of the cylinder units 26 and 27 compresses the refrigerant by varying the volume of the compression chamber, which is defined by the corresponding piston 33 or 43 and the corresponding vane 45, through the rotation of the piston 33 or 43. The vane 45 is illustrated only for the second cylinder unit 27.

[0034] The first cylinder 32 and the second cylinder 42 are disposed so as to be stacked in the axial direction of the crankshaft 15. The upper first cylinder 32 is disposed on the side closer to the electric motor 12, and the lower second cylinder 42 is disposed on the side farther from the electric motor 12.

[0035] Each of the cylinders 32 and 42 has an inner peripheral surface that defines the corresponding cylinder chamber 31 or 41. Each of the cylinders 32 and 42 has an annular and plate-shaped form with the corresponding cylinder chamber 31 or 41 on the inside. Each of the cylinders 32 and 42 has an end face on the side closer to the electric motor 12 and another end face on the side farther from the electric motor 12.

[0036] The respective centers of the first cylinder chamber 31 and the second cylinder chamber 41 substantially coincide with the rotational centerline of the crankshaft 15. These cylinder chambers 31 and 41 have substantially the same diameter and the same height, i.e., both extend along the axial direction of the crankshaft 15.

[0037] The first cylinder chamber 31 is a space within the first cylinder 32 and is closed by the main bearing 16 and the partition plate 29. The first cylinder chamber 31 accommodates the first eccentric portion 25a of the crankshaft 15.

[0038] The second cylinder chamber 41 is a space within the second cylinder 42 and is closed by the partition plate 29 and the auxiliary bearing 17. The second cylinder chamber 41 accommodates the second eccentric portion 25b of the crankshaft 15.

[0039] The compression mechanism 13 includes: a first discharge-valve mechanism, which has (i) a discharge port provided in the main bearing 16 for discharging the refrigerant compressed in the first cylinder chamber 31 to the outside of the first cylinder chamber 31 and (ii) a discharge valve provided in the main bearing 16 for opening and closing this discharge port; and a first discharge muffler 55 provided in the main bearing 16 for

covering the first discharge-valve mechanism.

[0040] The discharge port of the first discharge-valve mechanism communicates with the first cylinder chamber 31.

[0041] When the pressure difference between the inside and the outside of the first cylinder chamber 31 reaches a predetermined pressure difference value due to the compression action of the compression mechanism 13, the discharge valve of the first discharge-valve mechanism opens the discharge port and thereby discharges the compressed refrigerant into the first discharge muffler 55.

[0042] The first discharge muffler 55 covers the first discharge-valve mechanism. The first discharge muffler 55 has a discharge hole that extends through the first discharge muffler 55. The compressed refrigerant discharged into the first discharge muffler 55 is discharged into the sealed container 11 through the discharge hole.

[0043] The first discharge muffler 55 and the first cylinder 32 are fixed to the main bearing 16 by a plurality of fastening members, such as bolts 56. The bolts 56 extend through the first discharge muffler 55 and the main bearing 16 to reach the first cylinder 32.

[0044] The compression mechanism 13 further includes: a second discharge-valve mechanism, which has (i) a discharge port provided in the auxiliary bearing 17 for discharging the refrigerant compressed in the second cylinder chamber 41 and (ii) a discharge valve provided in the auxiliary bearing 17 for opening and closing this discharge port; and a second discharge muffler 57 provided in the auxiliary bearing 17 for covering the second discharge-valve mechanism.

[0045] The discharge port of the second discharge-valve mechanism communicates with the second cylinder chamber 41.

[0046] When the pressure difference between the inside and the outside of the second cylinder chamber 41 reaches a predetermined pressure difference value due to the compression action of the compression mechanism 13, the discharge valve of the second discharge-valve mechanism opens the discharge port and thereby discharges the compressed refrigerant into the second discharge muffler 57.

[0047] The second discharge muffler 57 covers the second discharge-valve mechanism. The compressed refrigerant discharged into the second discharge muffler 57 is guided to the first discharge muffler 55 through holes extending through the auxiliary bearing 17, the second cylinder 42, the partition plate 29, and the first cylinder 32, and is then discharged into the sealed container 11.

[0048] The second discharge muffler 57, the auxiliary bearing 17, the second cylinder 42, and the partition plate 29 are fixed to the first cylinder 32 by a plurality of fastening members, such as bolts 58. The bolts 58 extend through the second discharge muffler 57, the auxiliary bearing 17, the second cylinder 42, and the partition plate 29 to reach the first cylinder 32.

[0049] The first piston 33 is fitted to the peripheral

surface of the first eccentric portion 25a and is accommodated in the first cylinder chamber 31. The first piston 33 performs an eccentric motion in accordance with the rotation of the crankshaft 15, while making a portion of its outer peripheral surface in line contact with the inner peripheral surface of the first cylinder chamber 31.

[0050] The second piston 43 is fitted to the peripheral surface of the second eccentric portion 25b and is accommodated in the second cylinder chamber 41. The second piston 43 performs an eccentric motion in accordance with the rotation of the crankshaft 15, while making a portion of its outer peripheral surface in line contact with the inner peripheral surface of the second cylinder chamber 41.

[0051] Although both the contact between the first piston 33 and the first cylinder 32 and the contact between the second piston 43 and the second cylinder 42 are indirect through an oil film (not shown) rather than direct contact, these contacts through the oil film are simply referred to as "contact", for convenience of description. The same applies to: the contact between the first piston 33 and the first eccentric portion 25a; the contact between the second piston 43 and the second eccentric portion 25b; the contact between the first piston 33 and the main bearing 16; the contact between the second piston 43 and the auxiliary bearing 17; the contact between the first piston 33 and the partition plate 29; and the contact between the second piston 43 and the partition plate 29.

[0052] The accumulator 7 is fixed to the sealed container 11 of the compressor 2 by a clamp band 59.

[0053] Figs. 2 and 3 are longitudinal cross-sectional views of the accumulator according to the embodiment of the present invention.

[0054] As shown in Figs. 1 to 3, the accumulator 7 according to the present embodiment includes: a cylindrical container 61 that is supported in an upright state; a partition plate 62 that is provided within the container 61 and divides an internal space S of the container 61 into a refrigerant inlet chamber IR and a refrigerant outlet chamber OR; an inlet pipe 63 that is fixed to the container 61 and has an inlet passage IP communicating with the refrigerant inlet chamber IR; at least one communication pipe 65 that penetrates the partition plate 62 and has a communication passage CP placing the refrigerant inlet chamber IR in communication with the refrigerant outlet chamber OR; and a plurality of outlet pipes 66 that are fixed to the container 61 and has outlet passages OP communicating with the refrigerant outlet chamber OR.

[0055] The accumulator 7 further includes: a strainer 71 that is disposed between the inlet pipe 63 and the communication pipe 65 and filters foreign substances from the refrigerant introduced into the accumulator 7; a separation plate 72 that is disposed between the strainer 71 and the communication pipe 65 and separates the refrigerant having passed through the strainer 71 into a gaseous refrigerant and a liquid refrigerant; and a support plate 73 that is disposed between the separation

plate 72 and the partition plate 62 and supports the communication pipe 65 in cooperation with the partition plate 62.

[0056] As to the number of the communication pipes 65, it is sufficient that at least one communication pipe 65 is provided. For convenience of description, the accumulator 7 of the present embodiment is assumed to include a plurality of communication pipes 65, for example, two communication pipes 65. The number of the communication pipes 65 is determined in consideration of the pressure loss of the communication passage CP, which places the refrigerant inlet chamber IR in communication with the refrigerant outlet chamber OR.

[0057] The container 61 is fixed to the sealed container 11 of the compressor 2 by the clamp band 59. The container 61 is cylindrical. The container 61 includes: a cylindrical body 61a extending in the vertical direction; a hemispherical or elliptical upper end plate 61b configured to close one of both end portions of the body 61a, i.e., to close the upper end portion; and a hemispherical or elliptical lower end plate 61c configured to close the other end portion, i.e., the lower end portion of the body 61a.

[0058] The body 61a supports the strainer 71, the separation plate 72, the support plate 73, and the partition plate 62 in the order of the refrigerant flow.

[0059] The upper end plate 61b supports the inlet pipe 63, through which the refrigerant compressed by the compressor 2 and circulated through the refrigeration cycle apparatus 1 flows into the accumulator 7. The inlet pipe 63 is connected to the refrigerant piping 8.

[0060] The inlet pipe 63 is fixed to the upper end plate 61b and is connected to the refrigerant piping 8. The inlet pipe 63 is a straight pipe, which extends along the centerline of the body 61a so as to coincide with the centerline of the body 61a.

[0061] The refrigerant flowing from the inlet pipe 63 into the accumulator 7 first reaches the strainer 71. The strainer 71 has a required mesh size to prevent foreign substances from flowing into the compression mechanism 13 of the compressor 2.

[0062] The separation plate 72 prevents the refrigerant having passed through the strainer 71 from flowing directly into the communication pipes 65. The separation plate 72 is a plate having an upwardly convex shape that functions like an umbrella over the communication pipes 65. The separation plate 72 has a plurality of openings 72a through which the refrigerant can pass. The separation plate 72 blocks the lines of sight directly below the inlet pipe 63 and directly above the communication pipes 65. The plurality of openings 72a of the separation plate 72 are formed outside a virtual smallest circle that encloses the plurality of communication pipes 65 as seen from the inlet pipe 63. The refrigerant having reached the separation plate 72 flows downward through the plurality of openings 72a of the separation plate 72 into the refrigerant inlet chamber IR of the container 61.

[0063] The support plate 73 and the partition plate 62 cooperate to support at least one of the communication

pipes 65 within the container 61.

[0064] The support plate 73 has holes for supporting the communication pipes 65 such that the refrigerant inlet chamber IR forms a continuous space, and also has suitable openings that do not hinder the flow of both the liquid refrigerant and the gaseous refrigerant. The support plate 73 preferably has appropriate supporting strength and appropriate supporting rigidity for preventing the communication pipes 65, which extend from the partition plate 62 toward the separation plate 72, from tipping over.

[0065] The partition plate 62 has no openings other than the holes for supporting the communication pipes 65 such that the internal space S of the container 61 is divided into the refrigerant inlet chamber IR and the refrigerant outlet chamber OR. The partition plate 62 is joined to the inner surface of the container 61 in a liquid-tight and gas-tight manner, thereby preventing leakage of the refrigerant from the refrigerant inlet chamber IR into the refrigerant outlet chamber OR through any path other than the communication pipes 65. It is sufficient that the partition plate 62 has a plane perpendicular to the centerline of the container 61. In the upright state of the accumulator 7, the partition plate 62 defines a plane extending horizontally.

[0066] Each of the communication pipes 65 has an inlet opening 65i positioned in the refrigerant inlet chamber IR and an outlet opening 65o positioned in the refrigerant outlet chamber OR. The inlet opening 65i corresponds to the upstream end of the communication passage CP, and the outlet opening 65o corresponds to the downstream end of the communication passage CP.

[0067] Each of the communication pipes 65 is disposed within the container 61 and is fixed to the support plate 73 and the partition plate 62, thereby placing the refrigerant inlet chamber IR in communication with the refrigerant outlet chamber OR. Each of the communication pipes 65 is a straight pipe extending along and parallel to the centerline of the body 61a.

[0068] The length of each of the communication pipes 65 depends on the amount of the refrigerant charged in the refrigeration cycle apparatus 1 and is preferably at least about one-half of the overall length of the accumulator 7.

[0069] Each of the outlet pipes 66 is a suction pipe 8b of the compressor 2 and communicates with the cylinder chamber 31 or 41 of the corresponding cylinder unit 26 or 27 of the compression mechanism 13. The number of the outlet pipes 66 is equal to the number of cylinders of the compressor 2. In the case of a multi-cylinder compressor 2 as shown in Fig. 1, the accumulator 7 is connected to the compressor 2 via the same number of outlet pipes 66 as the number of cylinders. In the case of a single-cylinder compressor 2, the accumulator 7 only needs to be connected to the compressor 2 via one outlet pipe 66. In other words, the accumulator 7 only needs to have at least one outlet pipe 66, and it is preferred that the accumulator 7 have the same number of outlet pipes 66

as the number of cylinders of the compressor 2.

[0070] Each of the outlet pipes 66 discharges the gaseous refrigerant, which is separated from the refrigerant having flowed into the accumulator, out of the accumulator 7. Each of the outlet pipes 66 is fixed to the lower end plate 61c and is connected to the compressor 2. The portion of each outlet pipe 66 within the container 61 is a straight pipe extending along and parallel to the centerline of the body 61a.

[0071] Each of the outlet pipes 66 includes: an inlet opening 66i positioned in the refrigerant outlet chamber OR; and an outlet opening 66o communicating with the corresponding cylinder chamber 31 or 41. The inlet opening 66i corresponds to the upstream end of the outlet flow passage OP, and the outlet opening 66o corresponds to the downstream end of the outlet flow passage OP.

[0072] The plurality of outlet pipes 66 overlap with the plurality of communication pipes 65 in the radial direction of the container 61. That is, the inlet openings 66i of the plurality of outlet pipes 66 are disposed above the outlet openings 65o of the plurality of communication pipes 65.

[0073] The inlet openings 66i of the plurality of outlet pipes 66 are closer to the partition plate 62 than to the outlet openings 65o of the plurality of communication pipes 65. The outlet openings 65o of the plurality of communication pipes 65 are closer to the lower end plate 61c than to the inlet openings 66i of the plurality of outlet pipes 66.

[0074] In other words, the accumulator 7 is configured to be mountable on the compressor 2 in such a manner that the inlet openings 66i of the plurality of outlet pipes 66 are positioned above the outlet openings 65o of the plurality of communication pipes 65.

[0075] The inlet openings 66i of the plurality of outlet pipes 66 face upwardly toward the partition plate 62, and the outlet openings 65o of the plurality of communication pipes 65 face downwardly toward the lower end plate 61c.

[0076] The inlet openings 65i of the plurality of communication pipes 65 are closer to the upper end plate 61b than to the partition plate 62, and the inlet openings 66i of the plurality of outlet pipes 66 are closer to the partition plate 62 than to the lower end plate 61c.

[0077] Each of the inlet openings 65i of the plurality of communication pipes 65 is positioned at substantially the same height. In other words, the accumulator 7 is configured such that the inlet openings 65i of the plurality of communication pipes 65 can be positioned at substantially the same height.

[0078] The container 61 is an assembly of three members, which are divided at intermediate portions of the body 61a on the side of the upper end plate 61b and on the side of the lower end plate 61c and are hermetically joined. The inlet pipe 63, the strainer 71, and the separation plate 72 are preferably incorporated into the upper member prior to the assembly of the container 61. The outlet pipes 66 are preferably incorporated into the lower member prior to the assembly of the container 61. The

partition plate 62, the support plate 73, and the communication pipes 65 are preferably incorporated into the central member prior to the assembly of the container 61. The support plate 73 may be disposed at the division plane between the upper member and the central member or may be fixed to the interior of the central member.

[0079] The container 61 may be an assembly of two members, which are divided at an intermediate portion of the body 61a and are hermetically joined. The inlet pipe 63, the strainer 71, and the separation plate 72 are preferably incorporated into the upper member prior to the assembly of the container 61. The outlet pipes 66, the partition plate 62, the support plate 73, and the communication pipes 65 are preferably incorporated into the lower member prior to the assembly of the container 61. The support plate 73 may be disposed on the division plane between the two members or may be fixed to the interior of the lower member.

[0080] Fig. 4 is a cross-sectional view of the accumulator according to the embodiment of the present invention.

[0081] Fig. 4 is a cross-sectional view by which positional relationship among the container 61 of the accumulator 7, the plurality of communication pipes 65, and the plurality of outlet pipes 66 can be understood, for example, a crosssection view along the line IV-IV of Figs. 2 and 3.

[0082] As shown in Fig. 4, the inlet openings 66i of the plurality of outlet pipes 66 of the accumulator 7 according to the present embodiment are positioned so as not to vertically overlap with the outlet openings 65o of the plurality of communication pipes 65. In other words, the accumulator 7 is configured to be installable such that the inlet openings 66i of the plurality of outlet pipes 66 do not vertically overlap with the outlet openings 65o of the plurality of communication pipes 65.

[0083] The accumulator 7 according to the present embodiment includes: two outlet pipes 66 corresponding to the two cylinders of the compressor 2; and two communication pipes 65 that place the refrigerant inlet chamber IR in communication with the refrigerant outlet chamber OR. Accordingly, the two outlet pipes 66 and the two communication pipes 65 are alternately arranged or staggered in the circumferential direction of the container 61. Under such arrangement, the plurality of communication pipes 65 and the plurality of outlet pipes 66 overlap with each other as viewed in the radial direction of the container 61.

[0084] Under such positional relationship between the plurality of communication pipes 65 and the plurality of outlet pipes 66, even if the liquid level of the liquid refrigerant accumulated in the refrigerant inlet chamber IR reaches the inlet opening 65i of any of the communication pipes 65 and thereby causes the liquid refrigerant to flow downward through the communication passage CP of any of the communication pipes 65, the liquid refrigerant flowing out of the communication passage CP to the refrigerant outlet chamber OR is prevented from

flowing directly into the outlet flow passage OP through the inlet opening 66i of any outlet pipe 66.

[0085] In the accumulator 7 configured as described above, the refrigerant flowing from the inlet pipe 63 into the refrigerant inlet chamber IR within the container 61 impinges on the separation plate 72 and is separated into the gaseous refrigerant and the liquid refrigerant. The separated liquid refrigerant further flows downward within the refrigerant inlet chamber IR from the opening 72a of the separation plate 72, and accumulates from the bottom of the refrigerant inlet chamber IR, i.e., from the side of the partition plate 62. The separated gaseous refrigerant flows from the opening 72a of the separation plate 72 through the plurality of communication pipes 65 into the refrigerant outlet chamber OR. The gaseous refrigerant having flowed into the refrigerant outlet chamber OR is drawn into the outlet pipes 66 and delivered to the compressor 2.

[0086] Unless the liquid level of the liquid refrigerant accumulated in the refrigerant inlet chamber IR reaches the inlet openings 65i of the plurality of communication pipes 65, the accumulator 7 precludes the liquid refrigerant from flowing into the refrigerant outlet chamber OR.

[0087] Even in the case where the liquid level of the liquid refrigerant accumulated in the refrigerant inlet chamber IR reaches the inlet openings 65i of the plurality of communication pipes 65, the liquid refrigerant flows downward through the communication pipes 65 and accumulates from the bottom of the container 61, i.e., from the side of the lower end plate 61c. Even in this case, unless the liquid level of the liquid refrigerant accumulated in the refrigerant outlet chamber OR reaches the inlet openings 66i of the plurality of outlet pipes 66, the accumulator 7 precludes the liquid refrigerant from flowing into the outlet pipes 66. In this manner, the accumulator 7 can prevent liquid compression of the compressor 2 by multiple mechanisms.

[0088] Fig. 5 is a schematic diagram illustrating comparison of a supercharging effect between the accumulator according to the present embodiment and a conventional accumulator.

[0089] In Fig. 5, the horizontal axis represents the operating frequency of the crankshaft 15 of the compressor 2 in hertz (Hz, 1/second), and the vertical axis represents the normalized volumetric efficiency obtained by dividing the volumetric efficiency at each operating frequency by the maximum volumetric efficiency when the operating frequency of the compressor 2 is varied from 30 Hz to 120 Hz.

[0090] The conventional accumulator shown as a comparative example in Fig. 5 does not include any of the communication pipes 65 and the partition plate 62 of the accumulator 7 according to the present embodiment. The conventional accumulator is assumed to include: outlet pipes 66 that protrude from the lower end plate 61c into the internal space S of the container 61 so as to extend to the vicinity of the separation plate 72 and have inlet openings 66o facing the separation plate 72; and a

support plate 73 that supports the outlet pipes 66. In this conventional accumulator 7, the length of the straight-pipe portion of the outlet pipes 66 within the container 61 is assumed to be 0.35 times the length of the straight-pipe portion of the outlet pipes 66 within the container 61 according to the present embodiment.

[0091] In the case of being connected to exactly the same compressor 2, the volumetric efficiency of the conventional accumulator indicated by the dashed line α reaches its maximum at an operating frequency of 85 Hz, whereas the volumetric efficiency of the accumulator 7 according to the present embodiment indicated by the solid line β reaches its maximum at an operating frequency of 110 Hz. That is, the accumulator 7 according to the present embodiment exhibits a supercharging effect at higher frequencies as compared with the conventional accumulator. The accumulator 7 allows the pipe length of the suction piping system of the compressor 2 including the outlet pipes 66 and the communication pipes 65 to be readily adjusted to a pipe length necessary for the supercharging effect, and thus, provides an extremely high degree of design freedom in accordance with the characteristics of the compressor 2.

[0092] Next, the relationship among the total cross-sectional area ΣA_{ip} of the inlet passages IP, the total cross-sectional area ΣA_{cp} of the communication passages CP, and the total cross-sectional area ΣA_{op} of the outlet flow passages OP will be described.

[0093] The total cross-sectional area ΣA_{ip} of the inlet passages IP is substantially equal to the cross-sectional area A_{ip} of a single inlet pipe 63.

[0094] The total cross-sectional area ΣA_{cp} of the communication passages CP is the sum of the cross-sectional areas A_{cp} of the respective communication pipes 65. The cross-sectional areas A_{cp} of the plurality of communication pipes 65 may be equal to each other or may differ. In other words, the plurality of communication pipes 65 may be a plurality of pipes having the same inner diameter or a plurality of pipes having different inner diameters.

[0095] When an intended total cross-sectional area ΣA_{cp} can be achieved by using pipes having the same inner diameter in combination, it is sufficient for the plurality of communication pipes 65 to have the same inner diameter. When an intended total cross-sectional area ΣA_{cp} can be achieved by using pipes having different inner diameters in combination, the plurality of communication pipes 65 may have different inner diameters.

[0096] The total cross-sectional area ΣA_{op} of the outlet flow passages OP is the sum of the cross-sectional areas A_{op} of the respective outlet pipes 66. The cross-sectional areas A_{op} of the plurality of outlet pipes 66 may be equal to each other or may differ. In other words, the plurality of outlet pipes 66 may be a plurality of pipes having the same inner diameter or may be a plurality of pipes having different inner diameters. The cross-sectional area A_{op} of each of the outlet pipes 66 depends on the effective volume of the corresponding cylinder unit 26 or 27.

[0097] The total cross-sectional area ΣA_{ip} of the inlet passages IP is preferably larger than the total cross-sectional area ΣA_{op} of the outlet flow passages OP. This magnitude relationship of the flow-passage cross-sectional areas promotes stagnation and retention of the liquid refrigerant in the accumulator 7 and facilitates separation of the liquid refrigerant and the gaseous refrigerant.

[0098] Further, the total cross-sectional area ΣA_{cp} of the communication passages CP is preferably equal to or larger than the total cross-sectional area ΣA_{op} of the inlet passages IP. This magnitude relationship of the flow-passage cross-sectional areas facilitates a rapid flow of the gaseous refrigerant, separated in the refrigerant inlet chamber IR, into the refrigerant outlet chamber OR.

[0099] Fig. 6 is a schematic diagram illustrating relationship between the cross-sectional area of the communication passage and the cross-sectional area of the outlet passage of the accumulator according to the present embodiment.

[0100] In Fig. 6, the horizontal axis represents the area ratio AR obtained by dividing the total cross-sectional area ΣA_{cp} of the communication passages CP by the total cross-sectional area ΣA_{op} of the outlet flow passages OP, and the vertical axis represents the volumetric efficiency of the compressor 2 at the same operating frequency of the compressor 2.

[0101] The area ratio AR is obtained by dividing the total cross-sectional area ΣA_{cp} of the communication passages CP by the total cross-sectional area ΣA_{op} of the outlet flow passages OP.

[0102] As shown in Fig. 6, when the area ratio AR is less than 1.2, the volumetric efficiency of the compressor 2 increases rapidly. When the area ratio AR is 1.2 or larger, the volumetric efficiency of the compressor 2 converges at a sufficiently elevated level. Thus, the total cross-sectional area ΣA_{cp} of the communication passages CP is preferably 1.2 times or more the total cross-sectional area ΣA_{op} of the outlet flow passages OP.

[0103] Thus, it is preferred that the total cross-sectional area ΣA_{cp} of the plurality of communication passages CP be equal to or larger than the total ΣA_{ip} of the cross-sectional areas A_{ip} of the inlet passages IP and be 1.2 times or more the total ΣA_{op} of the cross-sectional areas A_{op} of the plurality of outlet flow passages OP. This magnitude relationship between the cross-sectional areas is preferably maintained even when the number of each of the inlet pipe 63, the communication pipes 65, and the outlet pipes 66 is one.

[0104] As shown in Fig. 6, the volumetric efficiency of the compressor 2 decreases when the area ratio AR exceeds a predetermined value. Specifically, when the area ratio AR exceeds 1.30, the volumetric efficiency of the compressor 2 exhibits a decreasing trend. When the area ratio AR exceeds 1.6, the volumetric efficiency of the compressor 2 falls below the volumetric efficiency at an area ratio of 1.2.

[0105] Furthermore, if the area ratio AR is increased excessively, i.e., if the communication passages CP are made excessively large, the proportion of the communication passages CP within the internal space S of the accumulator 7 becomes large, thereby limiting the liquid-refrigerant storage-capacity of the refrigerant inlet chamber IR and the refrigerant outlet chamber OR. Hence, the area ratio AR is more preferably 1.6 or less.

[0106] In general, the capacity and the inner dimension of the accumulator 7 to be mounted on the compressor 2 are appropriately varied depending on the operating capacity of the compressor 2. For example, the inner dimension of the accumulator 7 is generally three to six times the outer diameter of the outlet pipes 66. In the present embodiment, the inner dimension of the accumulator 7 is approximately five times the outer diameter of the outlet pipes 66. The inlet openings 65i of the communication pipes 65 are disposed so as not to face the plurality of openings formed in the separation plate 72. Thus, the refrigerant flowing through the plurality of openings of the separation plate 72 is prevented from being directly supplied to the inlet openings 65i of the communication pipes 65.

[0107] The total cross-sectional area ΣA_{cp} of the communication passage CP can reach its maximum value as long as both of the following conditions are satisfied: (i) the lower end portions of the plurality of communication pipes 65 and the upper end portions of the plurality of outlet pipes 66 vertically overlap with each other within the refrigerant outlet chamber OR; and (ii) the openings 72a of the separation plate 72 are positioned outside a virtual minimum circle that encloses the plurality of communication pipes 65 as viewed from the inlet pipes 63. In the case of adopting such positional relationship between the communication pipes 65 and the outlet pipes 66, setting the area ratio AR to 1.6 or less can prevent enlargement of the accumulator 7 while maintaining the high volumetric efficiency of the compressor 2 and without reducing the storage capacity of the liquid refrigerant in the refrigerant inlet chamber IR.

[0108] As described above, the accumulator 7 according to the present embodiment can be installed in such a manner that: the inlet opening 66i of at least one outlet pipe 66 is positioned above the outlet opening 65o of at least one communication pipe 65; and the inlet opening 66i of at least one outlet pipe 66 does not overlap with the outlet opening 65o of at least one communication pipe 65 in the vertical direction.

[0109] The compressor 2 and the refrigeration cycle apparatus 1 according to the present embodiments include the accumulator 7 in which: the inlet opening 66i of at least one outlet pipe 66 is positioned above the outlet opening 65o of at least one communication pipe 65; and the inlet opening 66i of at least one outlet pipe 66 does not overlap with the outlet opening 65o of at least one communication pipe 65 in the vertical direction.

[0110] Accordingly, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 can store the

liquid refrigerant in a multi-stage manner in the refrigerant inlet chamber IR and the refrigerant outlet chamber OR within the accumulator 7 even when the liquid refrigerant returns to the accumulator 7.

[0111] Under such a configuration, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 can prevent the liquid refrigerant from easily flowing out of at least one of the outlet pipes 66, thereby preventing liquid compression in the compressor 2.

[0112] Furthermore, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 can readily achieve both prevention of the liquid compression in the compressor 2 and utilization of the supercharging effect, which results from adjustment of the pipe length of the suction piping system of the compressor 2 including the outlet pipes 66 and the communication pipes 65 as shown in Fig. 5.

[0113] The accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 according to the present embodiments include: the inlet openings 66i of the outlet pipes 66 facing upwardly toward the partition plate 62; and the outlet openings 65o of the communication pipes 65 facing downwardly toward the lower end plate 61c. Further, the portions of the outlet pipes 66 within the container 61, the inlet pipe 63, and the communication pipes 65 are straight pipes extending in parallel with the centerline of the body 61a of the container 61. Accordingly, the accumulator 7 to be vertically installed, the compressor 2 to be vertically installed, and the refrigeration cycle apparatus 1 including them can readily achieve both the prevention of the liquid compression in the compressor 2 and the utilization of the supercharging effect.

[0114] Furthermore, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 according to the present embodiments include the inlet openings 66i of the outlet pipes 66 closer to the partition plate 62 than to the lower end plate 61c. Thus, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 ensure the storage capacity of the liquid refrigerant in the refrigerant outlet chamber OR. Maximizing the storage capacity of the liquid refrigerant in the refrigerant outlet chamber OR prevents the liquid refrigerant having flowed out of the communication pipes 65 into the refrigerant outlet chamber OR from immediately flowing into the compressor 2, even in the event of overflow of the liquid refrigerant from the refrigerant inlet chamber IR into the communication pipes 65.

[0115] The accumulator 7 according to the present embodiment includes the plurality of communication pipes 65 in which the inlet openings 65i can be positioned at substantially the same height. In addition, the compressor 2 and the refrigeration cycle apparatus 1 according to the present embodiments include the plurality of communication pipes 65 in which the inlet openings 65i are positioned at substantially the same height.

[0116] Hence, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 can readily estab-

lish positional relationship between the communication pipes 65 and the outlet pipes 66 in such a manner that: the flow cross-sectional areas of the communication passages CP is maintained; and the outlet openings 65o of the communication pipes 65 and the inlet openings 66i of the outlet pipes 66 do not overlap with each other in the vertical direction along which the liquid refrigerant flows downward.

[0117] In other words, even if the liquid level of the liquid refrigerant accumulated in the refrigerant inlet chamber IR reaches the inlet opening 65i of any of the communication pipes 65 and the liquid refrigerant flows downward through the communication passage CP of any of the communication pipes 65, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 prevent the liquid refrigerant flowing out of the communication passages CP into the refrigerant outlet chamber OR from outflowing directly into the outlet flow passages OP through the inlet openings 66i of the outlet pipes 66.

[0118] Further, the plurality of communication pipes 65 can be set such that their respective communication passages CP are individually different or the same, thereby readily adjusting the total pressure loss of the plurality of communication passages CP.

[0119] Further, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 according to the present embodiments include the plurality of outlet pipes 66. Thus, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 can readily be adapted to a multi-cylinder compressor 2.

[0120] The accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 according to the present embodiments include at least one communication pipe 65 for which the total ΣA_{cp} of the cross-sectional areas Acp is equal to or larger than the total ΣA_{ip} of the cross-sectional areas Aip of the inlet passages IP and is 1.2 times or more the total ΣA_{op} of the cross-sectional areas Aop of the plurality of outlet flow passages OP.

[0121] Accordingly, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 improve the gas-liquid separation performance of the accumulator 7 and promote the utilization of the supercharging effect, without obstructing the flow of the refrigerant within the accumulator 7 due to the pressure loss in at least one communication pipe 65, which places the refrigerant inlet chamber IR in communication with the refrigerant outlet chamber OR.

[0122] Moreover, the accumulator 7 and the refrigeration cycle apparatus 1 according to the present embodiments include the inlet pipe 63 for which the total ΣA_{ip} of the cross-sectional areas Aip is larger than the total ΣA_{op} of the cross-sectional areas Aop of the outlet flow passages OP. Accordingly, the accumulator 7, the compressor 2, and the refrigeration cycle apparatus 1 promote stagnation and retention of the liquid refrigerant in the accumulator 7 and thereby enhance the separation between the liquid refrigerant and the gaseous refrigerant.

[0123] Therefore, the accumulator 7, the compressor

2, and the refrigeration cycle apparatus 1 according to the present embodiments can achieve both the gas-liquid separation capability of reliably preventing an outflow of a liquid refrigerant (i.e., the gas-liquid separation capability of reliably preventing the liquid compression of the compressor 2) and easy adjustment of the pipe length of the suction piping system suitable for obtaining the supercharging effect of the compressor 2.

[0124] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions, and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

REFERENCE SIGNS LIST

[0125]

1	refrigeration cycle apparatus
2	rotary compressor
3	radiator
5	expansion device
6	heat absorber
7	accumulator
8	refrigerant piping
8b	suction pipe
8a	discharge pipe
11	sealed container
11a	body
11b	upper end plate
11c	lower end plate
12	electric motor
13	compression mechanism
14	frame
15	crankshaft
15a	middle portion
15b	lower end portion
16	main bearing
17	auxiliary bearing
18	sealed terminal portion
21	stator
22	rotor
23	lead wire
25	eccentric portion
25a	first eccentric portion
25b	second eccentric portion
26	first cylinder unit
27	second cylinder unit
29	partition plate
31	first cylinder chamber
32	first cylinder
33	first rolling piston

	41	second cylinder chamber
	42	second cylinder
	43	second rolling piston
	45	vane
5	55	first discharge muffler
	55, 56	bolt
	57	second discharge muffler
	58	bolt
	59	clamp band
10	61	container
	61a	body
	61b	upper end plate
	61c	lower end plate
	62	partition plate
15	63	inlet pipe
	65	communication pipe
	65i	inlet opening
	65o	outlet opening
	66	outlet pipe
20	66i	inlet opening
	66o	outlet opening
	71	strainer
	72	separation plate
	73	support plate

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Claims

1. An accumulator comprising:

30	a container;
	a partition plate that is provided within the container and divides an internal space of the container into a refrigerant inlet chamber and a refrigerant outlet chamber;
35	an inlet pipe that is fixed to the container and has an inlet passage communicating with the refrigerant inlet chamber;
40	at least one communication pipe that penetrates the partition plate and has a communication passage placing the refrigerant inlet chamber in communication with the refrigerant outlet chamber; and
45	at least one outlet pipe that is fixed to the container and has an outlet flow passage communicating with the refrigerant outlet chamber, wherein:
	the at least one communication pipe has an outlet opening positioned in the refrigerant outlet chamber;
50	the at least one outlet pipe has an inlet opening positioned in the refrigerant outlet chamber; and
55	the accumulator can be installed in such a manner that
	(i) the inlet opening of the at least one outlet pipe is positioned above the out-

let opening of the at least one communication pipe and
 (ii) the inlet opening of the at least one outlet pipe does not overlap with the outlet opening of the at least one communication pipe in a vertical direction.

2. The accumulator according to claim 1, wherein:

the container is cylindrical and includes a cylindrical body, an upper end plate closing one end of the body, and a lower end plate closing another end of the body;
 the inlet pipe is fixed to the upper end plate;
 the outlet pipe is fixed to the lower end plate;
 an inner portion of the outlet pipe within the container, the inlet pipe, and the communication pipe are straight pipes extending in a direction along a centerline of the cylindrical body;
 the inlet opening of the outlet pipe faces upwardly toward the partition plate; and
 the outlet opening of the communication pipe faces downwardly toward the lower end plate.

3. The accumulator according to claim 2, wherein the inlet opening of the outlet pipe is closer to the partition plate than to the lower end plate.

4. The accumulator according to claim 2 or claim 3, wherein:

the at least one communication pipe has an inlet opening positioned in the refrigerant inlet chamber; and
 the inlet opening of the communication pipe is closer to the upper end plate than to the partition plate.

5. The accumulator according to any one of claim 1 to claim 4, wherein:

the at least one communication pipe comprises a plurality of communication pipes;
 each of the communication pipes has an inlet opening positioned in the refrigerant inlet chamber; and
 the inlet opening of each of the plurality of communication pipes can be positioned at substantially a same height.

6. The accumulator according to any one of claim 1 to claim 5, wherein the at least one outlet pipe comprises a plurality of outlet pipes.

7. The accumulator according to any one of claim 1 to claim 6, wherein:

a total cross-sectional area of the communica-

tion passage is equal to or larger than a total cross-sectional area of the inlet passage and is also equal to or larger than 1.2 times a total cross-sectional area of the outlet flow passage; and
 the total cross-sectional area of the inlet passage is larger than the total cross-sectional area of the outlet flow passage.

8. A compressor comprising:

a sealed container;
 a compression mechanism that is accommodated in the sealed container;
 an electric motor that is accommodated in the sealed container and generates driving force of the compression mechanism; and
 the accumulator according to any one of claim 1 to claim 7, disposed outside the sealed container and connected to a suction side of the compression mechanism.

9. A refrigeration cycle apparatus comprising:

the compressor according to claim 8;
 a radiator;
 an expansion device;
 a heat absorber; and
 refrigerant piping that connects the compressor, the heat radiator, the expansion device, and the evaporator to circulate a refrigerant.

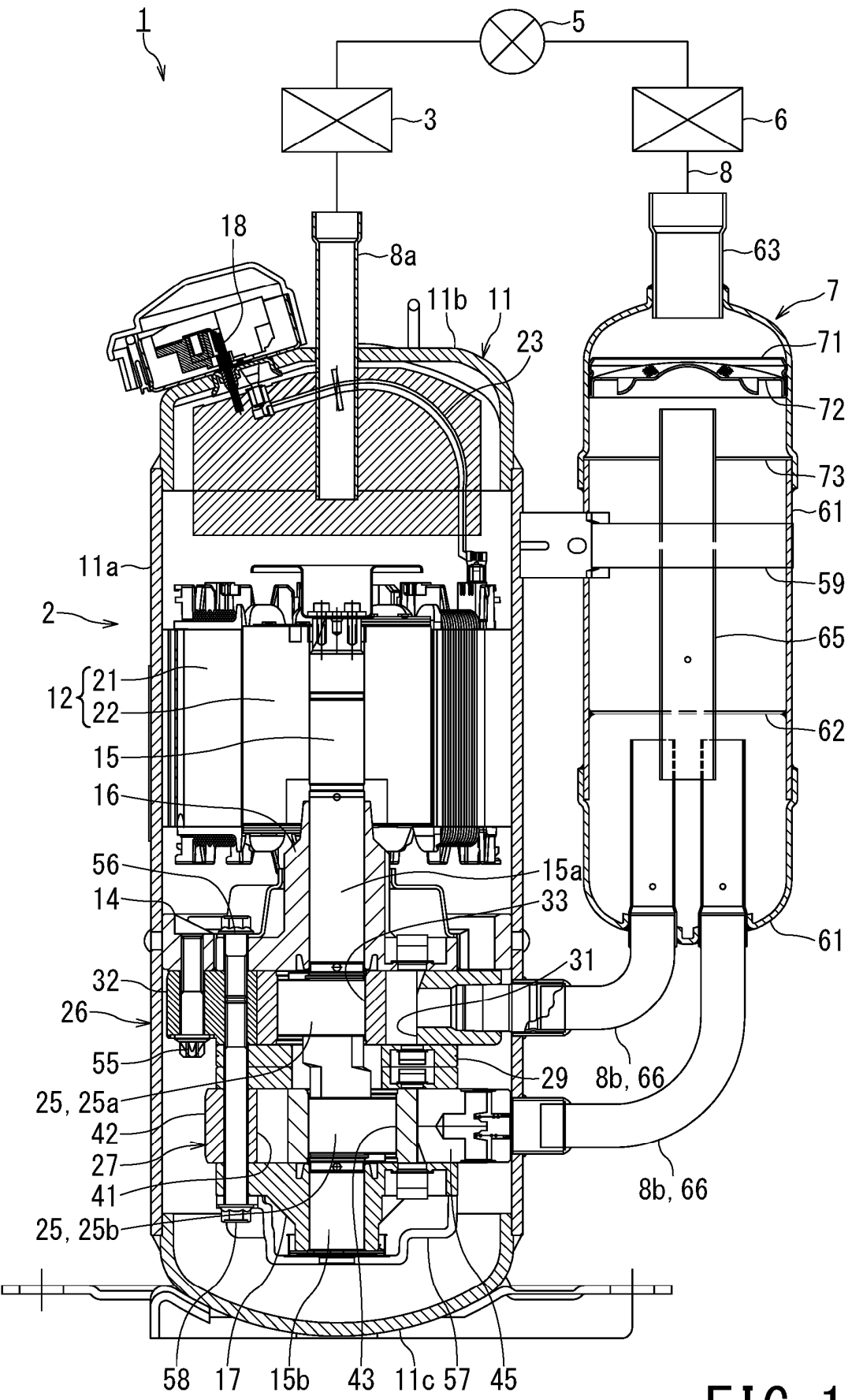


FIG. 1

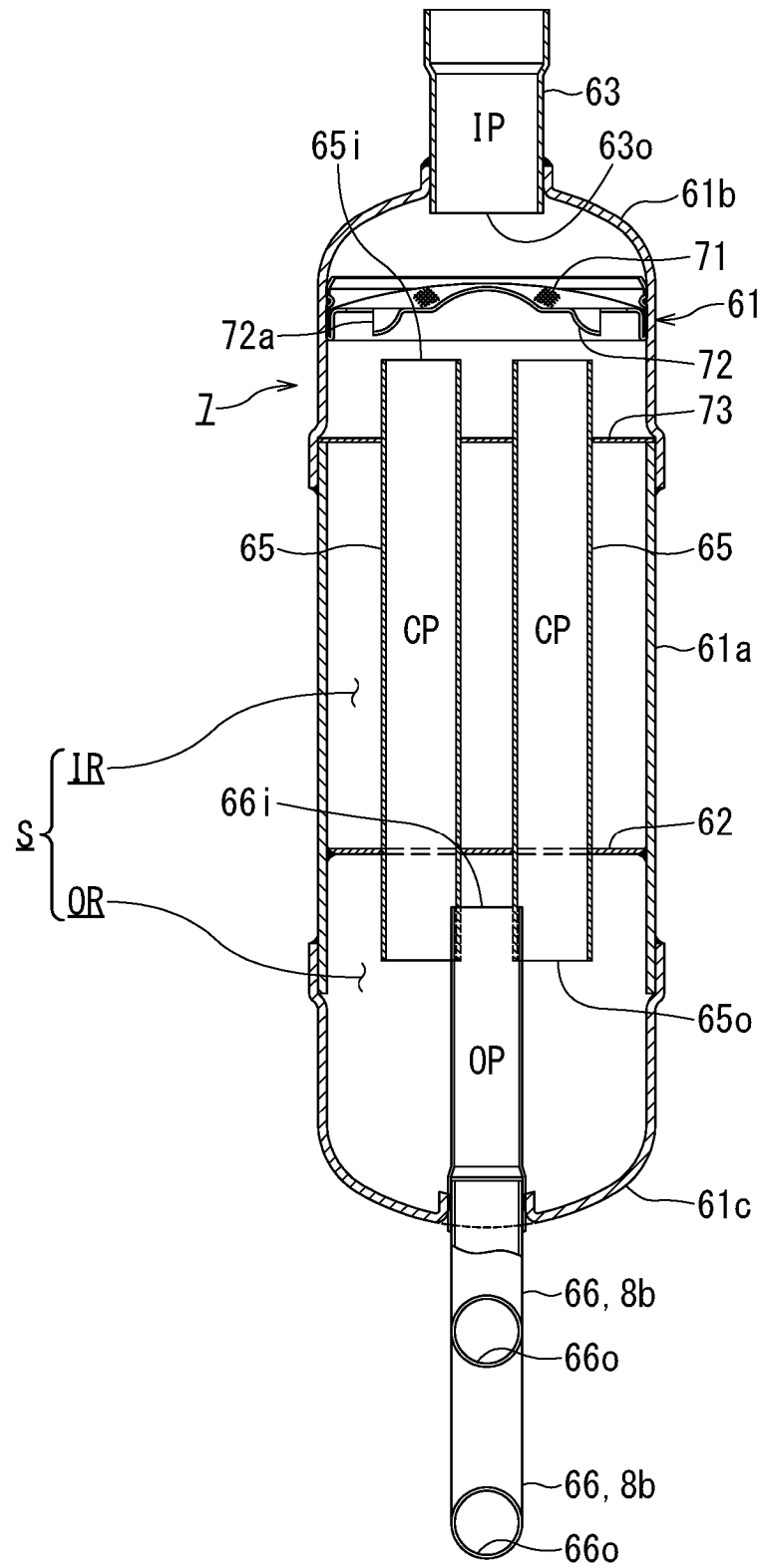


FIG. 2

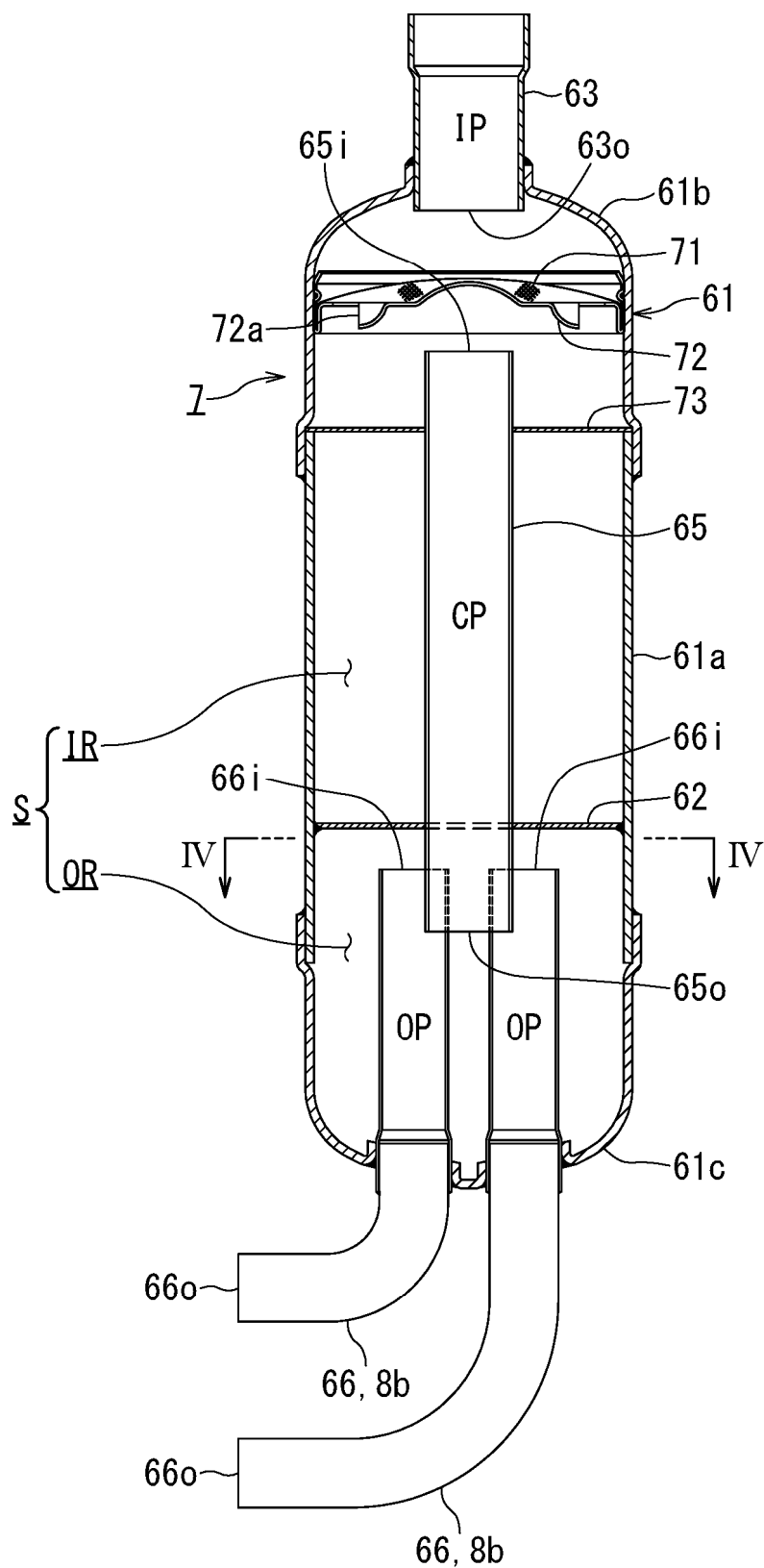


FIG. 3

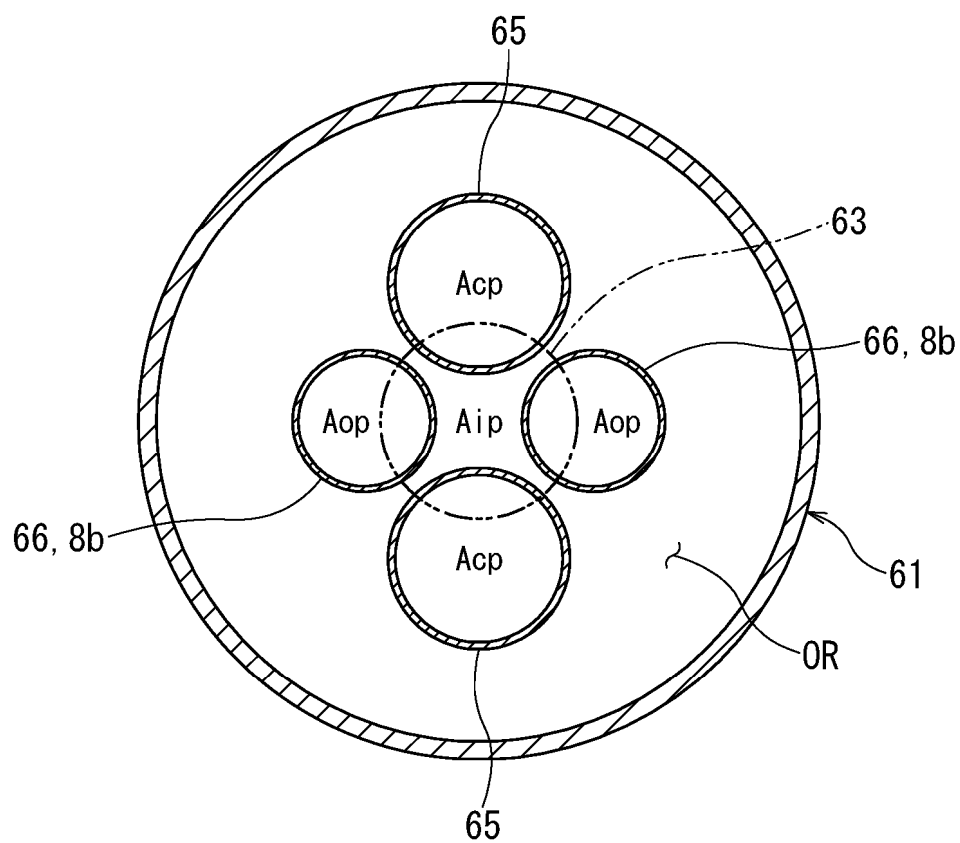


FIG. 4

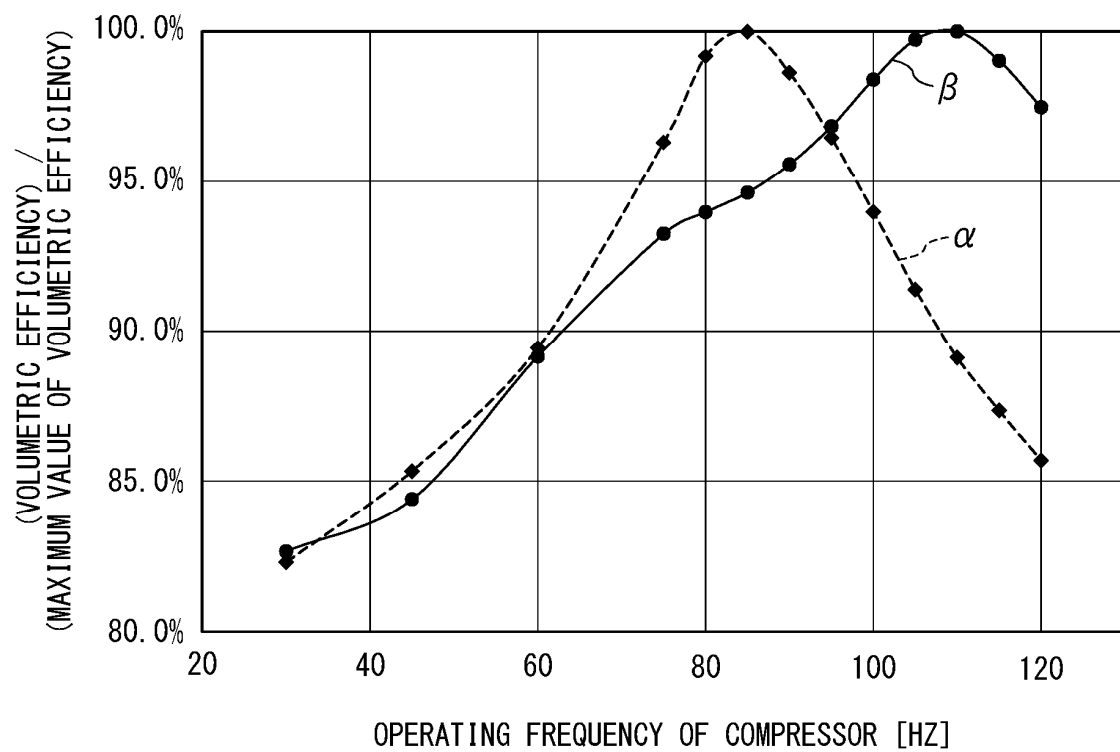


FIG. 5

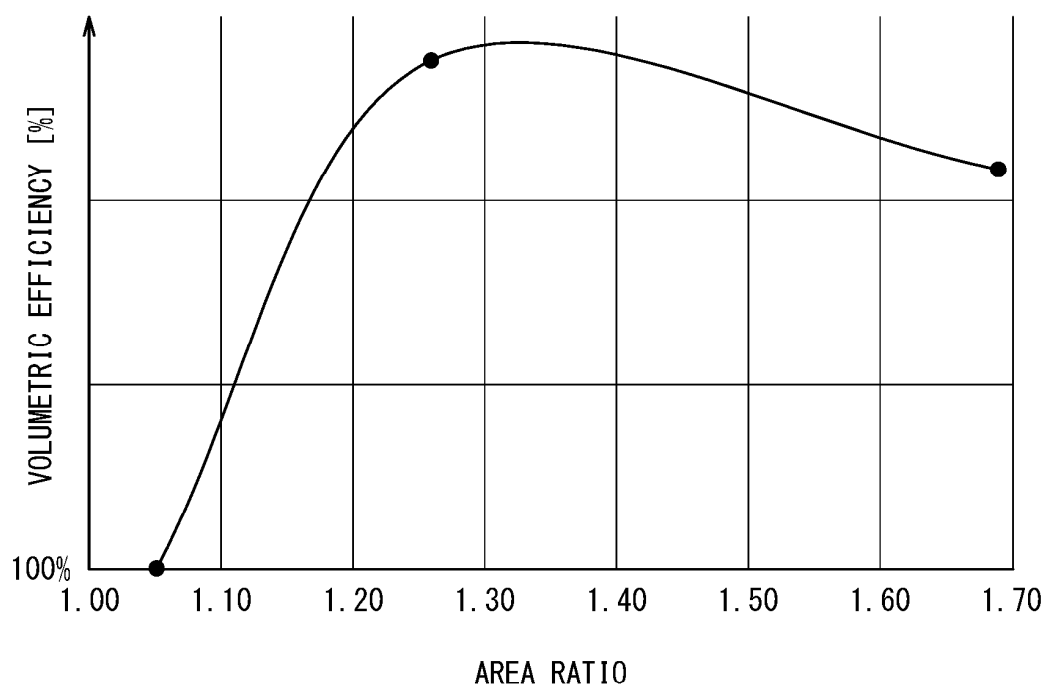


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2023/027686

A. CLASSIFICATION OF SUBJECT MATTER

F25B 43/00(2006.01)i
FI: F25B43/00 E

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)

F25B43/00; F04C29/12

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 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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	JP 2016-17694 A (FUJITSU GENERAL LIMITED) 01 February 2016 (2016-02-01) paragraphs [0011]-[0045], fig. 1-3	1-9
Y	JP 4-350479 A (IZUMI GIKEN KK) 04 December 1992 (1992-12-04) paragraphs [0008]-[0017], fig. 1, 3	1-9
Y	JP 8-271094 A (MATSUSHITA REFRIGERATION COMPANY) 18 October 1996 (1996-10-18) paragraphs [0014]-[0017], fig. 1-2	1-9
A	CN 207763306 U (GUANGDONG MEIZHI COMPRESSOR CO., LTD.) 24 August 2018 (2018-08-24) entire text, all drawings	1-9

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

12 September 2023

Date of mailing of the international search report

26 September 2023

Name and mailing address of the ISA/IP

Japan Patent Office (ISA/JP)
3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915
Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2023/027686

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	2016-17694	A	01 February 2016	(Family: none)	
JP	4-350479	A	04 December 1992	(Family: none)	
JP	8-271094	A	18 October 1996	(Family: none)	
CN	207763306	U	24 August 2018	(Family: none)	

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

REFERENCES CITED IN THE DESCRIPTION

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