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(54) **ROTARY COMPRESSOR**
ROTATIONSVERDICHTER
COMPRESSEUR ROTATIF

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Description

[Technical Field]

[0001] The present invention relates to a rotary compressor used for an air conditioner, for example.

[Background Art]

[0002] Japanese Unexamined Patent Publication No. 2016-118142 discloses a 2-cylinder rotary compressor which includes an upper cylinder and a lower cylinder and is configured to compress refrigerant in a compression chamber formed in each of the cylinders. An accumulator is attached adjacent to the compressor. The accumulator is connected to two suction pipes. One of the two suction pipes is connected to the upper cylinder whereas the other one of the suction pipes is connected to the lower cylinder. To the upper cylinder and the lower cylinder, the refrigerant is supplied from the accumulator through the respective suction pipes. In the compression chamber formed in each of the upper cylinder and the lower cylinder, a piston having a roller is provided. The compression chamber is divided by the piston into a low-pressure chamber into which the refrigerant is introduced and a high-pressure chamber in which the refrigerant is compressed.

[Citation List]

[Patent Literatures]

[0003]

[Patent Literature 1] Japanese Unexamined Patent Publication No. 2016-118142
WO 03/054391 discloses a compressor having the features of the preamble of independent claim 1.
JP H02 218884 discloses a different rotary compressor and measures to react to thermal loads.

[Summary of Invention]

[Technical Problem]

[0004] When a 2-cylinder rotary compressor is downsized, an external device such as an accumulator for supplying refrigerant is preferably downsized, too. It is, however, difficult to downsize the accumulator when two suction pipes are connected to the accumulator. To solve this problem, the accumulator may be downsized by connecting the 2-cylinder rotary compressor to the accumulator by a single suction pipe. This arrangement, however, is disadvantageous in that suction resistance may be increased by the branching of the suction pipe, and hence the compressor efficiency may be deteriorated.

[0005] An object of the present invention is to provide a rotary compressor which can be downsized and is able to suppress the deterioration of compressor efficiency.

[Solution to Problem]

[0006] A rotary compressor of the present invention is a rotary compressor comprising a compression mechanism and a driving mechanism including a drive shaft driving the compression mechanism, the compression mechanism and a driving mechanism being housed in the rotary compressor. The compression mechanism includes: a plurality of cylinders in which compression chambers are formed, respectively, the cylinders being aligned in the axial direction of the drive shaft so that the drive shaft is inside the compression chambers; a plurality of end plates provided at both ends of the cylinders in the axial direction to define the compression chambers; and a plurality of pistons provided in the respective compression chambers and driven by the drive shaft. The cylinders includes a first cylinder and a second cylinder adjacent to the first cylinder via one of the end plates. A suction passage including a first passage and a second passage branched from the first passage is formed in the rotary compressor, the first passage supplies the compression chamber of the first cylinder with refrigerant from an external device via a suction pipe, and the second passage supplies the compression chamber of the second cylinder with the refrigerant. The surface area of a region facing the suction passage in the second cylinder is smaller than the surface area of a region facing the suction passage in the first cylinder. A difference between the height of the second cylinder in the axial direction and the height in the axial direction of the piston provided in the compression chamber of the second cylinder is smaller than a difference between the height of the first cylinder in the axial direction and the height in the axial direction of the piston provided in the compression chamber of the first cylinder.

[0007] The external device may be an accumulator or a device which is provided between an accumulator and the rotary compressor of the present invention.

[0008] In the present invention the first passage may be arranged so that the first passage passes through the first cylinder but does not pass through the second cylinder, and the second passage is branched from the first passage may be the first cylinder and may pass through both the first cylinder and the second cylinder.

[0009] In the present invention the first cylinder may be configured to be inserted by the suction pipe so that a leading end of the suction pipe is in the first cylinder.

[0010] In the present invention an end plate arranged on the opposite side of the second cylinder with respect to the first cylinder may be configured to be inserted by the suction pipe so that a leading end of the suction pipe is in the end plate.

[0011] In the present invention preferably, in each of the cylinders, a difference between the height of the cylinder in the axial direction and the height in the axial direction of the piston provided in the compression chamber of the cylinder decreases as the surface area of a region facing the suction passage in the cylinder decreases.

[0012] In the present invention preferably, in each of the cylinders, a relation $3.9\times0.0001\leq(Hc-Hp)/Hc-1.4\times0.0001\times As/(Hc\cdot Ls)\leq6.7\times0.0001$ is satisfied where the height of the cylinder in the axial direction is denoted as He (mm), the height in the axial direction of the piston provided in the compression chamber in the cylinder is denoted as Hp (mm), the surface area of a region facing the suction passage in the cylinder is denoted as As (mm^2), and the length of the suction passage in the cylinder in a direction orthogonal to the axial direction is denoted as Ls (mm).

[Advantageous Effects of Invention]

[0013] A suction passage is formed in the rotary compressor of the present invention, and the suction passage includes a first passage through which refrigerant is supplied to the compression chamber of the first cylinder and a second passage which is branched from the first passage and through which the refrigerant is supplied to the compression chamber of the second cylinder. The surface area of a region facing the suction passage in the second cylinder is smaller than the surface area of a region facing the suction passage in the first cylinder. For this reason, as compared to the first cylinder, the decrease in temperature of the refrigerant at around the region facing the suction passage in the cylinder is small in the second cylinder. For this reason, a difference in temperature between the second cylinder and the piston provided in the compression chamber of the second cylinder is small, with the result that a difference in amount of dimensional change between the second cylinder and the piston at thermal expansion is small. In this rotary compressor, the difference between the height of the cylinder and the height of the piston (i.e., the gap between the end face of the piston in the axial direction and the end face of the end plate in the axial direction) is arranged to be small in the second cylinder as compared to the first cylinder, with the result that oil leakage from the inner periphery of the piston to the compression chamber is suppressed, and the volume efficiency and the indicated efficiency are thereby improved for the second cylinder. Therefore, even when the two cylinders are connected to the external device by a single suction pipe in order to downsize the compressor, the decrease in compressor efficiency due to the increase in suction resistance is compensated by the improvement in volume efficiency and indicated efficiency, with the result that the decrease in compressor efficiency is suppressed. To put it differently, downsizing of the compressor and suppression of decrease in compressor efficiency are both achieved.

[Brief Description of Drawings]

[0014]

[FIG. 1] FIG. 1 is a view showing a rotary compressor of First Embodiment of the present invention, together with an accumulator.
[FIG. 2A] FIG. 2A is a top view of an upper cylinder of the rotary compressor shown in FIG. 1.
[FIG. 2B] FIG. 2B is a top view of a lower cylinder of the rotary compressor shown in FIG. 1.
[FIG. 3] FIG. 3 is a partially enlarged view of a compression mechanism of the rotary compressor shown in FIG. 1.
[FIG. 4] FIG. 4 is a view showing a rotary compressor of Second Embodiment of the present invention.
[FIG. 5A] FIG. 5A is a top view of an upper cylinder of the rotary compressor shown in FIG. 4.
[FIG. 5B] FIG. 5B is a top view of a lower cylinder of the rotary compressor shown in FIG. 4.
[FIG. 6] FIG. 6 is a partially enlarged view of a compression mechanism of the rotary compressor shown in FIG. 4.
[FIG. 7] FIG. 7 is a view showing a rotary compressor of Third Embodiment of the present invention.
[FIG. 8] FIG. 8 is a partially enlarged view of a compression mechanism of the rotary compressor shown in FIG. 7.
[FIG. 9] FIG. 9 is a graph showing results of a test conducted by using plural rotary compressors.

[Description of Embodiments]

[First Embodiment]

[0015] To begin with, a rotary compressor 1 of First Embodiment will be described with reference to FIG. 1 to FIG. 3. As shown in FIG. 1, the compressor 1 of the present embodiment is a 2-cylinder rotary compressor which includes a closed container 2 and further includes a driving mechanism 3 and a compression mechanism 4 which are housed in the closed container 2. The closed container 2 is a cylindrical container which is closed at both upper and lower ends. An accumulator 5 is attached adjacent to the closed container 2. The accumulator 5 is connected to the compression mechanism 4 by a single suction pipe 6 through which refrigerant is introduced. An outlet tube 7 is provided at an upper part of the closed container 2 to discharge the refrigerant compressed by the compression mechanism 4. Lubricating oil is stored at a bottom portion of the closed container 2.

[0016] The compressor 1 is, for example, incorporated in a refrigerating cycle in an air conditioner, and is configured to compress refrigerant supplied from the suction pipe 6 and discharge the refrigerant from the outlet tube 7. The refrigerant used in the compressor 1 is, for example, R32 or R410A. The compressor 1 is oriented as shown in FIG. 1, i.e., is oriented such that the axial direction (which is identical with the axial direction of a later-described drive shaft 3b) of the compressor 1 is parallel to the up-down direction.

[0017] The driving mechanism 3 is provided to drive the compression mechanism 4, and is constituted by a motor 3a which is a driving source and the drive shaft 3b attached to the motor 3a. The motor 3a includes a substantially annular stator 3aa fixed to the inner circumferential surface of the closed container 2 and a substantially annular rotor 3ab provided radially inside the stator 3aa with an air gap being formed between the stator and the rotor. The rotor 3ab includes a magnet (not shown) whereas the stator 3aa includes a coil (not shown).

[0018] The drive shaft 3b is fixed to the inner circumferential surface of the rotor 3ab, and rotates on its axis together with the rotor 3ab so as to drive the compression mechanism 4. The drive shaft 3b has eccentric portions 3c and 3d which are in a later-described compression chamber 31 and in a later-described compression chamber 51, respectively (see FIG. 2A, FIG. 2B, and FIG. 3). Each of the eccentric portions 3c and 3d is cylindrical in shape, and has a central axis which is eccentric from the rotation center of the drive shaft 3b. To the eccentric portions 3c and 3d, pistons 32 and 52 of the compression mechanism 4 are attached, respectively.

[0019] Inside a substantially lower half of the drive shaft 3b, an oil supply passage (not shown) is formed. The oil supply passage extends along the up-down direction and is branched at several parts in radial directions of the drive shaft 3b. A helical-blade-shaped pump member (not shown) is attached to the lower end of the drive shaft 3b to suck the lubricating oil into the oil supply passage in accordance with the rotation of the drive shaft 3b. The lubricating oil sucked from the lower end of the drive shaft 3b by the pump member is discharged from a side face of the drive shaft 3b and is supplied to slide members of the compression mechanism 4, such as the compression chambers 31 and 51, for example.

[0020] The compression mechanism 4 includes upper mufflers 10a and 10b, an upper head 20 (end plate), an upper cylinder 30 (cylinder), a middle plate 40 (end plate), a lower cylinder 50 (cylinder), a lower head 60 (end plate), and a lower muffler 70. These members are provided in this order from top to bottom, along the axial direction of the drive shaft 3b.

[0021] As shown in FIG. 1 and FIG. 2A, the upper cylinder 30 is a substantially circular plate. At a central portion of the upper cylinder 30, the compression chamber 31 is formed as a circular hole penetrating the upper cylinder 30 in the axial direction of the drive shaft 3b. The piston 32 is provided in the compression chamber 31. The piston 32 is constituted by an annular roller 32a and a blade 32b which extends radially outward from the outer circumferential surface of the roller 32a. The roller 32a is attached to be rotatable relative to the outer circumferential surface of the eccentric portion 3c and is provided in the compression chamber 31.

[0022] As shown in FIG. 2A and FIG. 3, in the upper cylinder 30, a lateral passage 30a which extends in the radial direction of the upper cylinder 30 is formed as a suction passage for introducing refrigerant into the compression chamber 31. A radially inner end portion of the lateral passage 30a is open at the compression chamber 31, whereas a radially outer end portion of the lateral passage 30a is open at the outer circumferential surface of the upper cylinder 30. The suction pipe 6 is inserted into the lateral passage 30a from the radially outer end portion of the lateral passage 30a, and a leading end of the suction pipe 6 is at around the center of the lateral passage 30a. In the upper cylinder 30, a vertical passage 30b which extends vertically downward from the lateral passage 30a is formed as a suction passage for introducing refrigerant into the compression chamber 51. The vertical passage 30b is branched from a part of the lateral passage 30a, which is between the radially inner end portion of the lateral passage 30a and the leading end of the suction pipe 6. The vertical passage 30b extends vertically downward and is open at the bottom surface of the upper cylinder 30.

[0023] As shown in FIG. 2A, a blade accommodation portion 33 is formed in the upper cylinder 30. This portion 33 is a recess formed radially outward from the circumferential wall surface of the compression chamber 31. A pair of bushes 34 are housed in the blade accommodation portion 33 to oppose each other in the circumferential direction of the upper cylinder 30. Each bush 34 is a half of a substantially cylindrical member. The pair of bushes 34 are swingable in the blade accommodation portion 33 while the blade 32b is provided between them. Between the pair of bushes 34, the blade 32b is movable in the radial direction of the upper cylinder 30. The compression chamber 31 is divided into a low-pressure chamber and a high-pressure chamber by the blade 32b.

[0024] As shown in FIG. 1, the upper head 20 is provided to be in contact with the upper end face of the upper cylinder 30. The compression chamber 31 is defined on account of the closure of the upper end of the compression chamber 31 by the upper head 20. The upper head 20 is substantially annular in shape, and the drive shaft 3b is rotatably inserted at a central portion of the upper head 20. The upper head 20 is fixed to the inner circumferential surface of the closed container 2 by welding, for example.

[0025] The upper mufflers 10a and 10b are provided above the upper head 20. Between the upper head 20 and the upper muffler 10b and between the upper muffler 10a and the upper muffler 10b, an upper muffler space is formed. This upper muffler space is provided for the purpose of reducing noise due to the discharge of the refrigerant.

[0026] As shown in FIG. 2A, a discharge hole 35 is formed in the upper head 20 to cause the compression chamber 31 to communicate with the upper muffler space so that the refrigerant compressed in the compression chamber 31 is discharged to the upper muffler space. The discharge hole 35 is closed by a plate-shaped discharge valve (not shown) . The discharge valve is elastically deformed when the pressure in the compression chamber 31 becomes equal to or higher than a predetermined pressure, with the result that the discharge hole 35 is opened.

[0027] The middle plate 40 is a circular plate and is provided to be in contact with the lower end face of the upper cylinder 30 and the upper end face of the lower cylinder 50 as shown in FIG. 1. As shown in FIG. 3, the middle plate 40 closes the lower end of the compression chamber 31 of the upper cylinder 30 to define the compression chamber 31 and closes the upper end of the compression chamber 51 of the lower cylinder 50 to define the compression chamber 51. In the middle plate 40, a vertical passage 40a connected to the vertical passage 30b of the upper cylinder 30 is formed as a suction passage for introducing the refrigerant into the compression chamber 51. The vertical passage 40a connects the vertical passage 30b of the upper cylinder 30 to a later-described lateral passage 50a of the lower cylinder 50.

[0028] As shown in FIG. 1 and FIG. 2B, the lower cylinder 50 which is adjacent to the upper cylinder 30 via the middle plate 40 is a substantially circular plate in the same manner as the upper cylinder 30. At a central portion of the lower cylinder 50, the compression chamber 51 is formed as a circular hole penetrating the lower cylinder 50 in the axial direction of the drive shaft 3b. The piston 52 is provided in the compression chamber 51. The piston 52 is constituted by an annular roller 52a and a blade 52b which extends radially outward from the outer circumferential surface of the roller 52a. The roller 52a is attached to be rotatable relative to the outer circumferential surface of the eccentric portion 3d and is provided in the compression chamber 51.

[0029] As shown in FIG. 2B and FIG. 3, in the lower cylinder 50, a lateral passage 50a which extends in the radial direction of the lower cylinder 50 is formed as a suction passage for introducing the refrigerant into the compression chamber 51. The lateral passage 50a is a cutout formed in the top surface of the lower cylinder 50. A radially inner end portion of the lateral passage 50a is open at the compression chamber 51. A radially outer end portion of the lateral passage 50a is closed by the wall surface of the lower cylinder 50 in the radial direction and is open upward. As shown in FIG. 3, the radially outer end portion of the lateral passage 50a is connected to the vertical passage 40a of the middle plate 40 at the upward opening. Except at the opening, the lateral passage 50a is closed by the bottom surface of the middle plate 40.

[0030] As shown in FIG. 2B, a blade accommodation portion 53 is formed in the lower cylinder 50. This portion 53 is a recess formed radially outward from the circumferential wall surface of the compression chamber 51. A pair of bushes 54 are housed in the blade accommodation portion 53 to oppose each other in the circumferential direction of the lower cylinder 50. Each bush 54 is a half of a substantially cylindrical member. The pair of bushes 54 are swingable in the blade accommodation portion 53 while the blade 52b is provided between them. Between the pair of bushes 54, the blade 52b is movable in the radial direction of the lower cylinder 50. The compression chamber 51 is divided into a low-pressure chamber and a high-pressure chamber by the blade 52b.

[0031] As shown in FIG. 1, the lower head 60 is provided to be in contact with the lower end face of the lower cylinder 50. The compression chamber 51 is defined on account of the closure of the lower end of the compression chamber 51 by the lower head 60. The lower head 60 is substantially annular in shape, and the drive shaft 3b is rotatably inserted at a central portion of the lower head 60.

[0032] The lower muffler 70 is provided below the lower head 60. A lower muffler space is formed between the lower head 60 and the lower muffler 70. This lower muffler space is provided for the purpose of reducing noise due to the discharge of the refrigerant.

[0033] As shown in FIG. 2B, a discharge hole 55 is formed in the lower head 60 to cause the compression chamber 51 to communicate with the lower muffler space so that the refrigerant compressed in the compression chamber 51 is discharged to the lower muffler space. The discharge hole 55 is closed by a plate-shaped discharge valve (not shown) . The discharge valve is elastically deformed when the pressure in the compression chamber 51 becomes equal to or higher than a predetermined pressure, with the result that the discharge hole 55 is opened.

[0034] The lower muffler space communicates with the upper muffler space via the through holes formed in the lower head 60, the lower cylinder 50, the middle plate 40, the upper cylinder 30, and the upper head 20,

[0035] A suction passage including an upper suction passage (first passage) and a lower suction passage (second passage) branched from the upper suction passage (first passage) is formed in the rotary compressor 1 of the present embodiment. The upper suction passage supplies the compression chamber 31 of the upper cylinder 30 with refrigerant. The upper suction passage supplies the compression chamber 51 of the lower cylinder 50 with the refrigerant. In the present embodiment, the upper suction passage is a part of the lateral passage 30a formed in the upper cylinder 30 and is a horizontal passage from the leading end of the suction pipe 6 to the compression chamber 31. The upper suction passage passes through the upper cylinder 30 but does not pass through the lower cylinder 50. The lower suction passage is constituted by the vertical passage 30b formed in the upper cylinder 30, the vertical passage 40a formed in the middle plate 40, and the lateral passage 50a formed in the lower cylinder 50 (see FIG. 3). The lower suction passage passes through both of the upper cylinder 30 and the lower cylinder 50.

[0036] To put it differently, in the upper cylinder 30, a horizontal passage from the leading end of the suction pipe 6 to the compression chamber 31 in the lateral passage 30a (not including a part from the leading end of the suction pipe 6 to the radially outer end portion of the lateral passage 30a of the lateral passage 30a) and the vertical passage 30b constitute the suction passage. The lateral passage 50a constitutes the suction passage in the lower cylinder 50. In the present embodiment, the surface area of a region facing the suction passage in the lower cylinder 50 is smaller than the surface area of a region facing the suction passage in the upper cylinder 30.

[0037] The phrase "the surface area of a region facing a suction passage in a cylinder" indicates the surface area of the inner circumferential surface of a wall of the cylinder, which constitutes the suction passage, i.e., the surface area of a wall surface of the cylinder, where the refrigerant sucked from the accumulator 5 passes through. On this account, the surface area of the region facing the suction passage in the upper cylinder 30 is equal to the total of the surface area of the region facing the horizontal passage from the leading end of the suction pipe 6 to the compression chamber 31 in the lateral passage 30a and the surface area of the region facing the vertical passage 30b, and the surface area of the region facing the suction passage in the lower cylinder 50 is equal to the surface area of the region facing the lateral passage 50a.

[0038] In the lower cylinder 50 in which the surface area of the region facing the suction passage is small as compared to the upper cylinder 30, the decrease in temperature of the refrigerant at around the region facing the suction passage is small as compared to the upper cylinder 30. For this reason, a difference in temperature between the lower cylinder 50 and the piston 52 provided in the compression chamber 51 of the lower cylinder 50 is small, with the result that a difference in amount of dimensional change between the lower cylinder 50 and the piston 52 at thermal expansion is small.

[0039] Accordingly, in the compressor 1 of the present embodiment, as shown in FIG. 3, the difference between the height A3 of the lower cylinder 50 and the height A4 of the piston 52 in the compression chamber 51 of the lower cylinder 50 is smaller than the difference between the height A1 of the upper cylinder 30 and the height A2 of the piston 32 in the compression chamber 31 of the upper cylinder 30 ($A3-A4<A1-A2$). The difference between the height A1 of the upper cylinder 30 and the height A2 of the piston 32 and the difference between the height A3 of the lower cylinder 50 and the height A4 of the piston 52 are those when the compressor 1 is not driven (i.e., at normal temperature).

[0040] A suction passage including an upper suction passage and a lower suction passage branched from the upper suction passage is formed in the rotary compressor 1 of the present embodiment. The upper suction passage supplies the compression chamber 31 of the upper cylinder 30 with refrigerant. The suction pipe 6 is connected to the compression chamber 31. The lower suction passage supplies the compression chamber 51 of the lower cylinder 50 with the refrigerant. The surface area of a region facing the suction passage in the lower cylinder 50 is smaller than the surface area of a region facing the suction passage in the upper cylinder 30. For this reason, as compared to the upper cylinder 30, the decrease in temperature of the refrigerant at around the region facing the suction passage in the cylinder is small in the lower cylinder 50. On this account, a difference in temperature between the lower cylinder 50 and the piston 52 provided in the compression chamber 51 of the lower cylinder 50 is small, with the result that a difference in amount of dimensional change between the lower cylinder 50 and the piston 52 at thermal expansion is small. As a result, as compared to the upper cylinder 30, problems are less likely to occur in the lower cylinder 50 even when the gaps between the end face in the axial direction of the piston 52 and the end faces in the axial direction of the end plates 40 and 60 adjacent to the piston 52 are narrow. This suppresses oil leakage from the inner periphery of the piston to the compression chamber and improves the volume efficiency and the indicated efficiency. Therefore, even when the two cylinders 30 and 50 are connected to the accumulator 5 by a single suction pipe 6 in order to downsize the compressor 1, the decrease in compressor efficiency due to the increase in suction resistance is compensated by the improvement in volume efficiency and indicated efficiency, with the result that the decrease in compressor efficiency is suppressed. As such, downsizing of the compressor 1 and suppression of decrease in compressor efficiency are both achieved in the present embodiment.

[0041] In the present embodiment, the upper suction passage (first passage) passes through the upper cylinder 30 but does not pass through the lower cylinder 50, whereas the lower suction passage (second passage) is branched from the upper suction passage in the upper cylinder 30 and passes through both the upper cylinder 30 and the lower cylinder

50. With this arrangement, it is possible to easily construct the structure in which the surface area of the region facing the suction passage in the lower cylinder 50 is smaller than the surface area of the region facing the suction passage in the upper cylinder 30.

[0042] In addition to the above, in the present embodiment, the upper cylinder 30 is configured to be inserted by the suction pipe 6 so that the leading end of the suction pipe 6 is provided inside the upper cylinder 30. With this arrangement, the passage for the refrigerant from the leading end of the suction pipe 6 to the compression chamber 31 of the upper cylinder 30 is constituted solely of the linear lateral passage 30a, with the result that the increase in suction resistance is suppressed.

[Second Embodiment]

[0043] The following will describe a compressor of Second Embodiment with reference to FIG. 4 to FIG. 6. While the compressor 1 of First Embodiment is arranged so that the upper cylinder 30 is configured to be inserted by the suction pipe 6 of the accumulator 5, the compressor 101 of the present embodiment is different from the compressor of First Embodiment in that an upper head 120 is configured to be inserted by a suction pipe 6 of an accumulator 5. In the present embodiment, structures identical with those of First Embodiment are denoted by the same reference symbols and may not be explained.

[0044] In the compressor 101 of the present embodiment, a driving mechanism 3 and a compression mechanism 104 are housed. In this compressor 101, as shown in FIG. 5A and FIG. 6, a lateral passage 120a extending in the radial direction of the upper head 120 and a vertical passage 120b extending vertically downward from the lateral passage 120a are formed in the upper head 120 which opposes a lower cylinder 50 over an upper cylinder 130, as a suction passage for introducing refrigerant into a compression chamber 31 of the upper cylinder 130. A radially inner end portion of the lateral passage 120a is closed by the wall surface of the upper head 120 in the radial direction and is open downward. The radially inner end portion of the lateral passage 120a is connected to a lateral passage 130a of the upper cylinder 130 at the downward opening. A radially outer end portion of the lateral passage 120a is open at the outer circumferential surface of the upper head 120. The suction pipe 6 is inserted into the lateral passage 120a, and a leading end of the suction pipe 6 is at around the center of the lateral passage 120a.

[0045] In the upper cylinder 130, the lateral passage 130a which extends in the radial direction of the upper cylinder 130 is formed as a suction passage for introducing the refrigerant into the compression chamber 31 of the upper cylinder 130. The lateral passage 130a is a cutout formed in the top surface of the upper cylinder 130. A radially inner end portion of the lateral passage 130a is open at the compression chamber 31. A radially outer end portion of the lateral passage 130a is closed by the wall surface of the upper cylinder 130 in the radial direction and is open upward. The radially outer end portion of the lateral passage 130a is connected to the vertical passage 120b of the upper head 120 at the upward opening. Except at the opening, the lateral passage 130a is closed by the bottom surface of the upper head 120. In the upper cylinder 130, a vertical passage 130b which extends vertically downward from the lateral passage 130a is formed as a suction passage for introducing the refrigerant into the compression chamber 51 of a lower cylinder 150. The vertical passage 130b is branched from the lateral passage 130a, extends vertically downward, and is open at the bottom surface of the upper cylinder 130.

[0046] In the middle plate 40, a vertical passage 40a connected to the vertical passage 130b of the upper cylinder 130 is formed as a suction passage for introducing the refrigerant into the compression chamber 51 of the lower cylinder 50. The vertical passage 40a connects the vertical passage 130b of the upper cylinder 130 to a later-described lateral passage 50a of the lower cylinder 50.

[0047] As shown in FIG. 5B and FIG. 6, in the lower cylinder 50 adjacent to the upper cylinder 130 via the middle plate 40, a lateral passage 50a which extends in the radial direction of the lower cylinder 50 is formed as a suction passage for introducing the refrigerant into the compression chamber 51. The lateral passage 50a is a cutout formed in the top surface of the lower cylinder 50. A radially inner end portion of the lateral passage 50a is open at the compression chamber 51. A radially outer end portion of the lateral passage 50a is closed by the wall surface of the lower cylinder 50 in the radial direction and is open upward. As shown in FIG. 6, the radially outer end portion of the lateral passage 50a is connected to the vertical passage 40a of the middle plate 40 at the upward opening. Except at the opening, the lateral passage 50a is closed by the bottom surface of the middle plate 40.

[0048] A suction passage including an upper suction passage (first passage) and a lower suction passage (second passage) branched from the upper suction passage (first passage) is formed in the rotary compressor 101 of the present embodiment. The upper suction passage supplies the compression chamber 31 of the upper cylinder 130 with refrigerant. The lower suction passage supplies the compression chamber 51 of the lower cylinder 50 with the refrigerant. In the present embodiment, the upper suction passage is constituted by (i) a horizontal passage from the leading end of the suction pipe 6 to the radially inner end portion of the lateral passage 50a and the vertical passage 120b in the lateral passage 120a, which are formed in the upper head 120 and (ii) the lateral passage 130a formed in the upper cylinder 130. The lower suction passage is constituted by the vertical passage 130b formed in the upper cylinder 130, the vertical passage 40a formed in the middle plate 40, and the lateral passage 50a formed in the lower cylinder 50 (see FIG. 6).

[0049] To put it differently, the lateral passage 130a and the vertical passage 130b constitute the suction passage in the upper cylinder 130. The lateral passage 50a constitutes the suction passage in the lower cylinder 50. In the present embodiment, the surface area of a region facing the suction passage in the lower cylinder 50 is smaller than the surface area of a region facing the suction passage in the upper cylinder 130.

[0050] In the lower cylinder 50 in which the surface area of the region facing the suction passage is small as compared to the upper cylinder 130, the decrease in temperature of the refrigerant at around the region facing the suction passage is small as compared to the upper cylinder 130. On this account, a difference in temperature between the lower cylinder 50 and the piston 52 provided in the compression chamber 51 of the lower cylinder 50 is small, with the result that a difference in amount of dimensional change between the lower cylinder 50 and the piston 52 at thermal expansion is small.

[0051] Accordingly, in the compressor 101 of the present embodiment, as shown in FIG. 6, the difference between the height A3 of the lower cylinder 50 and the height A4 of the piston 52 in the compression chamber 51 of the lower cylinder 50 is smaller than the difference between the height A1 of the upper cylinder 130 and the height A2 of the piston 32 in the compression chamber 31 of the upper cylinder 130 (A3-A4<A1-A2). The difference between the height A1 of the upper cylinder 130 and the height A2 of the piston 32 and the difference between the height A3 of the lower cylinder 50 and the height A4 of the piston 52 are those when the compressor 101 is not driven (i. e., at normal temperature).

[0052] A suction passage including an upper suction passage and a lower suction passage branched from the upper suction passage is formed in the rotary compressor 101 of the present embodiment. The upper suction passage supplies the compression chamber 31 of the upper cylinder 130 with refrigerant. The upper suction passage supplies the compression chamber 51 of the lower cylinder 50 with the refrigerant. The surface area of a region facing the suction passage in the lower cylinder 50 is smaller than the surface area of a region facing the suction passage in the upper cylinder 130. For this reason, as compared to the upper cylinder 130, the decrease in temperature of the refrigerant at around the region facing the suction passage in the cylinder is small in the lower cylinder 50. On this account, a difference in temperature between the lower cylinder 50 and the piston 52 provided in the compression chamber 51 of the lower cylinder 50 is small, with the result that a difference in amount of dimensional change between the lower cylinder 50 and the piston 52 at thermal expansion is small. As a result, as compared to the upper cylinder 130, problems are less likely to occur in the lower cylinder 50 even when the gaps between the end face in the axial direction of the piston 52 and the end faces in the axial direction of the end plates 40 and 60 adjacent to the piston 52 are narrow. This suppresses oil leakage from the inner periphery of the piston to the compression chamber and improves the volume efficiency and the indicated efficiency. Therefore, even when the two cylinders 130 and 50 are connected to the accumulator 5 by a single suction pipe 6 in order to downsize the compressor 101, the decrease in compressor efficiency due to the increase in suction resistance is compensated by the improvement in volume efficiency and indicated efficiency, with the result that the decrease in compressor efficiency is suppressed. As such, downsizing of the compressor 101 and suppression of decrease in compressor efficiency are both achieved in the present embodiment.

[0053] In the present embodiment, the upper suction passage (first passage) passes through the upper cylinder 130 but does not pass through the lower cylinder 50, whereas the lower suction passage (second passage) is branched from the upper suction passage in the upper cylinder 130 and passes through both the upper cylinder 130 and the lower cylinder 50. With this arrangement, it is possible to easily construct the structure in which the surface area of the region facing the suction passage in the lower cylinder 50 is smaller than the surface area of the region facing the suction passage in the upper cylinder 130.

[0054] In addition to the above, in the present embodiment, the upper head 120, as an end plate, arranged on the opposite side of the lower cylinder 50 with respect to the upper cylinder 130 is configured to be inserted by the suction pipe 6 so that the leading end of the suction pipe 6 is in the upper head 120. With this arrangement, the upper suction passage has one portion where the traveling direction of the refrigerant changes from vertical to horizontal in the upper cylinder 130, whereas the lower suction passage has one portion where the traveling direction of the refrigerant changes from vertical to horizontal in the lower cylinder 50. The upper suction passage and the lower suction passage are therefore unlikely to be significantly different from each other in terms of suction resistance.

(Third Embodiment)

[0055] The following will describe a compressor of Third Embodiment with reference to FIG. 7 and FIG. 8. The compressor 201 of Third Embodiment is different from the compressor of First Embodiment in that a lower cylinder 250 is configured to be inserted by a suction pipe 6 of an accumulator 5. In the present embodiment, structures identical with those of First Embodiment are denoted by the same reference symbols and may not be explained.

[0056] In the compressor 201 of the present embodiment, a driving mechanism 3 and a compression mechanism 204 are housed. As shown in FIG. 7 and FIG. 8, in the lower cylinder 250, a lateral passage 250a which extends in the radial direction of the lower cylinder 250 is formed as a suction passage for introducing refrigerant into the compression chamber 51 of the lower cylinder 250. A radially inner end portion of the lateral passage 250a is open at the compression chamber

51, whereas a radially outer end portion of the lateral passage 250a is open at the outer circumferential surface of the lower cylinder 250. The suction pipe 6 is inserted into the lateral passage 250a from the radially outer end portion of the lateral passage 250a, and a leading end of the suction pipe 6 is at around the center of the lateral passage 250a. In the lower cylinder 250, a vertical passage 250b which extends vertically upward from the lateral passage 250a is formed as a suction passage for introducing the refrigerant into the compression chamber 31 of an upper cylinder 230. The vertical passage 250b is branched from a part of the lateral passage 250a, which is between the radially inner end portion of the lateral passage 250a and the leading end of the suction pipe 6. The vertical passage 250b extends vertically upward and is open at the top surface of the lower cylinder 250. Furthermore, a vertical passage 250c extending vertically downward from the lateral passage 250a is formed in the lower cylinder 250. The vertical passage 250c is branched from a part of the lateral passage 250a, which is between the radially inner end portion of the lateral passage 250a and the leading end of the suction pipe 6 (i.e., a part vertically overlapping the vertical passage 250b). The vertical passage 250c extends vertically downward and is open at the bottom surface of the lower cylinder 250. This opening is closed by the lower head 60.

[0057] In a middle plate 240, a vertical passage 240a connected to the vertical passage 250b of the lower cylinder 250 is formed as a suction passage for introducing the refrigerant into the compression chamber 31. The vertical passage 240a connects the vertical passage 250b of the lower cylinder 250 to a later-described lateral passage 230a of the upper cylinder 230.

[0058] In the upper cylinder 230 adjacent to the lower cylinder 250 via the middle plate 240, the lateral passage 230a which extends in the radial direction of the upper cylinder 230 is formed as a suction passage for introducing the refrigerant into the compression chamber 31. The lateral passage 230a is a cutout formed in the bottom surface of the upper cylinder 230. A radially inner end portion of the lateral passage 230a is open at the compression chamber 31. A radially outer end portion of the lateral passage 230a is closed by the wall surface of the upper cylinder 230 in the radial direction and is open downward. The radially outer end portion of the lateral passage 230a is connected to the vertical passage 240a of the middle plate 240 at the downward opening. Except at the opening, the lateral passage 230a is closed by the top surface of the middle plate 240.

[0059] A suction passage including an lower suction passage (first passage) and a upper suction passage (second passage) branched from the lower suction passage (first passage) is formed in the rotary compressor 201 of the present embodiment. The lower suction passage supplies the compression chamber 51 of the lower cylinder 250 with refrigerant. The upper suction passage supplies the compression chamber 31 of the upper cylinder 230 with the refrigerant. In the present embodiment, the lower suction passage is a horizontal passage from the leading end of the suction pipe 6 to the compression chamber 51 in the lateral passage 250a formed in the lower cylinder 250, whereas the upper suction passage is constituted by the vertical passage 250b formed in the lower cylinder 250, the vertical passage 240a formed in the middle plate 240, and the lateral passage 230a formed in the upper cylinder 230.

[0060] To put it differently, in the lower cylinder 250, a horizontal passage from the leading end of the suction pipe 6 to the compression chamber 51 in the lateral passage 250a (not including a part from the leading end of the suction pipe 6 to the radially outer end portion of the lateral passage 250a of the lateral passage 250a) and the vertical passage 250b constitute the suction passage. The lateral passage 230a constitutes the suction passage in the upper cylinder 230. In the present embodiment, the surface area of a region facing the suction passage in the upper cylinder 230 is smaller than the surface area of a region facing the suction passage in the lower cylinder 250.

[0061] In the upper cylinder 230 in which the surface area of the region facing the suction passage is small as compared to the lower cylinder 250, the decrease in temperature of the refrigerant at around the region facing the suction passage is small as compared to the lower cylinder 250. On this account, a difference in temperature between the upper cylinder 230 and the piston 32 provided in the compression chamber 31 of the upper cylinder 230 is small, with the result that a difference in amount of dimensional change between the upper cylinder 230 and the piston 32 at thermal expansion is small.

[0062] Accordingly, in the compressor 201 of the present embodiment, as shown in FIG. 8, the difference between the height A1 of the upper cylinder 230 and the height A2 of the piston 32 in the compression chamber 31 of the upper cylinder 230 is smaller than the difference between the height A3 of the lower cylinder 250 and the height A4 of the piston 52 in the compression chamber 51 of the lower cylinder 250 ($A1-A2<A3-A4$). The difference between the height A3 of the lower cylinder 250 and the height A4 of the piston 52 and the difference between the height A1 of the upper cylinder 230 and the height A2 of the piston 32 are those when the compressor 201 is not driven (i.e., at normal temperature).

[0063] A suction passage including an lower suction passage and a upper suction passage branched from the lower suction passage is formed in the rotary compressor 201 of the present embodiment. The lower suction passage supplies the compression chamber 51 of the lower cylinder 250 with refrigerant. The upper suction passage supplies the compression chamber 31 of the upper cylinder 230 with the refrigerant. The surface area of a region facing the suction passage in the upper cylinder 230 is smaller than the surface area of a region facing the suction passage in the lower cylinder 250. For this reason, as compared to the lower cylinder 250, the decrease in temperature of the refrigerant at around the region facing the suction passage in the cylinder is small in the upper cylinder 230. On this account, a difference in temperature between the upper cylinder 230 and the piston 32 provided in the compression chamber 31 of the upper cylinder 230 is small, with the result that a difference in amount of dimensional change between the upper cylinder 230 and the piston 32 at thermal expansion is small. As a result, as compared to the lower cylinder 250, problems are less likely to occur in the upper cylinder 230 even when the gaps between the end face in the axial direction of the piston 32 and the end faces in the axial direction of the end plates 20 and 240 adjacent to the piston 32 are narrow. This suppresses oil leakage from the inner periphery of the piston to the compression chamber and improves the volume efficiency and the indicated efficiency. Therefore, even when the two cylinders 230 and 250 are connected to the accumulator 5 by a single suction pipe 6 in order to downsize the compressor 201, the decrease in compressor efficiency due to the increase in suction resistance is compensated by the improvement in volume efficiency and indicated efficiency, with the result that the decrease in compressor efficiency is suppressed. As such, downsizing of the compressor 201 and suppression of decrease in compressor efficiency are both achieved in the present embodiment.

[0064] In the present embodiment, the lower suction passage (first passage) passes through the lower cylinder 250 but does not pass through the upper cylinder 230, whereas the upper suction passage (second passage) is branched from the lower suction passage in the lower cylinder 250 and passes through both the lower cylinder 250 and the upper cylinder 230. With this arrangement, it is possible to easily construct the structure in which the surface area of the region facing the suction passage in the upper cylinder 230 is smaller than the surface area of the region facing the suction passage in the lower cylinder 250.

[0065] In addition to the above, in the present embodiment, the lower cylinder 250 is configured to be inserted by the suction pipe 6 so that the leading end of the suction pipe 6 is provided inside the lower cylinder 250. With this arrangement, the passage for the refrigerant from the leading end of the suction pipe 6 to the compression chamber 51 of the lower cylinder 250 is constituted solely of the linear lateral passage 250a, with the result that the increase in suction resistance is suppressed.

[Verification Test Using Actual Machines]

[0066] The following will describe results of a test performed by using rotary compressors. As described above, in the rotary compressor of the present invention, the difference between the height of the cylinder and the height of the piston is arranged to be small in the second cylinder as compared to the first cylinder, with the result that oil leakage from the inner periphery of the piston to the compression chamber is suppressed and the compressor efficiency is thereby improved. The smaller the difference between the height of the cylinder and the height of the piston is, the better the the compressor efficiency becomes. However, seizure due to sliding friction between the piston and the end plate tends to occur and the reliability is decreased. To put it another way, when the difference between the height of the cylinder and the height of the piston is large, the reliability is improved as seizure due to sliding friction between the piston and the end plate is less likely to occur, but the compressor efficiency is deteriorated.

[0067] Under this circumstance, the inventors of present invention conducted a verification test by using plural rotary compressors (including those of different types) in order to prove whether allowable compressor efficiency was obtained while the reliability was ensured. In this test, the following variables were used: the height He (mm) of a cylinder in the axial direction of a drive shaft; the height Hp (mm) of a piston provided in a compression chamber formed in the cylinder, in the axial direction; the surface area As (mm^2) of a region facing a suction passage in the cylinder; and the length Ls (mm) of the suction passage in the cylinder. The length Ls is the length of the suction passage in a plane orthogonal to the axial direction of the drive shaft, and is equivalent to the length in the radial direction of the cylinder in the embodiments above. Examples of the length Ls are indicated as L1 and L2 in FIG. 3, FIG. 6, and FIG. 8.

[0068] As to each of the compressors which were different in above-described four variables He, Hp, As, and Ls, whether seizure occurred due to sliding friction between the piston and an end plate and whether allowable compressor efficiency was obtained were evaluated. FIG. 9 is a graph showing the results of the test.

[0069] In FIG. 9, the parameter on the vertical axis indicates (difference in height between cylinder and piston (Hc-Hp) / height He of cylinder), i.e., a rate of change of the cylinder height with respect to temperature variation. As the temperature at around the region facing the suction passage in the cylinder is decreased by the refrigerant, the cylinder thermally contracts, with the result that the difference from the height of the piston (Hc-Hp) is decreased. When the difference becomes zero, the piston is stuck between the end plates and seizure occurs, and hence the compressor may be damaged. The larger the parameter on the vertical axis is, the less likely the seizure occurs.

[0070] The parameter on the horizontal axis indicates (surface area As of region facing suction passage in cylinder / cylinder height Hp × length Ls of suction passage in longitudinal direction), i.e., likelihood of temperature variation of the cylinder. The larger the surface area of the region facing the suction passage in the cylinder is, the more easily the temperature of the cylinder drops due to cooling by the refrigerant. Meanwhile, the longer the cylinder height and the length of the suction passage in the longitudinal direction are, the less easily the temperature of the cylinder drops on account of the increase in heat capacity. As such, the temperature at around the region facing the suction passage in the cylinder varies in accordance with the balance of the surface area As of the region, the cylinder height Hp, and the length Ls of the suction passage in the longitudinal direction.

[0071] In FIG. 9, an approximate line A which is depicted as a linear line is a limit line indicating the minimum performance in terms of compressor efficiency. Allowable compressor efficiency is obtained in a region below the approximate line A. Meanwhile, an approximate line B which is depicted as a linear line with the same inclination as the approximate line A is a limit line indicating minimum reliability (with no seizure) . Seizure does not occur in a region above the approximate line B. The approximate line A is expressed as follows:

$$(Hc-Hp)/Hc=1.4\times 0.0001\times As/(Hc\cdot Ls)+6.7\times 0.0001$$

The approximate line B is expressed as follows:

$$(Hc-Hp)/Hc=1.4\times 0.0001\times As/(Hc\cdot Ls)+3.9\times 0.0001$$

[0072] For this reason, when the above-described four variables He, Hp, As, and Ls satisfies a relation $3.9\times 0.0001\leq(Hc-Hp)/Hc-1.4\times 0.0001\times As/(Hc\cdot Ls)\leq 6.7\times 0.0001$, a compressor which is sufficient in both compressor efficiency and reliability is obtained.

[Modifications]

[0073] In First Embodiment above, the first cylinder may be a lower cylinder 50 and the second cylinder may be an upper cylinder 30. In other words, the surface area of a region facing the suction passage in the upper cylinder 30 may be smaller than the surface area of a region facing the suction passage in the lower cylinder 50. Likewise, in Second Embodiment, the first cylinder may be a lower cylinder 50 and the second cylinder may be an upper cylinder 130. In other words, the surface area of a region facing the suction passage in the upper cylinder 130 may be smaller than the surface area of a region facing the suction passage in the lower cylinder 50. Furthermore, in Third Embodiment, the first cylinder may be an upper cylinder 230 and the second cylinder may be a lower cylinder 250. In other words, the surface area of a region facing the suction passage in the lower cylinder 250 may be smaller than the surface area of a region facing the suction passage in the upper cylinder 230.

[0074] The arrangements (e.g., layout and cross-sectional shape) of the suction passage may be different from those described in First to Third Embodiments. For example, while in First to Third Embodiments the lateral passages 30a, 50a, 130a, 230a, and 250a extend in the radial direction of the cylinder, these lateral passages may extend in any directions in the plane orthogonal to the axial direction of the drive shaft, on condition that they communicate with the compression chamber.

[0075] While in First to Third Embodiments the accumulator fixed to the rotary compressor of the present invention is taken as an example of the external device, the external device is not limited to this. The external device may be an accumulator not fixed to the rotary compressor of the present invention or a device (e.g., an evaporator) which is not an accumulator, for example.

[0076] While in First to Third Embodiments the roller and the blade of the piston are integrated, the roller and the blade may be independent from each other.

[0077] While First to Third Embodiments describe the 2-cylinder rotary compressor including the upper cylinder and the lower cylinder, the rotary compressor may include three or more cylinders. In this case, in each of the three or more cylinders, the difference between the height of a cylinder in the axial direction of a drive shaft and the height of a piston provided in a compression chamber of the cylinder in the axial direction preferably decreases as the surface area of a region facing a suction passage in the cylinder decreases.

[0078] Thus, the embodiments of the present invention have been described hereinabove. However, the specific structure of the present invention shall not be interpreted as to be limited to the above described embodiments. The scope of the present invention is defined not by the above embodiments but by claims set forth below, and shall encompass every modification within the scope of the claims.

[Reference Signs List]

[0079]

1, 201 rotary compressor
3 driving mechanism

4, 204 compression mechanism
20, 120 upper head (end plate)
30, 130, 230 upper cylinder (cylinder, first cylinder)
31, 51 compression chamber
32, 52 piston
40, 240 middle plate (end plate)
50, 250 lower cylinder (cylinder, second cylinder)
60 lower head (end plate)

Claims

1. A rotary compressor (1; 101; 201) comprising a compression mechanism (4; 104; 204) and a driving mechanism (3) including a drive shaft (3b) driving the compression mechanism (4;104; 204), the compression mechanism (4; 104; 204) and the driving mechanism (3) being housed in the rotary compressor (1; 101; 201), the compression mechanism (4; 104; 204) including:

    a plurality of cylinders (30, 50; 50, 130; 230, 250) in which compression chambers (31, 51) are formed, respectively, the cylinders (30, 50; 50, 130;230, 250) being aligned in the axial direction of the drive shaft (3b) so that the drive shaft (3b) is inside the compression chambers (31, 51);
    a plurality of end plates (20, 40, 60; 40, 60, 120; 20, 60, 240) provided at both ends of the cylinders (30, 50; 50, 130; 230, 250) in the axial direction to define the compression chambers (31, 51); and
    a plurality of pistons (32, 52) provided in the respective compression chambers (31, 51) and driven by the drive shaft (3b),
    wherein the cylinders (30, 50; 50, 130; 230, 250) include a first cylinder (30; 130; 250) and a second cylinder (50; 50; 230) adjacent to the first cylinder (30; 130; 250) via one of the end plates(20, 40, 60; 40, 60, 120; 20, 60, 240),
    a suction passage including a first passage (30a; 120a, 120b, 130a; 250a) and a second passage (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) branched from the first passage (30a; 120a, 120b, 130a; 250a) is formed in the rotary compressor (1; 101; 201), the first passage supplies the compression chamber (31; 31; 51) of the first cylinder (30; 130; 250) with refrigerant from an external device via a suction pipe (6), and the second passage (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) supplies the compression chamber (51; 51; 31) of the second cylinder (50; 50; 230) with the refrigerant,
    characterised in that
    the surface area of a region facing the suction passage in the second cylinder (50; 50; 230) is smaller than the surface area of a region facing the suction passage in the first cylinder (30; 130; 250), and
    a difference between the height (A3; A3; A1) of the second cylinder (50; 50; 230) in the axial direction and the height (A4; A4; A2) in the axial direction of the piston (52; 52; 32) provided in the compression chamber (51; 51; 31) of the second cylinder (50; 50; 230) is smaller than a difference between the height (A1; A1; A3) of the first cylinder (30; 130; 250) in the axial direction and the height (A2; A2; A4) in the axial direction of the piston (32; 32; 52) provided in the compression chamber (31; 31; 51) of the first cylinder (30; 130; 250).

2. The rotary compressor (1; 101; 201) according to claim 1, wherein

    the first passage (30a; 120a, 120b, 130a; 250a) passes through the first cylinder (30; 130; 250) but does not pass through the second cylinder (50; 50; 230), and
    the second passage (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) is branched from the first passage (30a; 120a, 120b, 130a; 250a) in the first cylinder (30; 130; 250) and passes through both the first cylinder (30; 130; 250) and the second cylinder (50; 50; 230).

3. The rotary compressor (1) according to claim 2, wherein the first cylinder (30) is configured to be inserted by the suction pipe (6) so that a leading end of the suction pipe (6) is in the first cylinder (30).

4. The rotary compressor (101) according to claim 2, wherein an end plate (120) arranged on the opposite side of the second cylinder (50) with respect to the first cylinder (130) is configured to be inserted by the suction pipe (6) so that a leading end of the suction pipe (6) is in the end plate(120).

5. The rotary compressor (1; 101; 201) according to any one of claims 1 to 4, wherein, the height of the cylinder (30,

50; 50, 130; 230, 250) in the axial direction is less different from the height in the axial direction of the piston (32, 52) provided in the compression chamber (31, 51) of the cylinder (30, 50; 50, 130; 230, 250), when the surface area of a region facing the suction passage in the cylinder (30, 50; 50, 130; 230, 250) is smaller.

6. The rotary compressor (1; 101; 201) according to any one of claims 1 to 5, wherein, the first passage (30a; 120a, 120b, 130a; 250a) extends in the radial direction of the first cylinder (30; 130; 250) in the first cylinder (30; 130; 250) , and the second passage(30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) includes a vertical passage (30b; 130b; 250b) branched from the first passage (30a; 120a, 120b, 130a; 250a) in the first cylinder (30; 130; 250) and extends in the axial direction and a lateral passage (50a; 50a; 230a) extends in the radial direction of the second cylinder (50; 50; 230) in the second cylinder (50; 50; 230),

in each of the cylinders (30, 50; 30, 130; 230, 250), a relation $3.9\times0.0001\leq(Hc\text{-}Hp)/Hc\text{-}1.4\times0.0001\times As/(Hc\cdot Ls)\leq6.7\times0.0001$ is satisfied where the height of the cylinder in the axial direction is denoted as He (mm), the height in the axial direction of the piston provided in the compression chamber in the cylinder is denoted as Hp (mm), the surface area of a region facing the suction passage in the cylinder is denoted as As (mm^2), and the length of the suction passage in the cylinder in the radial direction of the cylinders (30, 50; 30, 130; 230, 250) is denoted as Ls (mm).

Patentansprüche

1. Rotationsverdichter (1; 101; 201) mit einem Verdichtungsmechanismus (4; 104; 204) und einem Antriebsmechanismus (3) mit einer Antriebswelle (3b), die den Verdichtungsmechanismus (4; 104; 204) antreibt, wobei der Verdichtungsmechanismus (4; 104; 204) und der Antriebsmechanismus (3) in dem Rotationsverdichter (1; 101; 201) untergebracht sind,

wobei der Verdichtungsmechanismus (4; 104; 204) Folgendes enthält:

eine Vielzahl von Zylindern (30, 50; 50, 130; 230, 250), in denen jeweils Verdichtungskammern (31, 51) ausgebildet sind, wobei die Zylinder (30, 50; 50, 130; 230, 250) in der axialen Richtung der Antriebswelle (3b) ausgerichtet sind, so dass sich die Antriebswelle (3b) innerhalb der Verdichtungskammern (31, 51) befindet;

eine Vielzahl von Endplatten (20, 40, 60; 40, 60, 120; 20, 60, 240), die an beiden Enden der Zylinder (30, 50; 50, 130; 230, 250) in der axialen Richtung vorgesehen sind, um die Verdichtungskammern (31, 51) zu definieren; und

eine Vielzahl von Kolben (32, 52), die in den jeweiligen Verdichtungskammern (31, 51) vorgesehen sind und von der Antriebswelle (3b) angetrieben werden,

wobei die Zylinder (30, 50; 50, 130; 230, 250) einen ersten Zylinder (30; 130; 250) und einen zweiten Zylinder (50; 50; 230) umfassen, der an den ersten Zylinder (30; 130; 250) über eine der Endplatten (20, 40, 60; 40, 60, 120; 20, 60, 240) angrenzt,

ein Ansaugkanal mit einem ersten Kanal (30a; 120a, 120b, 130a; 250a) und einem vom ersten Kanal (30a; 120a, 120b, 130a; 250b, 240a, 230a) abzweigenden zweiten Kanal (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) in dem Rotationsverdichter (1; 101; 201) ausgebildet ist, wobei der erste Kanal die Verdichtungskammer (31; 31; 51) des ersten Zylinders (30; 130; 250) über eine Saugleitung (6) mit Kältemittel aus einer externen Einrichtung versorgt, und der zweite Kanal (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) die Verdichtungskammer (51; 51; 31) des zweiten Zylinders (50; 50; 230) mit dem Kältemittel versorgt,

dadurch gekennzeichnet, dass

die Oberfläche eines dem Ansaugkanal zugewandten Bereichs in dem zweiten Zylinder (50; 50; 230) kleiner ist als die Oberfläche eines dem Ansaugkanal zugewandten Bereichs in dem ersten Zylinder (30; 130; 250), und eine Differenz zwischen der Höhe (A3; A3; A1) des zweiten Zylinders (50; 50; 230) in der axialen Richtung und der Höhe (A4; A4; A2) in der axialen Richtung des Kolbens (52; 52; 32), der in der Verdichtungskammer (51; 51; 31) des zweiten Zylinders (50; 50; 230) vorgesehen ist, kleiner ist als eine Differenz zwischen der Höhe (A1; A1; A3) des ersten Zylinders (30; 130; 250) in der axialen Richtung und der Höhe (A2; A2; A4) in der axialen Richtung des Kolbens (32; 32; 52), der in der Verdichtungskammer (31; 31; 51) des ersten Zylinders (30; 130; 250) vorgesehen ist.

2. Rotationsverdichter (1; 101; 201) nach Anspruch 1, wobei

der erste Kanal (30a; 120a, 120b, 130a; 250a) durch den ersten Zylinder (30; 130; 250), aber nicht durch den zweiten Zylinder (50; 50; 230) verläuft, und

der zweite Kanal (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) von dem ersten Kanal (3oa; 120a, 120b, 130a; 250a) in dem ersten Zylinder (30; 130; 250) abzweigt und sowohl durch den ersten Zylinder (30; 130; 250) als auch durch den zweiten Zylinder (50; 50; 230) verläuft.

3. Rotationsverdichter (1) nach Anspruch 2, wobei der erste Zylinder (30) so konfiguriert ist, dass er durch die Saugleitung (6) eingeführt wird, so dass sich ein vorderes Ende der Saugleitung (6) im ersten Zylinder (30) befindet.

4. Rotationsverdichter (101) nach Anspruch 2, wobei eine Endplatte (120), die auf der gegenüberliegenden Seite des zweiten Zylinders (50) in Bezug auf den ersten Zylinder (130) angeordnet ist, so konfiguriert ist, dass sie durch die Saugleitung (6) eingeführt wird, so dass sich ein vorderes Ende der Saugleitung (6) in der Endplatte (120) befindet.

5. Rotationsverdichter (1; 101; 201) nach einem der Ansprüche 1 bis 4, wobei sich die Höhe des Zylinders (30, 50; 50, 130; 230, 250) in der axialen Richtung weniger von der Höhe in der axialen Richtung des in der Verdichtungskammer (31, 51) des Zylinders (30, 50; 50, 130; 230, 250) vorgesehenen Kolbens (32, 52) unterscheidet, wenn die Oberfläche eines dem Ansaugkanal zugewandten Bereichs in dem Zylinder (30, 50; 50, 130; 230, 250) kleiner ist.

6. Rotationsverdichter (1; 101; 201) nach einem der Ansprüche 1 bis 5, wobei sich der erste Kanal (3oa; 120a, 120b, 130a; 250a) in der radialen Richtung des ersten Zylinders (30; 130; 250) im ersten Zylinder (30; 130; 250) erstreckt und der zweite Kanal (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) einen vertikalen Kanal (30b; 130b; 250b) aufweist, der von dem ersten Kanal (30a; 120a, 120b, 130a; 250a) in dem ersten Zylinder (30; 130; 250) abzweigt und sich in der axialen Richtung erstreckt, und ein seitlicher Kanal (50a; 50a; 230a) sich in der radialen Richtung des zweiten Zylinders (50; 50; 230) in dem zweiten Zylinder (50; 50; 230) erstreckt,
in jedem der Zylinder (30, 50; 30, 130; 230, 250) eine Beziehung $3{,}9\times 0{,}0001 \leq (Hc\text{-}Hp)/Hc - 1{,}4\times 0{,}0001\times As/(Hc\text{-}Ls) \leq 6{,}7\times 0{,}0001$ erfüllt ist, wobei die Höhe des Zylinders in der axialen Richtung als Hc (mm) bezeichnet wird, die Höhe des Kolbens in der axialen Richtung, der in der Verdichtungskammer in dem Zylinder vorgesehen ist, als Hp (mm) bezeichnet wird, die Oberfläche eines Bereichs, der dem Ansaugkanal in dem Zylinder gegenüberliegt, als As (mm^2) bezeichnet wird, und die Länge des Ansaugkanals in dem Zylinder in der radialen Richtung der Zylinder (30, 50; 30, 130; 230, 250) als Ls (mm) bezeichnet wird.

Revendications

1. Compresseur rotatif (1; 101; 201) comprenant un mécanisme de compression (4; 104; 204) et un mécanisme d'entraînement (3) comprenant un arbre d'entraînement (3b) entraînant le mécanisme de compression (4; 104; 204), le mécanisme de compression (4; 104; 204) et le mécanisme d'entraînement (3) étant logés dans le compresseur rotatif (1; 101; 201),
le mécanisme de compression (4; 104; 204) comprenant :

une pluralité de cylindres (30, 50; 50, 130; 230, 250) dans lesquels des chambres de compression (31, 51) sont formées, respectivement, les cylindres (30, 50; 50, 130; 230, 250) étant alignés dans la direction axiale de l'arbre d'entraînement (3b) de sorte que l'arbre d'entraînement (3b) se trouve à l'intérieur des chambres de compression (31, 51) ;
une pluralité de plaques d'extrémité (20, 40, 60; 40, 60, 120; 20, 60, 240) prévues aux deux extrémités des cylindres (30, 50; 50, 130; 230, 250) dans la direction axiale pour définir les chambres de compression (31, 51) ; et
une pluralité de pistons (32, 52) prévus dans les chambres de compression (31, 51) respectives et entraînés par l'arbre d'entraînement (3b),
dans lequel les cylindres (30, 50; 50, 130; 230, 250) comprennent un premier cylindre (30; 130; 250) et un second cylindre (50; 50; 230) adjacent au premier cylindre (30; 130; 250) par l'intermédiaire de l'une des plaques d'extrémité (20, 40, 60; 40, 60, 120; 20, 60, 240),
un passage d'aspiration comprenant un premier passage (30a; 120a, 120b, 130a; 250a) et un second passage (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) dérivé du premier passage (30a; 120a, 120b, 130a; 250a) est formé dans le compresseur rotatif (1; 101; 201), le premier passage alimente la chambre de compression (31; 31; 51) du premier cylindre (30; 130; 250) avec du réfrigérant provenant d'un dispositif externe par l'intermédiaire d'un tuyau d'aspiration (6), et le second passage (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) alimente la chambre de compression (51; 51; 31) du second cylindre (50; 50; 230) avec le réfrigérant,
caractérisé en ce que
la superficie d'une région faisant face au passage d'aspiration dans le second cylindre (50; 50; 230) est plus petite que la superficie d'une région faisant face au passage d'aspiration dans le premier cylindre (30; 130; 250), et

une différence entre la hauteur (A3; A3; A1) du second cylindre (50; 50; 230) dans la direction axiale et la hauteur (A4; A4; A2) dans la direction axiale du piston (52; 52; 32) prévu dans la chambre de compression (51; 51; 31) du second cylindre (50; 50; 230) est inférieure à une différence entre la hauteur (A1; A1; A3) du premier cylindre (30; 130; 250) dans la direction axiale et la hauteur (A2; A2; A4) dans la direction axiale du piston (32; 32; 52) prévu dans la chambre de compression (31; 31; 51) du premier cylindre (30; 130; 250) .

2. Compresseur rotatif (1; 101; 201) selon la revendication 1, dans lequel
le premier passage (30a; 120a, 120b, 130a; 250a) traverse le premier cylindre (30; 130; 250) mais ne traverse pas le second cylindre (50; 50; 230), et le second passage (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) est dérivé du premier passage (30a; 120a, 120b, 130a; 250a) dans le premier cylindre (30; 130; 250) et traverse à la fois le premier cylindre (30; 130; 250) et le second cylindre (50; 50; 230).

3. Compresseur rotatif (1) selon la revendication 2, dans lequel le premier cylindre (30) est configuré pour être inséré par le tuyau d'aspiration (6) de sorte qu'une extrémité avant du tuyau d'aspiration (6) se trouve dans le premier cylindre (30).

4. Compresseur rotatif (101) selon la revendication 2, dans lequel une plaque d'extrémité (120) disposée sur le côté opposé du second cylindre (50) par rapport au premier cylindre (130) est configurée pour être insérée par le tuyau d'aspiration (6) de sorte qu'une extrémité avant du tuyau d'aspiration (6) se trouve dans la plaque d'extrémité (120).

5. Compresseur rotatif (1; 101; 201) selon l'une quelconque des revendications 1 à 4, dans lequel la hauteur du cylindre (30, 50; 50, 130; 230, 250) dans la direction axiale est moins différente de la hauteur dans la direction axiale du piston (32, 52) prévu dans la chambre de compression (31, 51) du cylindre (30, 50; 50, 130; 230, 250), lorsque la surface d'une région faisant face au passage d'aspiration dans le cylindre (30, 50; 50, 130; 230, 250) est plus petite.

6. Compresseur rotatif (1; 101; 201) selon l'une quelconque des revendications 1 à 5, dans lequel le premier passage (30a; 120a, 120b, 130a; 250a) s'étend dans la direction radiale du premier cylindre (30; 130; 250) dans le premier cylindre (30; 130; 250), et le second passage (30b, 40a, 50a; 130b, 40a, 50a; 250b, 240a, 230a) comprend un passage vertical (30b; 130b; 250b) dérivé du premier passage (30a; 120a, 120b, 130a; 250a) dans le premier cylindre (30; 130; 250) et s'étend dans la direction axiale et un passage latéral (50a; 50a; 230a) s'étend dans la direction radiale du second cylindre (50; 50; 230) dans le second cylindre (50; 50; 230),
dans chacun des cylindres (30, 50; 30, 130; 230, 250), une relation $3{,}9 \times 0{,}0001 \leq (Hc-Hp)/Hc-1{,}4 \times 0{,}0001 \times As/(Hc \cdot Ls) \leq 6{,}7 \times 0{,}0001$ est satisfaite où la hauteur du cylindre dans la direction axiale est désignée par Hc (mm), la hauteur dans la direction axiale du piston prévu dans la chambre de compression dans le cylindre est désignée par Hp (mm), la surface d'une région faisant face au passage d'aspiration dans le cylindre est désignée par As (mm^2), et la longueur du passage d'aspiration dans le cylindre dans la direction radiale des cylindres (30, 50; 30, 130; 230, 250) est désignée par Ls (mm).

FIG.1

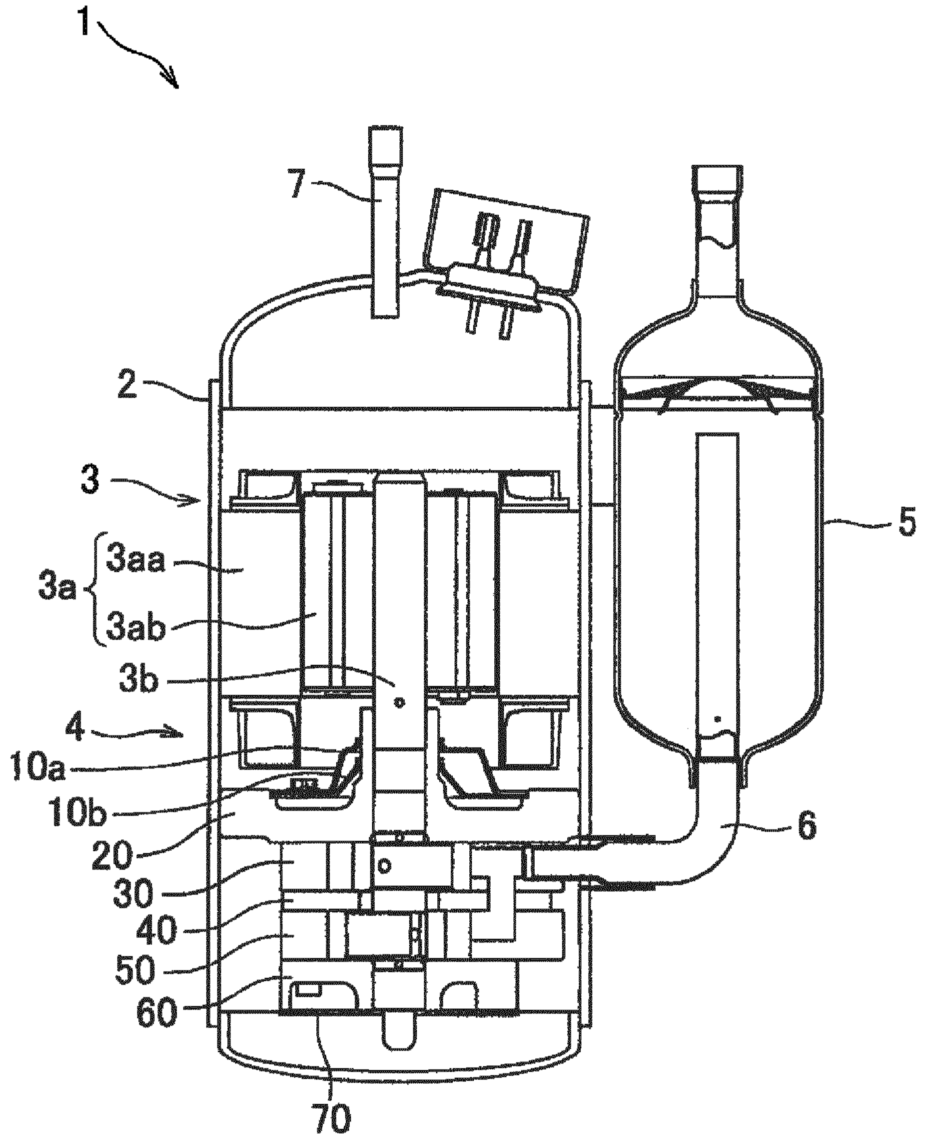


FIG.2A

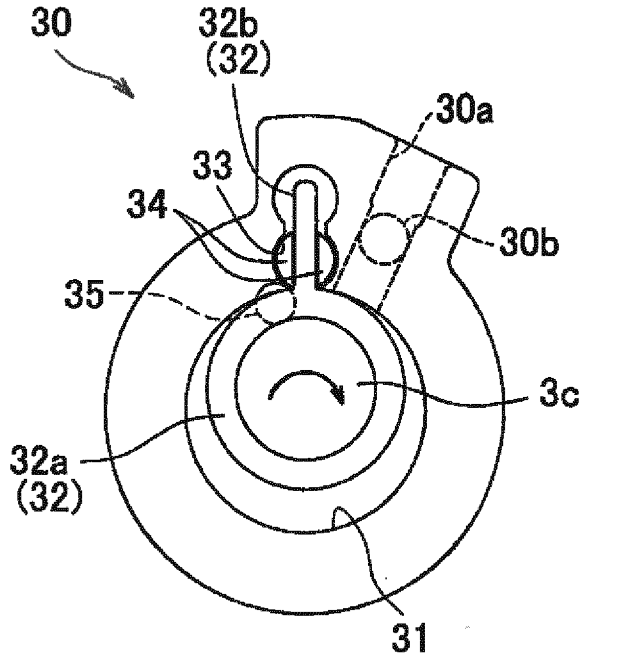

30
32b
(32)
30a
33
34
30b
35
3c
32a
(32)
31

FIG.2B

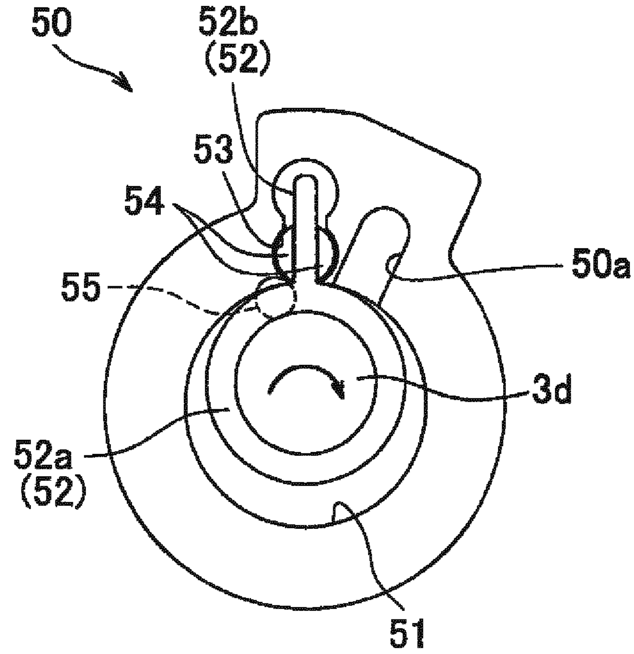

50
52b
(52)
53
54
50a
55
3d
52a
(52)
51

FIG.3

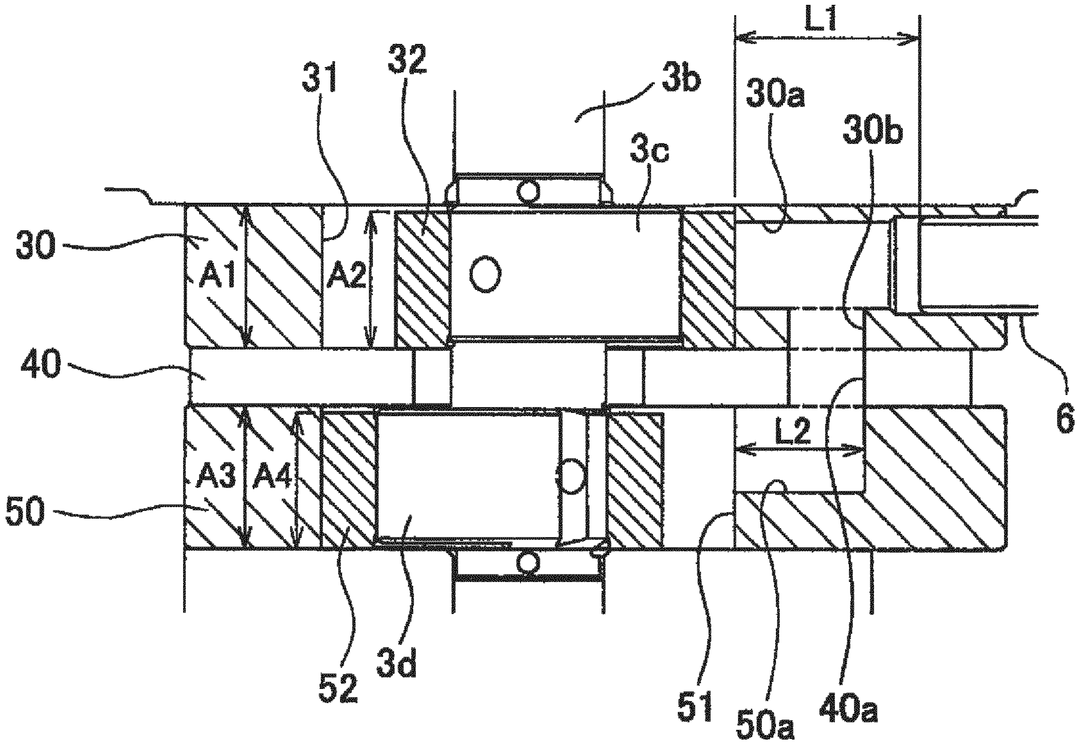


FIG.4

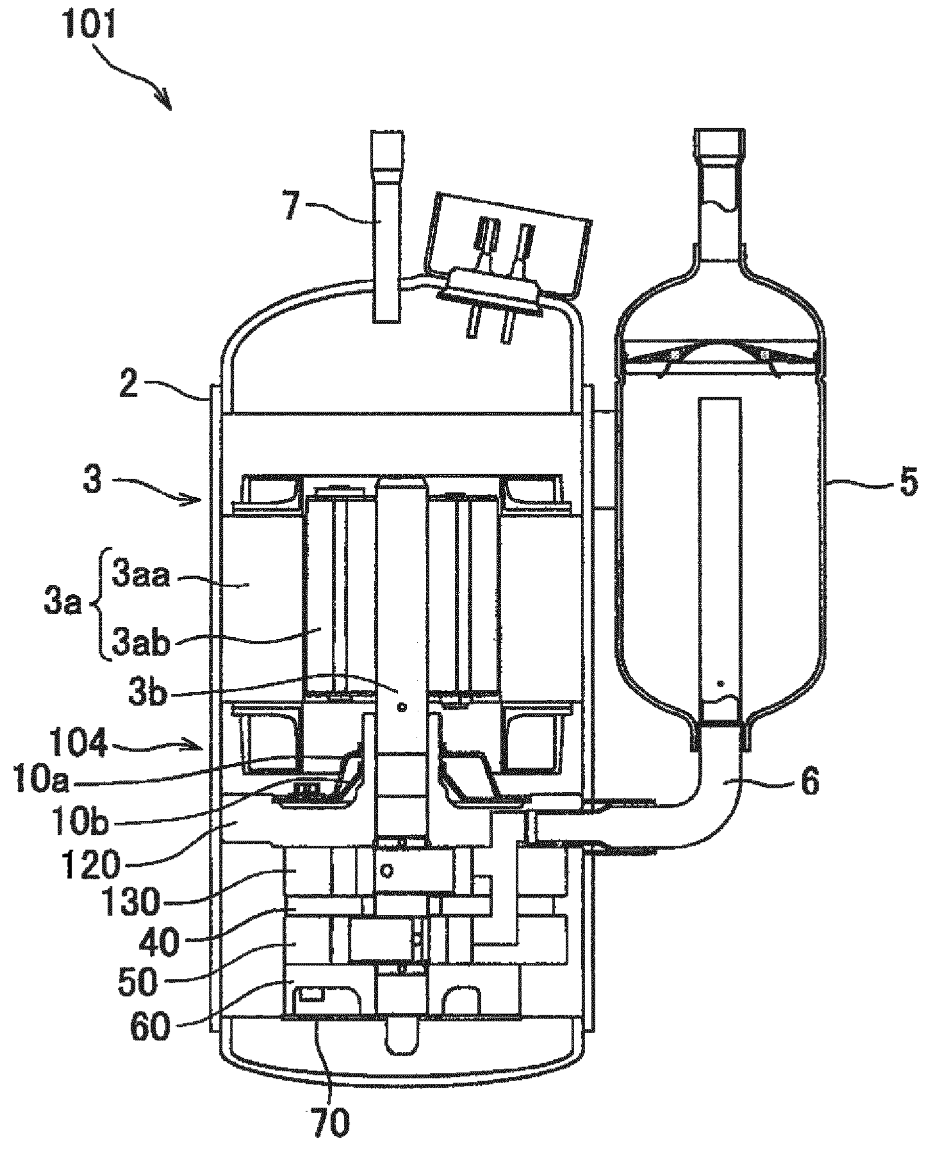


FIG.5A

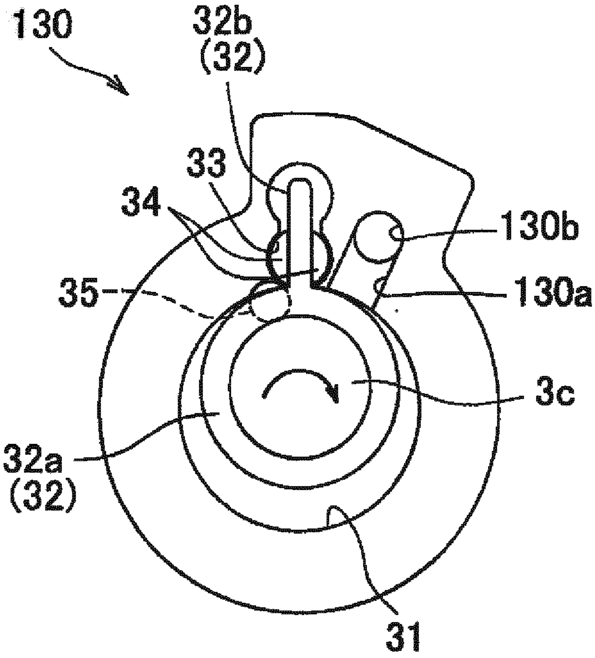

130
32b
(32)
33
34
35
130b
130a
3c
32a
(32)
31

FIG.5B

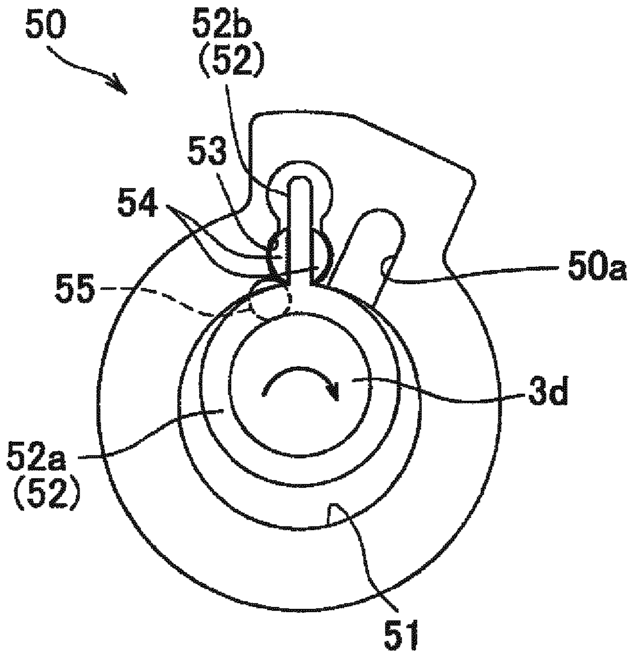

50
52b
(52)
53
54
55
50a
3d
52a
(52)
51

FIG.6

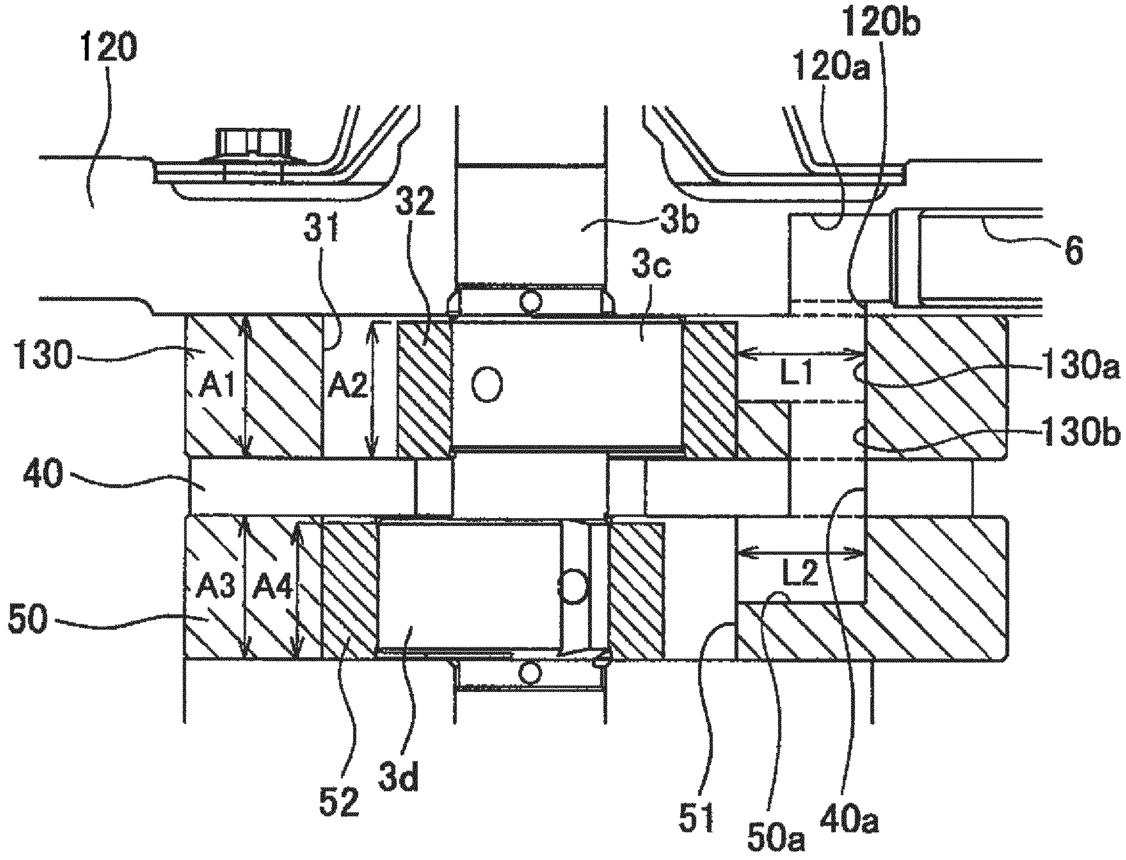

120
120b
120a
32
31
3b
6
3c
130
A1
A2
L1
130a
130b
40
A3
A4
L2
50
52
3d
51
50a
40a

FIG.7

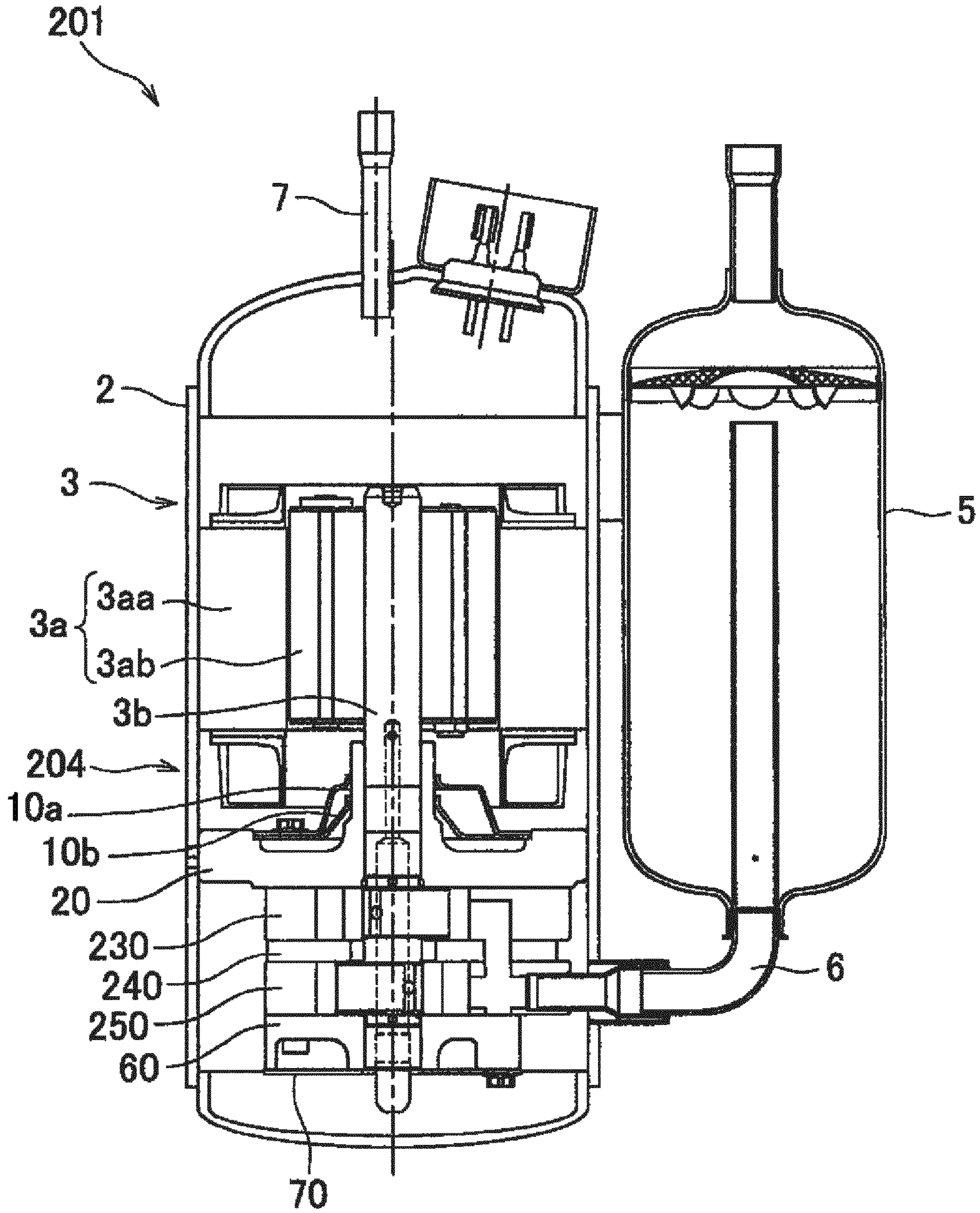


FIG.8

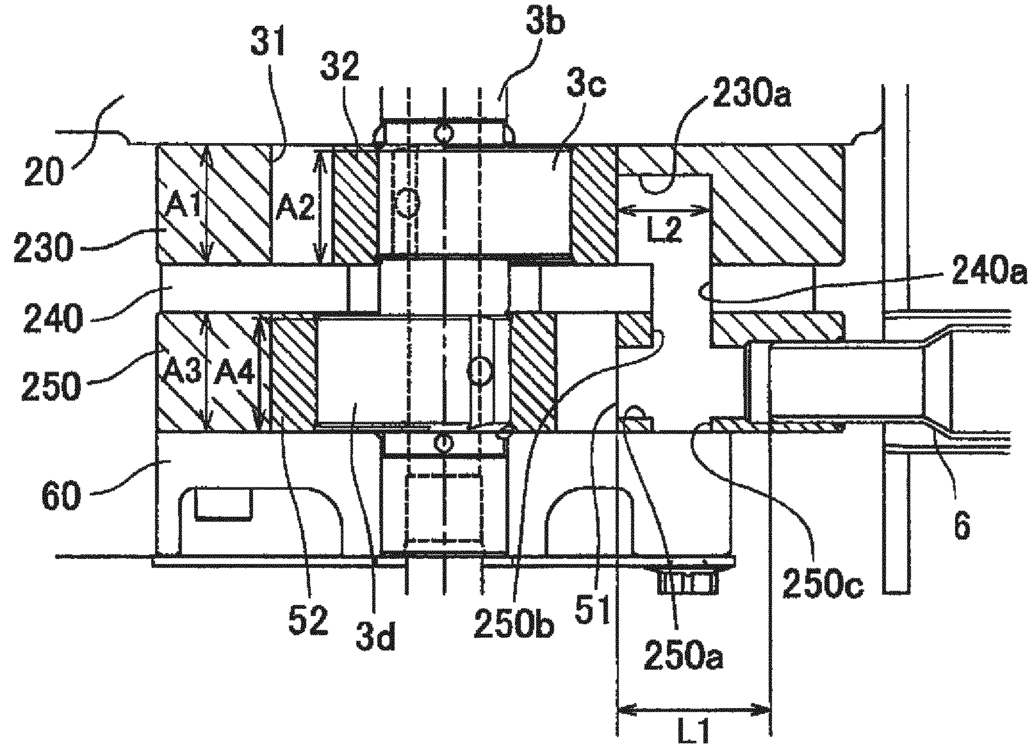
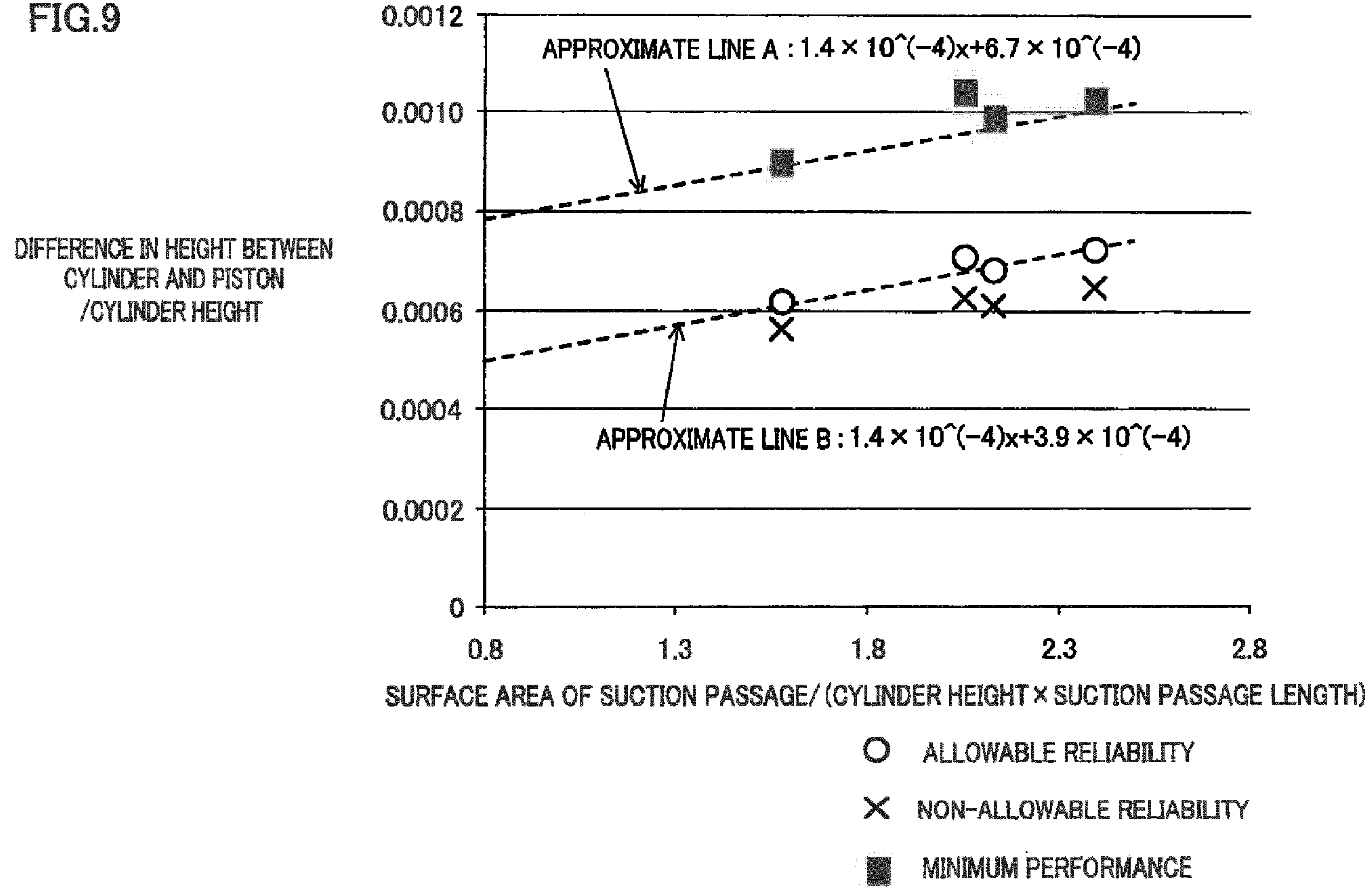

3b
31
32
3c
230a
20
A1
A2
L2
230
240a
240
A3
A4
250
60
6
250c
52
3d
250b
51
250a
L1

FIG.9


0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0
DIFFERENCE IN HEIGHT BETWEEN CYLINDER AND PISTON /CYLINDER HEIGHT
APPROXIMATE LINE A : 1.4 × 10^(−4)x+6.7 × 10^(−4)
APPROXIMATE LINE B : 1.4 × 10^(−4)x+3.9 × 10^(−4)
0.8
1.3
1.8
2.3
2.8
SURFACE AREA OF SUCTION PASSAGE/ (CYLINDER HEIGHT × SUCTION PASSAGE LENGTH)
ALLOWABLE RELIABILITY
NON-ALLOWABLE RELIABILITY
MINIMUM PERFORMANCE

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- WO 03054391 A **[0003]**
- JP H02218884 B **[0003]**