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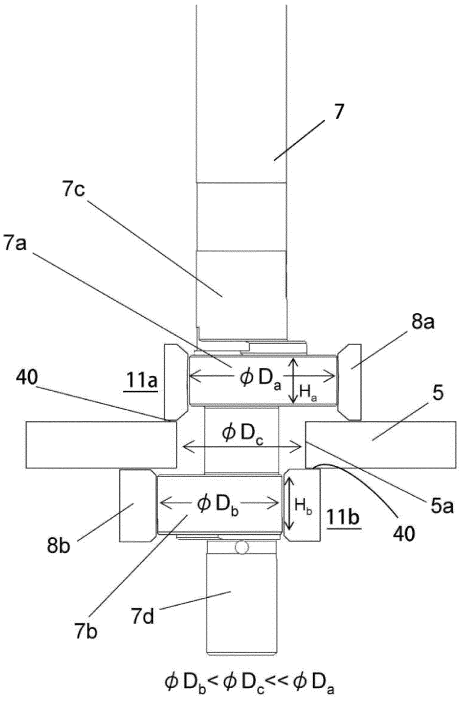
(54) ROTARY COMPRESSOR HAVING TWO CYLINDERS

(57) A rotary compressor having two cylinders in which two compression elements 4a and 4bare placed in adjacent to each other while sandwiching a partition plate 5 therebetween, a crankshaft 7 is inserted into a through hole 5a of the partition plate 5, if the crankshaft rotates, the rolling pistons 8 eccentrically rotates, and the two cylinders 6a and 6b compress operating fluid in the cylinders 6 by the eccentric rotation of the rolling pistons 8, wherein an inner diameter ϕDc of the through hole 5a is greater than an outer diameter ϕDb of the crankshaft eccentric portion7b and smaller than an outer diameter ϕDa of the crankshaft eccentric portion 7a. According to this, it is possible to provide an efficient compressor 11a and 11b.

[Fig. 3]



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Description

[TECHNICAL FIELD]

[0001] The present invention relates to a rotary compressor having two cylinders used for an air conditioner, a freezing machine, a blower, a water heater and the like.

[BACKGROUND TECHNIQUE]

[0002] A compressor is used in a freezing machine and an air conditioner. The compressor sucks gas refrigerant which is evaporated by an evaporator, compresses the gas refrigerant up to pressure required for condensation, and sends out the high temperature and high pressure gas refrigerant into a refrigerant circuit. As one of such compressors, a rotary compressor is known. Among the rotary compressors, there is a rotary compressor having two cylinders configuring two compressor chambers in the compressor, and this compressor has been developed as a high-performance compressor having characteristics of low-vibration, low-noise and capable of operating at high speed, and the compressor is required to be small in size and to have high capacity.

[0003] To provide the rotary compressor with high capacity, there is employed a method of increasing a height of a cylinder to increase the capacity, or a method of increasing an eccentric amount of a crankshaft to increase containment capacity of the compression chamber.

[0004] When the height of the cylinder is increased and the capacity is increased, it becomes necessary to increase a diameter of the crankshaft to cope with increase in a bearing load, and efficiency of the compressor is deteriorated.

[0005] A case in which the method of increasing the eccentric amount of the crankshaft is used in a rotary compressor having two cylinders will be described below. In the rotary compressor having the two cylinders, two compression chambers are partitioned by a partition plate, and a through hole into which the crankshaft is inserted must be formed in the partition plate. A diameter of the through hole is limited to such a size that the crankshaft can be inserted into the through hole at the time of assembling operation and generally, the diameter is slightly larger than a diameter of an eccentric portion of the crankshaft.

[0006] Under such a limitation, a problem caused when the eccentric amount of the crankshaft is increased will be described using Figs. 5. Fig. 5(a) is an assembling drawing of a crankshaft, a rolling piston and a partition plate when an eccentric amount is small. Fig. 5(b) is an assembling drawing when the eccentric amount is increased and a through hole of the partition plate is left as it is.

[0007] If eccentric amounts of crankshaft eccentric portions 107a and 107b with respect to a crankshaft 107 are increased, a length of a sealing portion 140 between end surfaces of rolling pistons 108a and 108b and an end surface of a partition plate 105 in a non-eccentric direction becomes short. A fine gap in which the rolling pistons 108a and 108b eccentrically rotate is provided in the sealing portion 140 in a height direction. To suppress leakage from this gap, it is desired that the length of the sealing portion 140 is formed as long as possible, but if the eccentric amounts of the crankshaft eccentric portions 107a and 107b are increased, the length of the sealing portion 140 becomes short as described above, and a problem that refrigerant leaks through the sealing portion 140 occurs.

[0008] To solve this problem, Figs. 6 and 7 show a rotary compressor described in Patent Document 1. Fig. 6 is a side sectional view of the rotary compressor, and Fig. 7 is an enlarged view of essential portions thereof.

[0009] As shown in Figs. 6 and 7, to design a through hole 105a of the partition plate 105 small, the crankshaft 107 is divided for each of the crankshaft eccentric portions 107a and 107b as units, the units are connected to each other through a connecting portion 141 and they are assembled. According to this, a diameter of the through hole 105a of the partition plate 105 is made smaller than that of the crankshaft eccentric portion 107b. According to this, the length of the sealing portion 140 can be set longer, and airtightness of compression chambers 111a and 111b is enhanced.

[PRIOR ART DOCUMENT]

[PATENT DOCUMENT]

[0010] [Patent Document 1] Japanese Patent Application Laid-open No.2005-337210

[SUMMARY OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0011] According to the conventional configuration, however, since the crankshaft 107 is divided into units, it is difficult to secure a coaxial degree after the compressor is assembled. Further, since an intermediate bearing is newly provided in the through hole 105a of the partition plate 105, there is a problem that a bearing loss is increased. Further, since the number of parts is increased, there is also a problem of costs.

[0012] The present invention has been accomplished to solve the conventional problems, and it is an object of the invention to provide an efficient compressor in which the number of parts is not increased, a diameter of a through hole of a partition plate is reduced, a length of a sealing portion is sufficiently secured, and airtightness of a compression chamber is enhanced.

[MEANS FOR SOLVING THE PROBLEM]

[0013] To solve the conventional problems, the

present invention provides a rotary compressor having two cylinders in which two compression elements having rolling pistons in the cylinders are placed in adjacent to each other while sandwiching a partition plate therebetween, a crankshaft which is rotated by an electrical element is inserted into a through hole of the partition plate, if the crankshaft rotates, the rolling pistons inserted into crankshaft eccentric portions eccentrically rotates, and the two cylinders compress operating fluid in the cylinders by the eccentric rotation of the rolling pistons, wherein an inner diameter ϕDc of the through hole is greater than an outer diameter ϕDb of one of the crankshaft eccentric portions and smaller than an outer diameter ϕDa of the other crankshaft eccentric portion.

[0014] Normally, it is necessary to set an outer diameter of each of the crankshaft eccentric portions to such a value that sufficient bearing proof strength is exerted against a load received from operating fluid which is compressed by the rolling piston in each of the compression elements. Hence, to realize high capacity, it is necessary to increase the diameters of the crankshaft eccentric portions, but when diameters of both the crankshaft eccentric portions are increased, an inner diameter of the through hole of the partition plate is increased with increase of the diameters of the crankshaft eccentric portions under the limitation of size which can be assembled, and a length of the sealing portion which is composed of an end surface of the rolling piston and the partition plate inevitably becomes small.

[0015] In the present invention, the outer diameter ϕDa of the other crankshaft eccentric portion is set larger than the inner diameter of the through hole of the partition plate. Therefore, in the compression element, it is possible to secure sufficient bearing proof strength against a load received from operating fluid which is compressed, and it is possible to secure the length of the sealing portion as long as possible without increasing the inner diameter of the through hole of the partition plate.

[EFFECT OF THE INVENTION]

[0016] According to the present invention, even if the capacity of the compressor is set large, since the length of the sealing portion between the partition plate and the end surface of the rolling piston long can be made long, it is possible to enhance the airtightness of the compression chamber, and it is possible to realize an efficient rotary compressor having two cylinders.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0017]

Fig. 1 is a longitudinal sectional view of a rotary compressor having two cylinders in an embodiment of the present invention;
Fig. 2 is a plan view of a compression element in the embodiment of the invention;
Fig. 3 is an explanatory diagram showing a positional relation when a crankshaft, a partition plate and rolling pistons of the embodiment of the invention are assembled in the embodiment of the invention;
Fig. 4 is an explanatory diagram showing a positional relation when a crankshaft, a partition plate and rolling pistons of a conventional technique are assembled in a conventional technique;
Fig. 5(a) is an assembling drawing of essential portions of a compressing mechanism in which an eccentric amount is made small in another conventional technique, and Fig. 5(b) is an assembling drawing of essential portions of a compressing mechanism in which the eccentric amount is made large in the conventional technique;
Fig. 6 is a side view of a rotary compressor having two cylinders in another conventional technique; and
Fig. 7 is an enlarged view of essential portion of the conventional technique.

[EXPLANATION OF SYMBOLS]

[0018]

1	hermetic container
2	electrical element
4	compression element
5	partition plate
5a	through hole
6	cylinder
7	crankshaft
7a	other crankshaft eccentric portion
7b	one crankshaft eccentric portion
7c	crankshaft main shaft portion
7d	crankshaft auxiliary shaft portion
8	rolling piston
11a, 11b	compression chamber
12	accumulator
20	oil-storing portion
22a, 22b	vane

[MODE FOR CARRYING OUT THE INVENTION]

[0019] A first aspect of the present invention provides a a rotary compressor having two cylinders in which two compression elements having rolling pistons in the cylinders are placed in adjacent to each other while sandwiching a partition plate therebetween, a crankshaft which is rotated by an electrical element is inserted into a through hole of the partition plate, if the crankshaft rotates, the rolling pistons inserted into crankshaft eccentric portions eccentrically rotates, and the two cylinders compress operating fluid in the cylinders by the eccentric rotation of the rolling pistons, wherein an inner diameter ϕDc of the through hole is greater than an outer diameter ϕDb of one of the crankshaft eccentric portions and smaller than an outer diameter ϕDa of the other crankshaft eccentric portion. The outer diameter ϕDa of the other

crankshaft eccentric portion is greater than the inner diameter of the through hole of the partition plate. Therefore, in the compression element, it is possible to secure a sufficient shaft diameter with respect to a load received from operating fluid which is compressed. Further, even if the eccentric amount is increased, the inner diameter of the through hole of the partition plate is not increased. Therefore, it is possible to secure a length of the sealing portion as long as possible.

[0020] According to a second aspect of the invention, in the rotary compressor having two cylinders of the first aspect, a height Hb of the one crankshaft eccentric portion in its axial direction is higher than a height Ha of the other crankshaft eccentric portion in its axial direction. Also when necessary bearing proof strength can not be secured only by the shaft diameter of the eccentric portion, it is possible to enhance the proof strength by the height of the bearing, and it is possible to minimize enlargement of the inner diameter of the through hole of the partition plate.

[0021] According to a third aspect of the invention, in the rotary compressor having two cylinders of the first or second aspect, capacity of a compression chamber of one of the compression elements which compresses by the one crankshaft eccentric portion is set smaller than capacity of a compression chamber of the other compression element. In the compression element, if the shaft diameter of the eccentric portion is increased, the inner diameter of the through hole of the partition plate is increased. According to the compression element, if the compression chamber capacity is made smaller than that of the other compression element and a bearing load itself is reduced, it is possible to secure reliability.

[0022] According to a fourth aspect of the invention, in the rotary compressor having two cylinders of any one of the first to third aspects, the compression element which compresses by the other crankshaft eccentric portion is placed closer to a main bearing which mainly pivotally supports the crankshaft. Hence, since one of the compression elements having a greater load can be pivotally supported in the vicinity of the bearing, moment applied to the bearing is reduced, and it is possible to secure high reliability for realizing the present invention. Here, the main bearing which mainly pivotally supports is a bearing having the greatest product of a square of the bearing diameter and a bearing length when the crankshaft itself is supported by a plurality of bearings, and in the case of the rotary compressor having two cylinders, the main bearing is provided on the side of an electrical element.

[0023] According to a fifth aspect of the invention, in the rotary compressor having two cylinders of any one of the first to fourth aspects, the through hole is filled with lubricating oil to which discharge pressure of the operating fluid compressed by the compression element is applied or the operating fluid to which discharge pressure of the operating fluid compressed by the compression element is applied. Pressure in the compression chamber is set substantially equal to discharge pressure. According to this, it becomes easily to supply lubricating oil to a sliding portion, and reliability of the compressor becomes excellent. However, in the rotary compressor having two cylinders, if the through hole is filled with high pressure lubricating oil or operating fluid, there is fear that the lubricating oil or the operating fluid leaks into the compression chamber by a pressure difference. If the through hole of the partition plate is filled with low pressure lubricating oil or operating fluid on the other hand, it is conceived that operating fluid compressed through the sealing portion leaks out from the compression chamber which is compressing and discharging, but there is not pressure difference with respect to the compression chamber which is sucking, and time during which a pressure difference is held through the sealing portion becomes short. That is, if the through hole is filled with high pressure lubricating oil, an effect for securing the length of the sealing portion of the present invention appears more outstandingly.

[0024] An embodiment of the present invention will be described with reference to the drawings. The invention is not limited to the embodiment.

(Embodiment)

[0025] Fig. 1 is a longitudinal sectional view of a rotary compressor having two cylinders in an embodiment of the present invention, and Fig. 2 is a plan view of a compression element.

[0026] In Fig. 1, an electrical element 2 and a compression element 4 are accommodated in a hermetic container 1. The electrical element 2 rotates a crankshaft 7, and the crankshaft 7 drives the compression element 4.

[0027] The compression element 4 is composed of compression elements 4a and 4b which independently carry out a compressing operation. The compression element 4a includes a cylinder 6a which forms a cylindrical space, and a rolling piston 8a which is placed in the cylinder 6a. The compression element 4b includes a cylinder 6b which forms a cylindrical space, and a rolling piston 8b which is placed in the cylinder 6b.

[0028] The crankshaft 7 includes crankshaft eccentric portions 7a and 7b. The partition plate 5 is placed between the two compression elements 4a and 4b. A main bearing 31 is placed on the compression element 4a on its side close to the electrical element 2. The main bearing 31 forms an upper end plate together with a bearing portion which pivotally supports a crankshaft main shaft portion 7c. The upper end plate closes an electrical element 2 of the compression element 4a. An auxiliary bearing 32 is placed on the compression element 4b on its side close to an oil-storing portion 20. The auxiliary bearing 32 forms a lower end plate together with a bearing portion which pivotally supports a crankshaft auxiliary shaft portion 7d. The lower end plate closes the oil-storing portion 20 of the compression element 4b.

[0029] The cylinder 6a is placed on an upper surface

of the partition plate 5, and the cylinder 6b is placed on a lower surface of the partition plate 5. The one crankshaft eccentric portion 7b is accommodated in the cylinder 6b, and the other crankshaft eccentric portion 7a is accommodated in the cylinder 6a.

[0030] The crankshaft eccentric portions 7a and 7b are integrally formed on the crankshaft 7. The rolling piston 8a is rotatably mounted on the other crankshaft eccentric portion 7a, and the rolling piston 8b is rotatably mounted on the one crankshaft eccentric portion 7b.

[0031] As shown in Fig. 2, a vane groove 21a is formed in the cylinder 6a, and a vane groove 21b is formed in the cylinder 6b. A vane 22a is slidably placed in the vane groove 21a, and a vane 22b is slidably placed in the vane groove 21b. Back pressure is applied to the vane 22a, and the vane 22a is always in abutment against the rolling piston 8a. Back pressure is applied to the vane 22b, and the vane 22b is always in abutment against the rolling piston 8b. The cylinder 6a is provided with a suction passage 9a, and the cylinder 6b is provided with a suction passage 9b. A suction pipe 10a is connected to the suction passage 9a, and a suction pipe 10b is connected to the suction passage 9b. The suction passage 9a and the suction passage 9b are independent from each other, and the suction pipe 10a and the suction pipe 10b are independent from each other. The suction pipe 10a is in communication with a compression chamber 11a through the suction passage 9a, and the suction pipe 10b is in communication with a compression chamber 11b through the suction passage 9b.

[0032] The suction pipes 10a and 10b are provided with an accumulator 12 for preventing liquid from being compressed in the compression chambers 11a and 11b. The accumulator 12 separates refrigerant into gas and liquid, and guides only refrigerant gap into the suction pipes 10a and 10b. The accumulator 12 has a cylindrical case 13, a refrigerant gas introducing pipe 14 is connected to an upper portion of the case 13, and two refrigerant gas lead-out pipes 15a and 15b are connected to a lower portion of the case 13. One ends of the refrigerant gas lead-out pipes 15a and 15b are connected to the suction pipes 10a and 10b, and the other ends of the refrigerant gas lead-out pipes 15a and 15b extend to an upper portion of a space in the case 13.

[0033] If the crankshaft 7 is rotated by the electrical element 2, the crankshaft eccentric portions 7a and 7b eccentrically rotate in the cylinders 6a and 6b, and the rolling pistons 8a and 8b rotate while abutting against the vanes 22a and 22b. The rolling pistons 8a and 8b repeatedly suck and compress refrigerant gap in both the cylinders 6a and 6b with a period deviated from each other by half rotation. Low pressure refrigerant which is sucked from the refrigerant gas introducing pipe 14 is separated into gas and liquid in the case 13, and refrigerant gap from which liquid refrigerant is separated is sucked into the compression chambers 11a and 11b respectively through the refrigerant gas lead-out pipes 15a and 15b, the suction pipes 10a and 10b and the suction passages 9a and 9b.

[0034] Lubricating oil in the oil-storing portion 20 of a bottom of the hermetic container 1 is supplied from a lower end of the crankshaft auxiliary shaft portion 7d to the through hole 5a through an interior of the crankshaft 7, and a region surrounded by the partition plate 5, the rolling pistons 8a and 8b and the crankshaft 7 is filled with the lubricating oil.

[0035] Action and an effect of the rotary compressor having two cylinders having the above-described configuration will be described below.

[0036] Fig. 3 is a side view of essential portions showing a positional relation when the crankshaft, the partition plate and the rolling pistons of the rotary compressor of the embodiment of the invention are assembled in the embodiment of the invention.

[0037] At the time of the assembling operation, the partition plate 5 is inserted from the crankshaft auxiliary shaft portion 7d, and is placed between the one crankshaft eccentric portion 7b and the other crankshaft eccentric portion 7a through the one crankshaft eccentric portion 7b. For this reason, it is necessary that an inner diameter ϕDc of the through hole 5a of the partition plate 5 is set greater than an outer diameter ϕDb of the one crankshaft eccentric portion 7b.

[0038] In the embodiment of the invention, the outer diameter ϕDa of the other crankshaft eccentric portion 7a is set greater than the inner diameter ϕDc of the through hole 5a, and the partition plate 5 can not be inserted from the crankshaft main shaft portion 7c. By setting the outer diameter ϕDa of the crankshaft eccentric portion 7a to the great value in this manner, it is possible to enhance the proof strength against a load received from the rolling piston 8a at the time of compression, and even if the capacity of the compression element 4a is set to the great value, it is possible to realize high reliability.

[0039] In Fig. 3, the through hole 5a is filled with lubricating oil. Discharge pressure is applied to the lubricating oil existing in the through hole 5a. The through hole 5a is filled with operating fluid in some cases. In this case also, discharge pressure is applied to the operating fluid existing in the through hole 5a. A pressure difference between the compression chamber 11a and the compression chamber 11b is secured by a sealing portion 40 which is composed of an end surface of the partition plate 5 and end surfaces of the rolling pistons 8a and 8b. However, the sealing portion 40 is provided with a fine gap in a height direction so that the rolling piston 8 can eccentrically rotate. To suppress leakage from the gap, it is desired that a length (length in radial direction) of the sealing portion 40 is set as long as possible. In the embodiment of the invention, by setting the outer diameter ϕDb of the one crankshaft eccentric portion 7b to the small value, it is possible to make the inner diameter ϕDc of the through hole 5a small. A length of the rolling piston 8b in the radial direction can be increased by a reduction length of the outer diameter ϕDb of the one crankshaft eccentric portion 7b in the radial direction. Therefore, the

sealing portion 40 can be made long in the radial direction, and it is possible to prevent lubricating oil from leaking from the through hole 5a to the compression chambers 11a and 11b.

[0040] As a comparative example, Fig. 4 is an assembling drawing when the outer diameter ϕDb of the one crankshaft eccentric portion 7b is set equal to the outer diameter ϕDa of the other crankshaft eccentric portion 7a.

[0041] If the outer diameter ϕDb of the one crankshaft eccentric portion 7b which is inserted into the through hole 5a is increased, the inner diameter ϕDc of the through hole 5a is increased. Therefore, although the outer diameter of the rolling piston 8b and the eccentric amount of the crankshaft eccentric portion 7b are the same, the length of the sealing portion 40 becomes short, and it can be found that leakage of lubricating oil from the through hole 5a to the compression chambers 11a and 11b is increased.

[0042] The outer diameter ϕDb of the one crankshaft eccentric portion 7b which is inserted into the through hole 5a of the partition plate 5 at the time of the assembling operation is set smaller than the outer diameter ϕDa of the other crankshaft eccentric portion 7a, and the inner diameter ϕDc of the through hole 5a is confined to such a size that the one crankshaft eccentric portion 7b having the small outer diameter can pass through the through hole 5a. According to this, the length of the sealing portion 40 can be increased, and it is possible to prevent high pressure lubricating oil from entering the compression chambers 11.

[0043] Since the outer diameter ϕDb of the one crankshaft eccentric portion 7b is smaller than the outer diameter ϕDa of the other crankshaft eccentric portion 7a, the bearing proof strength is deteriorated. To supplement the deterioration of the bearing proof strength, a shaft height Hb of the one crankshaft eccentric portion 7b may be set higher than a shaft height Ha of the other crankshaft eccentric portion 7a as shown in Fig. 3. According to this, also when necessary bearing proof strength can not be secured only by the shaft diameter of the one crankshaft eccentric portion 7b, it is possible to enhance the proof strength by the shaft height Hb, and it is possible to minimize enlargement of the inner diameter ϕDc of the through hole 5a of the partition plate 5.

[0044] Further, compression chamber capacity of the compression element 4b may be set smaller than compression chamber capacity of the compression element 4a. The compression chamber capacity of the compression element 4b is capacity of the compression chamber 11a which is formed by the cylinder 6a, the rolling piston 8a, the upper end plate of the main bearing 31 and the partition plate 5. The compression chamber capacity of the compression element 4a is capacity of the compression chamber 11b which is formed by the cylinder 6b, the rolling piston 8b, the lower end plate of the auxiliary bearing 32 and the partition plate 5.

[0045] According to this, although enlargement of the shaft diameter of the one crankshaft eccentric portion 7b is a cause of enlargement of the inner diameter ϕDc of the through hole 5a of the partition plate 5, it is possible to secure reliability by making the capacity of the compression chamber 11a of the compression element 4b smaller than the capacity of the compression chamber 11b of the compression element 4a, and by reducing a bearing load of the one crankshaft eccentric portion 7b.

[0046] The compression element 4a which compresses by the other crankshaft eccentric portion 7a may be placed closer to the main bearing 31 which mainly pivotally supports the crankshaft 7. Since the compression element 4a having a greater load can pivotally be supported in the vicinity of the main bearing 31, it is possible to reduce moment which is applied to the main bearing 31, and to secure high reliability for realizing the present invention.

[0047] Although the present invention has been described based on the rotary compressor having two cylinders, the same effect can be realized even if the invention is applied to the rotary compressor having three or more cylinders.

[INDUSTRIAL APPLICABILITY]

[0048] According to the rotary compressor having two cylinders of the present invention, it is possible to enhance the airtightness of the compression chamber and to enhance the efficiency of the compressor by suppressing leakage through a sealing portion between the partition plate and the end surface of the rolling piston. According to this, the invention can also be applied to usage of an air conditioner and a pump type water heater using CO2 which is natural refrigerant in addition to a compressor for an air conditioner using HFC-based refrigerant.

Claims

1. A rotary compressor having two cylinders in which two compression elements having rolling pistons in the cylinders are placed in adjacent to each other while sandwiching a partition plate therebetween,
   a crankshaft which is rotated by an electrical element is inserted into a through hole of the partition plate,
   if the crankshaft rotates, the rolling pistons inserted into crankshaft eccentric portions eccentrically rotates, and
   the two cylinders compress operating fluid in the cylinders by the eccentric rotation of the rolling pistons, wherein
   an inner diameter ϕDc of the through hole is greater than an outer diameter ϕDb of one of the crankshaft eccentric portions and smaller than an outer diameter ϕDa of the other crankshaft eccentric portion.

2. The rotary compressor having two cylinders according to claim 1, wherein a height Hb of the one crankshaft eccentric portion in its axial direction is higher

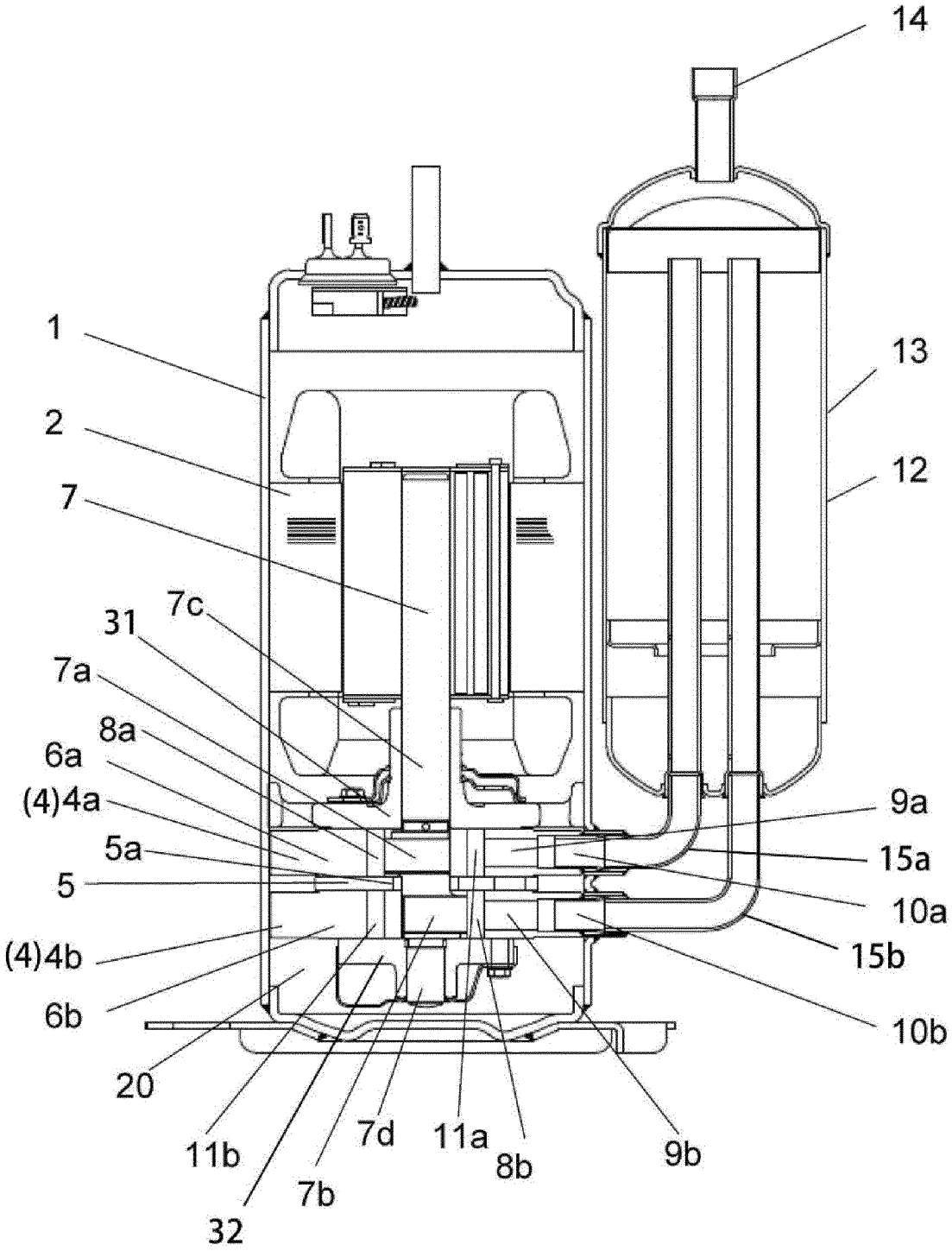
than a height Ha of the other crankshaft eccentric portion in its axial direction.

3. The rotary compressor having two cylinders according to claim 1 or 2, wherein capacity of a compression chamber of one of the compression elements which compresses by the one crankshaft eccentric portion is set smaller than capacity of a compression chamber of the other compression element.

4. The rotary compressor having two cylinders according to any one of claims 1 to 3, wherein the compression element which compresses by the other crankshaft eccentric portion is placed closer to a main bearing which mainly pivotally supports the crankshaft.

5. The rotary compressor having two cylinders according to any one of claims 1 to 4, wherein the through hole is filled with lubricating oil to which discharge pressure of the operating fluid compressed by the compression element is applied or the operating fluid to which discharge pressure of the operating fluid compressed by the compression element is applied.

[Fig. 1]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15a
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7d
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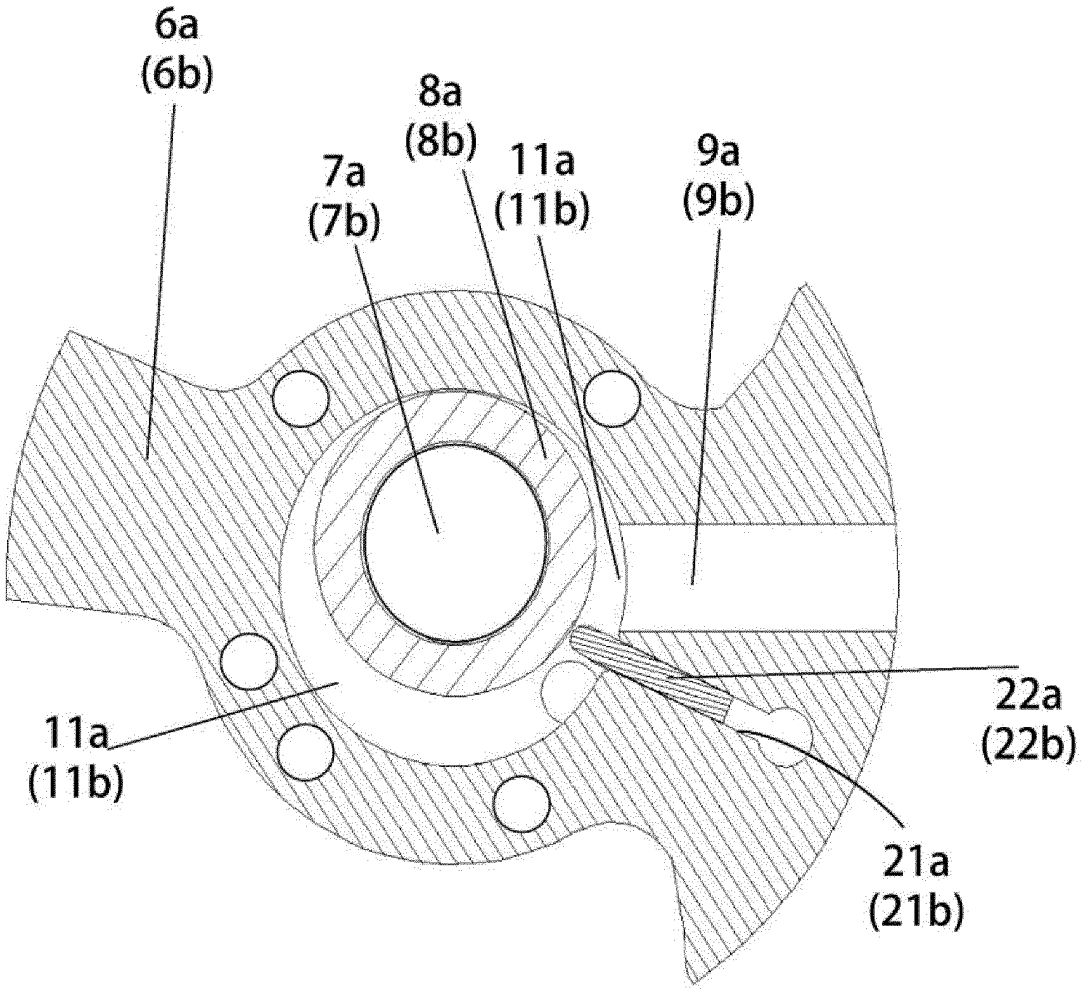
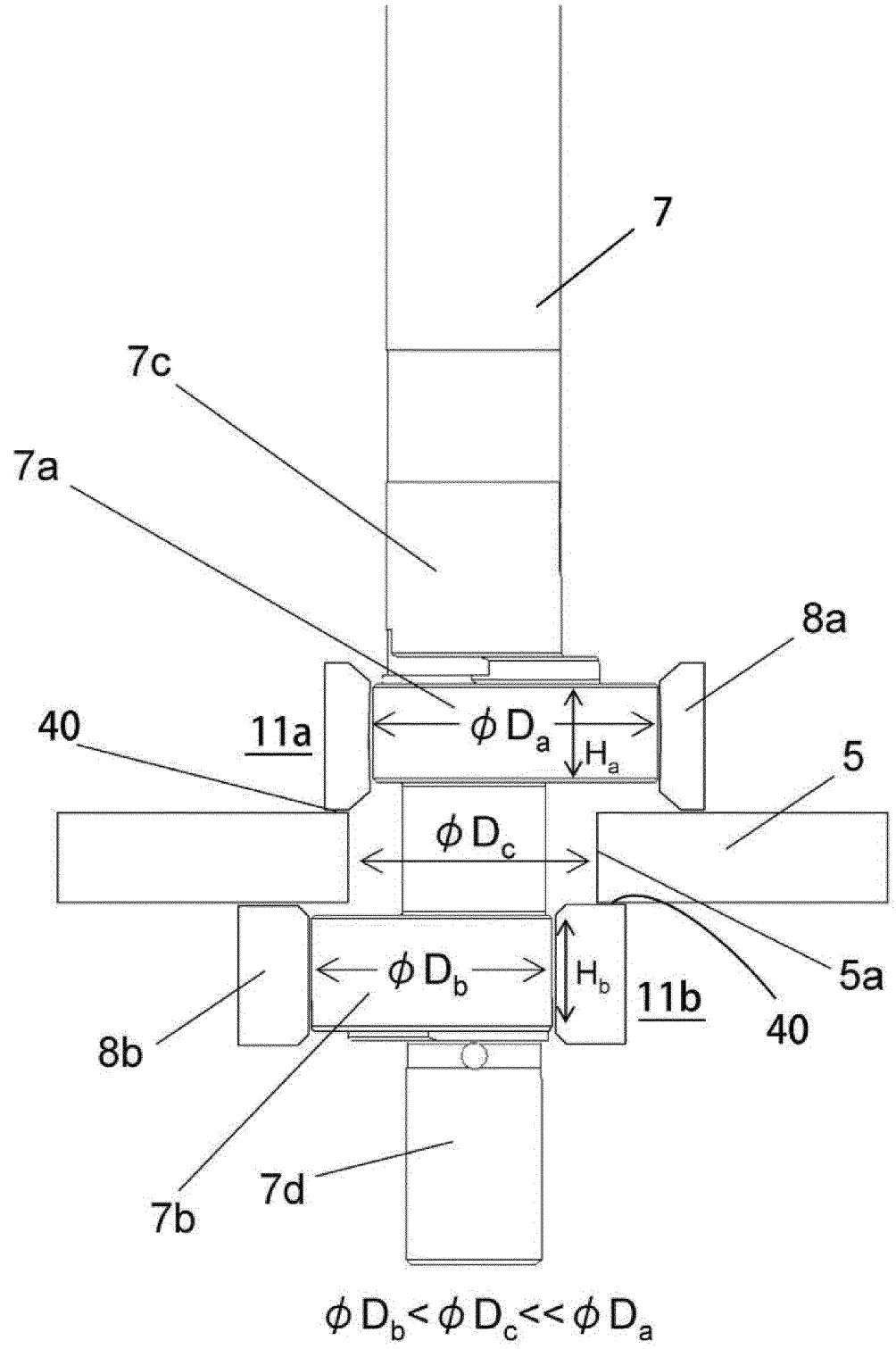
7b
8b
32

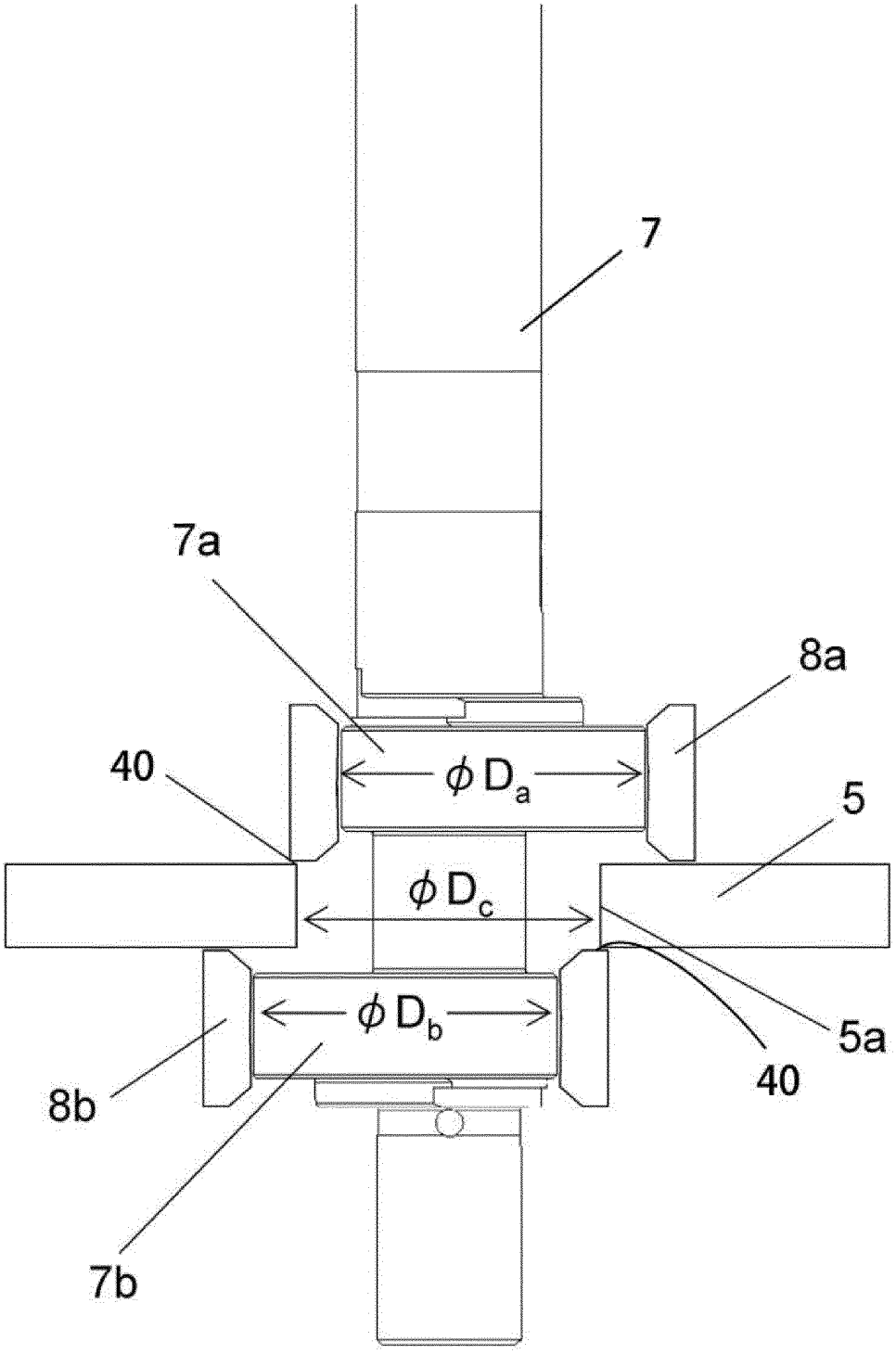
[Fig. 2]



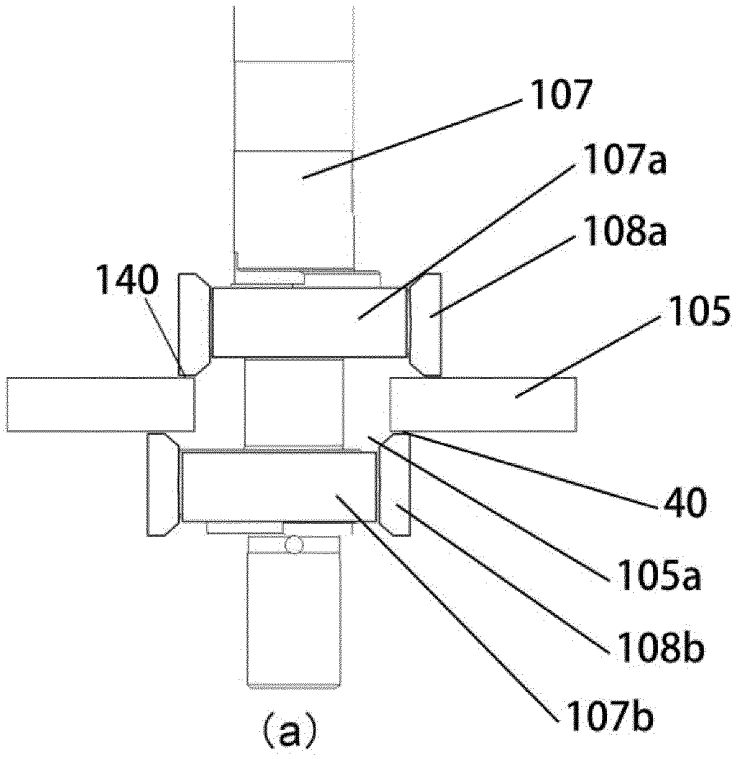
[Fig. 3]



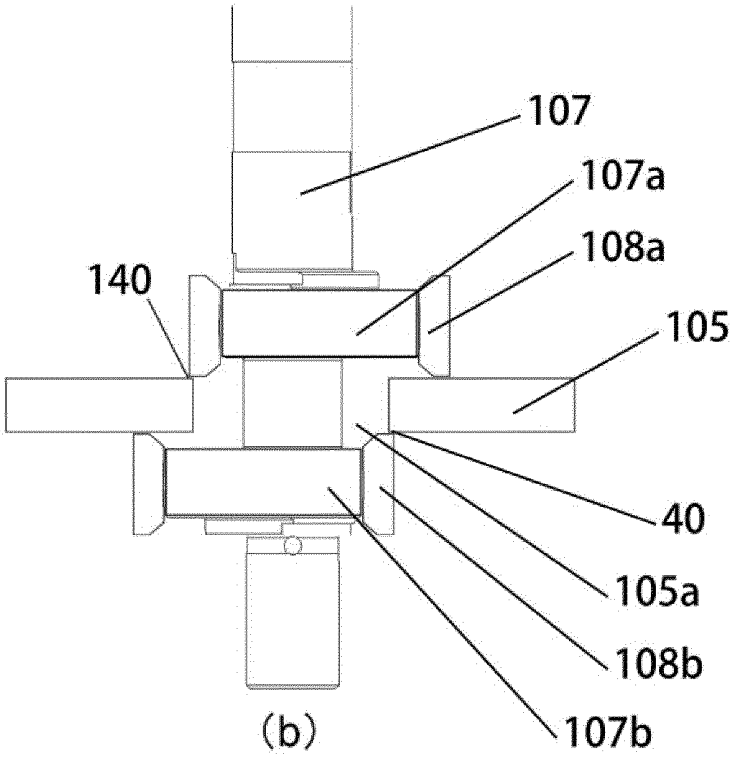
[Fig. 4]



[Fig. 5]

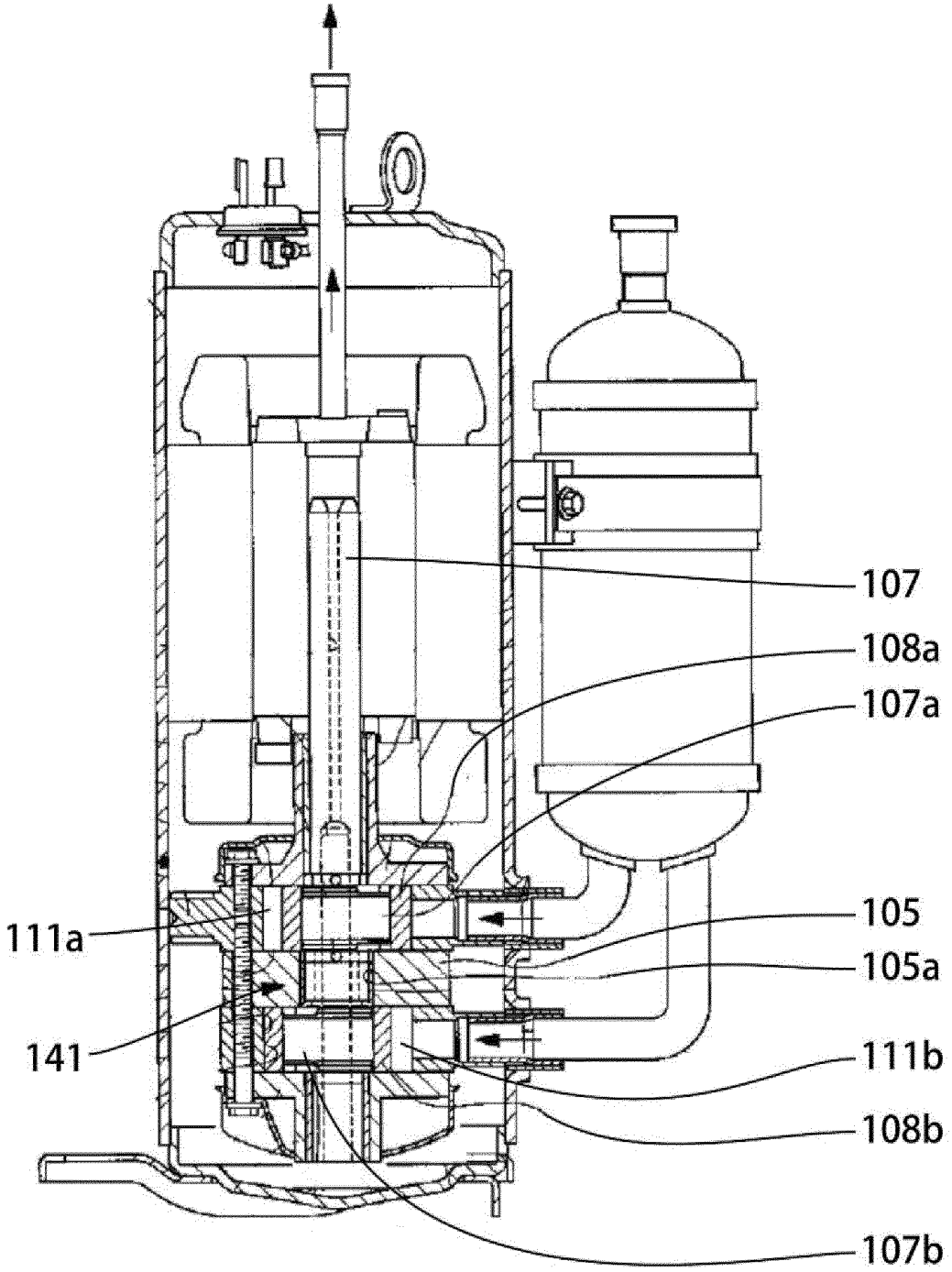

107
107a
108a
140
105
40
105a
108b
107b

(a)

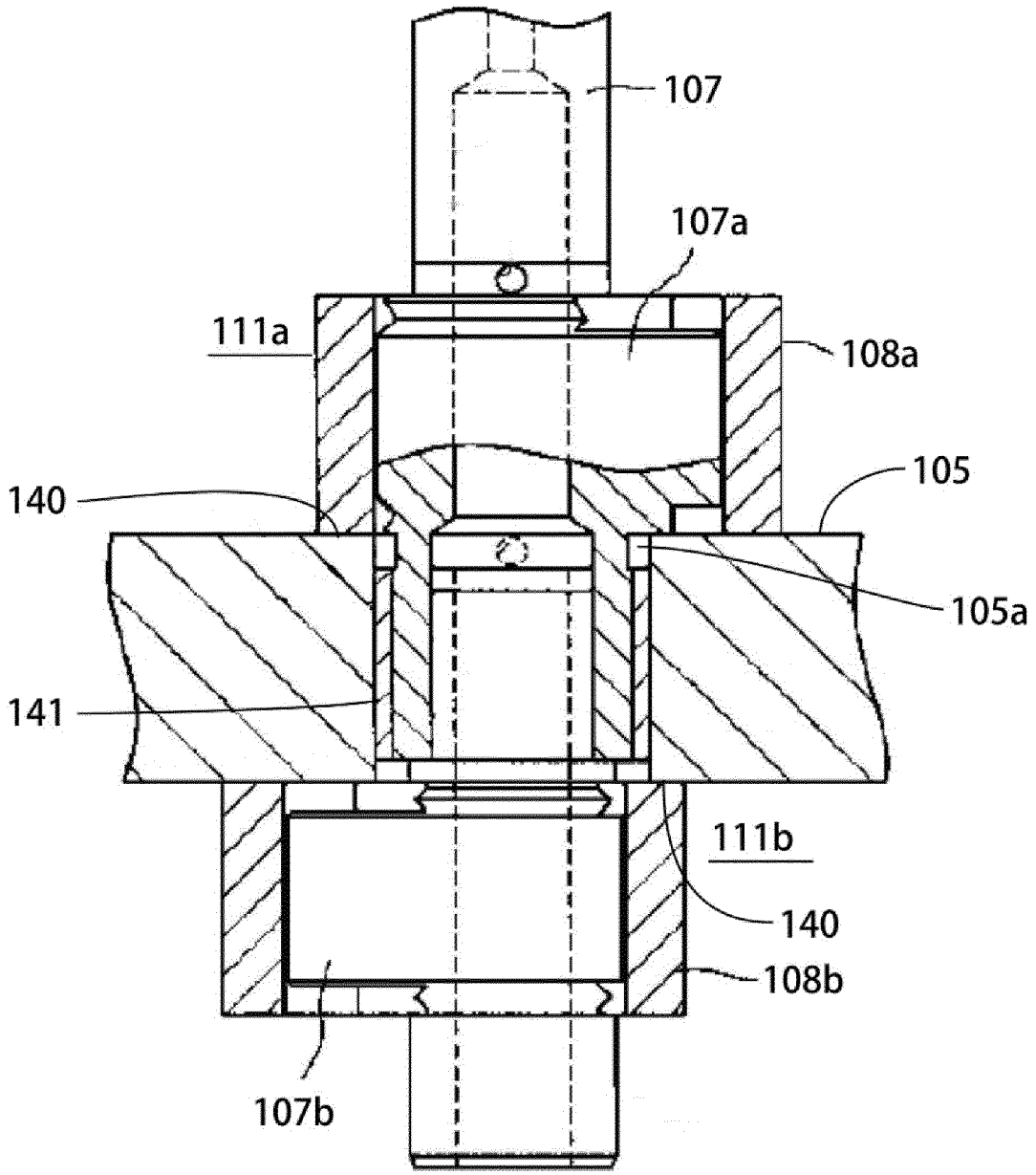

107
107a
108a
140
105
40
105a
108b
107b

(b)

[Fig. 6]



[Fig. 7]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/006665

A. CLASSIFICATION OF SUBJECT MATTER
F04C18/356(2006.01)i, *F04C23/00*(2006.01)i, *F04C27/00*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04C18/356, F04C23/00, F04C27/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2009-180203 A (Hitachi Appliances, Inc.), 13 August 2009 (13.08.2009), paragraphs [0004] to [0025]; fig. 1 to 3 & CN 101498307 A & KR 10-2009-0084612 A	1,4-5 2-3
Y	JP 3-258990 A (Matsushita Refrigeration Co.), 19 November 1991 (19.11.1991), page 2, upper left column, lines 8 to 13 (Family: none)	2-3
Y	JP 2009-275645 A (Mitsubishi Electric Corp.), 26 November 2009 (26.11.2009), paragraph [0007] (Family: none)	2-3

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

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Date of the actual completion of the international search	Date of mailing of the international search report
29 November, 2012 (29.11.12)	11 December, 2012 (11.12.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

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Patent documents cited in the description

- JP 2005337210 A **[0010]**