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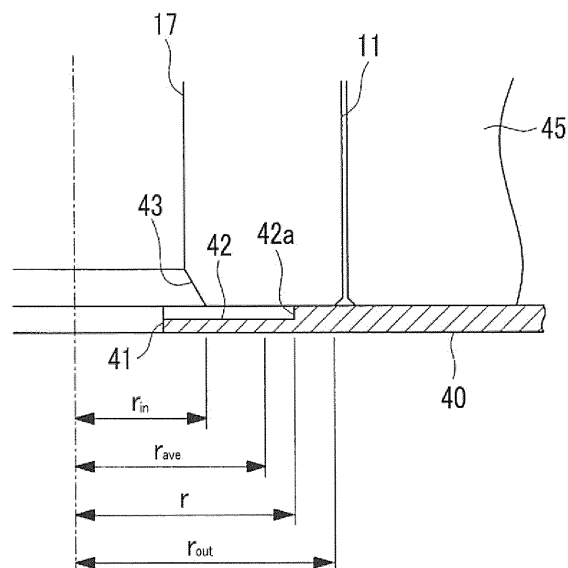
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(54) **FLUID MACHINE**

(57) This hermetic scroll compressor comprises: a ringshaped thrust plate (40) having a through hole (41) through which a lubricating oil flows; and a crankshaft (11) that is placed on the upper surface of the thrust plate (40) and that has a flow path (17) formed in the interior thereof through which the lubricating oil having passed through the through hole (41) of the thrust plate (40) flows. In a sliding region of the crankshaft (11) and the thrust plate (40), a recessed groove (42) to which the lubricating oil is supplied from the through hole (41) is formed in the crankshaft (11) and/or the thrust plate (40). The outer end part (42a), in the radial direction, of the groove (42) is located inward of the outermost peripheral portion of the sliding region.

FIG. 2



Description

Technical Field

[0001] The present invention relates to a fluid machine.

Background Art

[0002] In a vertically hermetic compressor, a housing internally accommodates a compression mechanism and a motor (electric motor) which drives the compression mechanism. The compression mechanism and a motor rotor are combined with each other by the same crankshaft. The crankshaft is disposed so that an axial direction is set to be a vertical direction, and a thrust load is applied to a lower end portion of the crankshaft. Here, the thrust load means a dead weight of the crankshaft and the motor rotor and an axial force of a magnet pulling force generated during operation.

[0003] When the above-described thrust load is supported, friction loss occurs in the lower end portion of the crankshaft. Therefore, a thrust bearing which comes into contact with the lower end portion of the crankshaft is installed as disclosed in PTL 1 and 2 below.

Citation List

Patent Literature

[0004]

[PTL 1] Japanese Unexamined Utility Model Registration Application Publication No. 62-78389

[PTL 2] Japanese Unexamined Patent Application Publication No. 2014-152747

Summary of Invention

Technical Problem

[0005] PTL 1 and 2 disclose that a lubricant is supplied to the thrust bearing so as to improve lubricating ability in the thrust bearing. Then, in the lower end portion of the crankshaft and a sliding region of the thrust bearing, an oil supply groove for supplying the lubricant to the thrust bearing is entirely formed in a radial direction, that is, so as to penetrate from an inner peripheral portion to an outer peripheral portion.

[0006] An oil passage inside a compressor is formed at the center of the crankshaft, and is branched to a journal bearing for supporting a radial load or a compression mechanism. The lubricant is supplied from a pump installed around the lower end portion of the crankshaft to the oil passage disposed at the center of the crankshaft. Thereafter, the lubricant is supplied to the journal bearing or the compression mechanism via the oil passage.

[0007] Therefore, in a case where the lubricant pressurized by the pump is supplied to the thrust bearing, if

the oil supply groove formed in the lower end portion of the crankshaft and the sliding region of the thrust bearing is entirely formed in the radial direction, the lubricant passes through the oil supply groove. As a result, a large amount of the lubricant pressurized by the pump flows out from the oil supply groove, thereby causing a problem in that the amount of the lubricant supplied to the journal bearing or the compression mechanism decreases.

[0008] The present invention is made in view of these circumstances, and an object thereof is to provide a fluid machine which can reduce friction loss occurring in a lower end portion of a crankshaft and which can reliably supply a lubricant to other sliding portions.

15 Solution to Problem

[0009] In order to solve the above-described problem, a fluid machine according to the present invention adopts the following means.

[0010] That is, according to an aspect of the present invention, there is provided a fluid machine including an annular plate part that has a through-hole through which a lubricant is circulated, and a crankshaft that is placed on an upper surface of the plate part, and that internally has a circulation passage for circulating the lubricant passing through the through-hole of the plate part. In a sliding region between the crankshaft and the plate part, at least one of the crankshaft and the plate part has a recess groove to which the lubricant is supplied from the through-hole. An outer end portion of the groove in a radial direction is located inward of an outermost peripheral portion in the sliding region.

[0011] According to this configuration, the through-hole is formed in the plate part, the circulation passage is formed inside the crankshaft placed on the upper surface of the plate part. After the lubricant is circulated through the through-hole of the plate part, the lubricant flows in the circulation passage of the crankshaft. In the crankshaft and the sliding region of the plate part, the groove is formed in at least one of the crankshaft and the plate part, and the lubricant is supplied from the through-hole to the groove. As a result, the sliding region of the crankshaft and the plate part are filled with the lubricant, and an oil film is formed, thereby enabling friction loss to be reduced. In addition, the outer end portion of the groove in the radial direction is located inward of the outermost peripheral portion in the above-described sliding region. Accordingly, the lubricant supplied to the groove is less likely to leak from an inner peripheral side to an outer peripheral side in the sliding region.

[0012] For example, the outer end portion of the groove in the radial direction is located inward as much as approximately 10% of a radius of the outermost peripheral portion in the above-described sliding region.

[0013] In the above-described aspect, the outer end portion of the groove in the radial direction may be located outward of an intermediate position between an innermost peripheral portion and the outermost peripheral portion.

tion in the sliding region.

[0014] According to this configuration, the groove can supply the lubricant outward of the intermediate position between the innermost peripheral portion and the outermost peripheral portion in the sliding region.

[0015] In the above-described aspect, an area of a region having the groove in the sliding region may be 50% to 80% of a total area located inward of the outer end portion of the groove in the radial direction in the sliding region.

[0016] According to this configuration, the oil film is likely to be formed in the crankshaft and the sliding region of the plate part by using the lubricant supplied to the groove.

[0017] In the above-described aspect, an inner portion of the groove in the radial direction or a portion facing the inner portion of the groove in the radial direction in the crankshaft or the plate part may have a tapered surface.

[0018] According to this configuration, the inner portion of the groove in the radial direction or the portion facing the inner portion has the tapered surface. Accordingly, the inner portion of the groove in the radial direction is widened in a height direction, and the lubricant is likely to be supplied into the groove.

[0019] In the above-described aspect, the groove may have a stepped shape, a tapered shape, or a dimple shape.

Advantageous Effects of Invention

[0020] According to the present invention, it is possible to reduce friction loss occurring in the lower end portion of the crankshaft and it is possible to reliably supply the lubricant to other sliding portions.

Brief Description of Drawings

[0021]

Fig. 1 is a longitudinal sectional view illustrating a scroll-type compressor according to an embodiment of the present invention.

Fig. 2 is a partially enlarged longitudinal sectional view illustrating a thrust plate of the scroll-type compressor according to the embodiment of the present invention.

Fig. 3 is a plan view illustrating the thrust plate of the scroll-type compressor according to the embodiment of the present invention.

Fig. 4 is a longitudinal sectional view illustrating an example of a groove formed in the thrust plate of the scroll-type compressor according to the embodiment of the present invention.

Fig. 5 is a longitudinal sectional view illustrating an example of the groove formed in the thrust plate of the scroll-type compressor according to the embodiment of the present invention.

Fig. 6 is a longitudinal sectional view illustrating an example of the groove formed in the thrust plate of the scroll-type compressor according to the embodiment of the present invention.

Fig. 7 is a longitudinal sectional view illustrating a lower end portion of a crankshaft, the thrust plate, and a suction pipe of the scroll-type compressor according to the embodiment of the present invention.

Fig. 8 is a graph illustrating the efficiency of an air conditioning device for each operation mode or for each performance evaluation.

Fig. 9 is a longitudinal sectional view illustrating a rotary compressor according to an embodiment of the present invention.

Description of Embodiments

[0022] Hereinafter, a hermetic scroll compressor according to an embodiment of the present invention will be described with reference to the drawings.

[0023] As illustrated in Fig. 1, a hermetic scroll compressor 1 as a scroll fluid machine includes a vertically long cylindrical hermetic housing 2 whose bottom portion is hermetic by a lower cover. An upper part of the hermetic housing 2 is hermetic by a discharge cover 3 and an upper cover 4, a discharge chamber 5 for discharging compressed high-pressure gas is formed between the discharge cover 3 and the upper cover 4.

[0024] Inside the hermetic housing 2, an upper bearing member (frame member) 6 is fixedly installed in the upper part, a scroll compression mechanism 7 is incorporated via the upper bearing member 6, and an electric motor 10 having a stator 8 and a rotor 9 is installed in the lower part. The electric motor 10 is incorporated by the stator 8 fixedly installed in the hermetic housing 2, and a crankshaft 11 is fixed to the rotor 9.

[0025] An upper end of the crankshaft 11 has a crank pin 12 whose axis is eccentric as much as a predetermined dimension. The crank pin 12 is connected to the scroll compression mechanism 7, thereby enabling the scroll compression mechanism 7 to be driven by the electric motor 10. The crankshaft 11 is supported by a journal bearing portion 6A of the upper bearing member 6 so that an upper portion is rotatable, and a lower end portion is rotatably supported by a lower journal bearing 13 disposed in the lower part of the hermetic housing 2.

[0026] A displacement-type oil supply pump 14 is disposed between the lower journal bearing 13 and the lower end portion of the crankshaft 11, and the lubricant 15 filling the bottom portion of the hermetic housing 2 is suctioned via a suction pipe 16. The lubricant 15 is configured to be discharged to a circulation passage 17 drilled inside the crankshaft 11 along an axial direction. The lubricant 15 can be supplied via the circulation passage 17 to portions requiring lubrication, such as the upper bearing member 6, the scroll compression mechanism 7, and the lower journal bearing 13.

[0027] The scroll compression mechanism 7 has the

upper bearing member 6 serving as one configuration component, and includes a fixed scroll 18 fixedly installed on the upper bearing member 6, an orbiting scroll 19 that is slidably supported by a thrust bearing portion 6B of the upper bearing member 6, and that forms a compression chamber 20 by meshing with the fixed scroll 18, a rotation prevention mechanism 21 such as an Oldham ring that is interposed between the upper bearing member 6 and the orbiting scroll 19, and that prevents rotation of the orbiting scroll 19 and allows orbital turning movement, and a drive bush 22 and a turning bearing (needle bearing) 23 which are disposed between the crank pin 12 of the crankshaft 11 and a bearing boss 19C disposed on a rear surface the orbiting scroll 19, and which transmit a rotational force of the crankshaft 11 to the orbiting scroll 19. The scroll compression mechanism 7 is installed on the upper bearing member 6 in a state where a central portion of an end plate of the fixed scroll 18 is connected to the discharge cover 3.

[0028] The fixed scroll 18 includes an end plate 18A and a spiral wrap 18B erected on the end plate 18A, and is configured so that a discharge port 24 is disposed in a central portion of the end plate 18A, and so that a tip seal 25 is installed on a wrap tooth tip surface of the spiral wrap 18B. In addition, the orbiting scroll 19 includes an end plate 19A and a spiral wrap 19B erected on the end plate 19A. A bearing boss 19C is disposed on a rear surface of the end plate 19A, and a tip seal 26 is installed on a wrap tooth tip surface of the spiral wrap 19B.

[0029] The scroll compression mechanism 7 suctions refrigerant gas suctioned into the hermetic housing 2 via a suction pipe 27 open at a position facing a stator winding 8A of the electric motor 10, into the compression chamber 20 from a suction port 28 open in the hermetic housing 2, and compresses the refrigerant gas into high-temperature and high-pressure gas. The compressed gas is discharged into the discharge chamber 5 via a discharge port 24 disposed in a central portion of the fixed scroll 18 and a discharge valve 29 disposed in the discharge cover 3, and further, the compressed gas is fed outward of the compressor via a discharge pipe 30 connected to the discharge chamber 5.

[0030] Hereinafter, referring to Figs. 2 to 7, a thrust plate 40 disposed in the compressor according to the present embodiment will be described.

[0031] The thrust plate 40 is a plate member disposed so as to be in contact with a lower end surface of the crankshaft 11. For example, the thrust plate 40 has a thickness of approximately 1 mm. The thrust plate 40 is installed between a lower surface of the lower journal bearing 13 and an upper surface of the suction pipe 16.

[0032] The thrust plate 40 has a through-hole 41 through which the lubricant 15 is circulated. The through-hole 41 causes a circulation passage 51 formed in the suction pipe 16 to communicate with the circulation passage 17 formed in the crankshaft 11. As a result, as illustrated in Fig. 7, the lubricant 15 passing through the suction pipe 16 is circulated through the through-hole 41

of the thrust plate 40. After the lubricant 15 is circulated through the through-hole 41 of the thrust plate 40 to the lubricant 15, the lubricant 15 flows in the circulation passage 17 of the crankshaft 11.

[0033] In the thrust plate 40, a groove 42 is formed in a sliding region between the crankshaft 11 and the thrust plate 40. The sliding region between the crankshaft 11 and the thrust plate 40 is a region where the lower end surface of the crankshaft 11 and the upper surface of the thrust plate 40 face each other. Hereinafter, a case will be described where the groove 42 is formed only in the thrust plate 40. However, the present invention is not limited to this example. For example, the groove according to the invention may be formed only in the crankshaft 11 in the sliding region between the crankshaft 11 and the thrust plate 40, or may be formed in both the crankshaft 11 and the thrust plate 40.

[0034] The groove 42 is formed in a recess shape in the thrust plate 40, and the lubricant 15 is supplied from the through-hole 41. That is, the groove 42 communicates with the circulation passage 51 formed in the suction pipe 16 and the circulation passage 17 formed in the crankshaft 11 on the through-hole 41 side of the thrust plate 40.

[0035] A minute recess is formed in the thrust plate 40. In this manner, dynamic pressure is generated in the sliding region, and floating occurs due to oil film pressure. As a result, friction loss occurring between the lower end surface of the crankshaft 11 and the upper surface of the thrust plate 40 can be reduced.

[0036] For example, a depth of the groove 42 is 5 μm to 10 μm . The depth of the groove 42 is determined depending on a ratio (Λ -value) between the thickness of the oil film generated between the lower end surface of the crankshaft 11 and the upper surface of the thrust plate 40 and composite roughness of the sliding surface. When the Λ -value (= thickness of oil film / composite roughness of sliding surface) is greater than 3, it is known that floating caused by the oil film surely occurs, and the oil film enables the crankshaft 11 to float with respect to the thrust plate 40. In addition, irrespective of whether the rotation speed of the crankshaft 11 is high or low, if the depth of the groove 42 is too shallow or too deep, the Λ -value becomes a low value. That is, irrespective of whether the rotation speed of the crankshaft 11 is high or low, there is an optimum depth of the groove 42 where the Λ -value becomes a maximum value.

[0037] In a case where the rotation speed of the crankshaft 11 is low, if the groove 42 is deep, the Λ -value tends to be 3 or less. In contrast, in a case where the rotation speed of the crankshaft 11 is high, even if the groove 42 is deep, the Λ -value can be maintained at a value greater than 3. That is, in a case where the rotation speed of the crankshaft 11 is low, a range of the depth of the groove 42 in which the Λ -value can be greater than 3 is narrower than a range in a case where the rotation speed of the crankshaft 11 is high.

[0038] In the compressor, when the diameter of the

crankshaft 11 is set to 10 mm to 40 mm, the rotation speed of the crankshaft 11 is 10 set to 10 rps to 140 rps, lubricant viscosity is set to 2 mPa·s to 30 mPa·s, and a total dead weight of the crankshaft 11 and the rotor 9 is set to 10 N to 100 N, the inventors perform analysis for calculating the Λ -value. As a result, the inventors confirm that the range of the depth of the groove 42 of the thrust plate 40 is desirably in the range of 5 μ m to 10 μ m.

[0039] In addition, based on the demonstration experiments, the inventors confirm the following. When the rotation speed of the crankshaft 11 is relatively low, for example, in a case where the rotation speed is lower than 40 rps, the depth of the groove 42 is desirably 5 μ m. When the rotation speed of the crankshaft 11 is relatively high, for example, in a case where the rotation speed is equal to or higher than 90 rps, the depth of the groove 42 is preferably 10 μ m. This result indicates the same tendency as the above-described analysis for calculating the A-value.

[0040] For example, Fig. 8 illustrates a graph when total efficiency of the compressor is set to 1 in a case where the thrust plate having no groove 42 is disposed during an intermediate cooling operation. As a result, during the intermediate cooling operation in which the rotation speed of the crankshaft 11 is relatively low, the efficiency in a case where the depth of the groove 42 is set to 5 μ m is higher than that in a case where the depth of the groove 42 is set to 10 μ m. On the other hand, during a rated heating operation in which the rotation speed of the crankshaft 11 is relatively high, the efficiency in a case where the depth of the groove 42 is set to 10 μ m is higher than that in a case where the depth of the groove 42 is set to 5 μ m.

[0041] That is, in a case where an energy-saving performance of an air conditioning device is evaluated using an annual performance factor (APF) whose weighting during the intermediate operation is higher than that during the rated operation, the depth of the groove 42 is desirably set to 5 μ m rather than 10 μ m.

[0042] The outer end portion 42a of the groove 42 in the radial direction is located inward of the outermost peripheral portion in the sliding region of the crankshaft 11 and the thrust plate 40. That is, the groove 42 does not communicate with a portion from the inside to the outermost peripheral portion in the radial direction of the sliding region. Therefore, the lubricant 15 supplied from the through-hole 41 to the groove 42 is likely to stay in the groove 42, and is less likely to leak to the outer peripheral side from the sliding region.

[0043] Unlike in the present embodiment, in a case where the groove 42 is formed to entirely penetrate in the radial direction of the sliding region, that is, from the inner peripheral portion to the outer peripheral portion, the lubricant 15 leaks out of the circulation system, the amount of the lubricant 15 supplied to the journal bearing or the compression mechanism decreases. In contrast, in a case of the present embodiment, the groove 42 does not communicate with the portion from the inside to the

outermost peripheral portion in the radial direction of the sliding region. Accordingly, without reducing the amount of the lubricant 15, the lubricant 15 can be sufficiently supplied to the journal bearing or the compression mechanism.

[0044] The outer end portion 42a of the groove 42 in the radial direction is located inward as much as approximately 10% of the radius of the outermost peripheral portion in the above-described sliding region. In this manner, it is possible to reliably prevent the lubricant 15 supplied to the groove 42 from leaking from the inner peripheral side to the outer peripheral side of the sliding region.

[0045] The outer end portion 42a of the groove 42 in the radial direction is located outward of an intermediate position between the innermost peripheral portion and the outermost peripheral portion in the sliding region. In this manner, the groove 42 can supply the lubricant 15 to the outside from the intermediate position between the innermost peripheral portion and the outermost peripheral portion in the sliding region.

[0046] The above-described relationship can be expressed by the following expression.

$$r_{ave} = (r_{out} - r_{in}) / 2 < r < 0.9 \times r_{out}$$

[0047] Here, r is the radius of the outer end portion 42a of the groove 42, that is, the radius of a boundary portion having a step difference formed therein, r_{out} is the radius of the outermost peripheral portion in the sliding region, and r_{in} is the radius of the innermost peripheral portion in the sliding region.

[0048] In addition, an area of the region having the groove 42 formed in the sliding region is desirably set to 50% to 80% of the total area of the sliding region inside the outer end portion 42a in the radial direction of the groove 42.

[0049] If an area of the region having the groove 42 formed in the sliding region is set to A_{step} and an area of the region (land region) having no groove 42 inside the outer end portion 42a in the radial direction of the groove 42 in the sliding region is set to A_{land} , the relationship is expressed by the following expression.

$$0.5 \leq A_{step} / (A_{step} + A_{land}) \leq 0.8$$

[0050] Since this condition is satisfied, dynamic pressure is generated in the sliding region, and floating occurs due to oil film pressure. In the example illustrated in Fig. 3, the groove 42 has a fan shape having a center angle of 60°, and is disposed at four positions for every angle of 90° in the circumferential direction. Accordingly, $A_{step} / (A_{step} + A_{land})$ is 0.67.

[0051] In addition, as illustrated in Fig. 2, a tapered surface 43 is formed in a portion facing the inner portion of the groove 42 in the radial direction in the crankshaft

11. In this way, the tapered surface 43 is formed on a side where the lubricant 15 is introduced in the groove 42. Accordingly, the inside of the groove 42 in the radial direction is widened in the height direction, and thus, the lubricant 15 is likely to be supplied into the groove 42. In the present invention, without being limited to a case where the tapered surface is formed in the portion facing the groove, the tapered surface may also be disposed in the inner peripheral portion of the groove. Even in this case, the lubricant 15 is likely to be supplied into the groove.

[0052] For example, a sectional shape taken along the circumferential direction of the groove 42 has a stepped shape (Fig. 4), a tapered shape (Fig. 5), or a dimple shape (Fig. 6). That is, a general shape used in the thrust bearing can also be applied to the present embodiment.

[0053] As illustrated in Figs. 2 and 7, a pump rotor 45 of the displacement-type oil supply pump 14 is disposed outside the sliding region. Then, the lower surface of the crankshaft 11 is flush with the lower surface of the pump rotor 45. Accordingly, even if the lubricant 15 slightly leaks from the crankshaft 11 and the sliding region of the thrust plate 40, the lubricant 15 can lubricate a portion between the lower surface of the pump rotor 45 and the upper surface of the thrust plate. In this case, it is possible to improve the efficiency of the displacement-type oil supply pump 14.

[0054] As described above, according to the present embodiment, the through-hole 41 is formed in the thrust plate 40, the circulation passage 17 is formed inside the crankshaft 11 placed on the upper surface of the thrust plate 40. After the lubricant 15 is circulated through the through-hole 41 of the thrust plate 40, the lubricant 15 flows in the circulation passage 17 of the crankshaft 11. In the crankshaft 11 and the sliding region of the thrust plate 40, the groove 42 is formed in the thrust plate 40, and the lubricant 15 is supplied to the groove 42 from the through-hole 41. As a result, the crankshaft 11 and the sliding region of the thrust plate 40 the lubricant 15 are filled with the lubricant 15 so as to form the oil film. In this manner, the friction loss can be reduced. In addition, the outer end portion 42a of the groove 42 in the radial direction is located inward of the outermost peripheral portion in the above-described sliding region. Accordingly, the lubricant 15 supplied to the groove 42 is less likely to leak from the inner peripheral side to the outer peripheral side of the sliding region.

[0055] Therefore, the friction loss can be reduced. Moreover, without reducing the amount of the lubricant 15, it is possible to sufficiently supply the lubricant 15 to the journal bearing or the compression mechanism. As a result, it is possible to achieve the highly efficient compressor and to improve the reliability of the compressor.

[0056] In the above-described embodiment, a case of the scroll-type compressor has been described. However, the present invention is not limited to this example. For example, the present invention is also applicable to a rotary compressor or a reciprocating-type compressor.

Furthermore, the fluid machine according to the present invention is not limited to the compressor, and is also applicable to an expansion machine.

[0057] Hereinafter, a case will be described where the thrust plate 40 according to the present embodiment is applied to the rotary compressor.

[0058] Fig. 9 is a longitudinal sectional view illustrating a configuration example of a hermetic single cylinder as an example of the rotary compressor. For the sake of convenience, hereinafter, an embodiment applied to the single cylinder rotary compressor will be described. However, as a matter of course, the present invention is similarly applicable to not only a double cylinder rotary compressor, but also a rotary compression mechanism of the compressor having a plurality of different compression mechanisms.

[0059] A hermetic rotary compressor 61 includes a housing 62 having a hermetic structure. The housing 62 is configured to include a cylindrical center housing 62A, an upper housing 62B hermetically closing an upper portion of the center housing 62A, and a lower housing 62C hermetically closing a lower portion of the center housing 62A. On the upper portion side inside the center housing 62A, an electric motor 64 having a stator 65 and a rotor 66 is fixedly installed as a drive source.

In addition, the rotor 66 is integrally combined with a crankshaft (rotary shaft) 67.

[0060] A single cylinder rotary compression mechanism 63 is installed in the lower portion of the electric motor 64. The rotary compression mechanism 63 is configured to include a cylinder main body 69 having a cylinder chamber 68 formed therein, an upper bearing 70 and a lower bearing 71 which are fixedly installed in the upper portion and the lower portion of the cylinder main body 69 and which hermetically close the upper portion and the lower portion of the cylinder chamber 68, a rotor 72 which is fitted to an eccentric part 67A of the crankshaft 67 and is rotated on the inner peripheral surface of the cylinder chamber 68, and a blade and a blade pressing spring (not illustrated) which partition the inside of the cylinder chamber 68 into a suction side and a discharge side.

[0061] In this rotary compression mechanism 63, either the cylinder main body 69 or the upper bearing 70 is fixedly installed on the inner peripheral surface of the center housing 62A at a plurality of circumferential locations by means of plug welding or caulking. Other members are integrally assembled to the fixedly installed member.

[0062] The rotary compression mechanism 63 sucks low-pressure refrigerant gas of the compressed fluid from an accumulator 74 integrated with the rotary compressor 61 into the cylinder chamber 68 via a suction pipe 73, and compresses the refrigerant gas by rotating the rotor 72. Thereafter, the compressed refrigerant gas is discharged into an upper muffler chamber 75 and a lower muffler chamber 76 which are formed using the upper bearing 70 and the lower bearing 71. A configura-

tion is adopted as follows. The high-pressure refrigerant gas compressed in this way is merged in the upper muffler chamber 75, and thereafter, is discharged into the center housing 62A. The inside of the upper muffler chamber 75 and the lower muffler chamber 76 and the inside of the center housing 62A are in a state where all of these substantially have no pressure difference.

[0063] The high-pressure refrigerant gas is circulated through a gas passage hole (not illustrated) disposed around the electric motor 64, and is guided to an upper space of the electric motor 64. Furthermore, the high-pressure refrigerant gas is fed to the outside of the rotary compressor 61, that is, to the refrigerating cycle side via a discharge pipe 77.

[0064] In the rotary compression mechanism 63, the cylinder main body 69, the upper bearing 70 and the lower bearing 71 which are disposed above and below the cylinder main body 69, and the lower muffler 7A forming the lower muffler chamber 76 below the lower bearing 71 are integrated with each other by means of screw fastening of the bolt 78 penetrating in the axial direction of the crankshaft 67.

[0065] Both the upper muffler chamber 75 and the lower muffler chamber 76 have no difference between internal pressure and external pressure. However, in the illustrated configuration example, sealing performance against the lubricant 15 is required. Accordingly, only the lower muffler 76A is fastened by the bolt 78. However, both the upper muffler 75A and the lower muffler 76A may adopt a structure in which both of these are fastened by the bolt 78 or a structure in which any one of these is fastened by the bolt 78. The present embodiment is not particularly limited thereto.

[0066] Here, the thrust plate 40 is a plate member disposed so as to be in contact with the lower end surface of the crankshaft 67. For example, the thrust plate 40 has a thickness of approximately 1 mm. The thrust plate 40 is installed between the lower surface of the lower journal bearing 13 and the upper surface of the lower muffler 76A.

[0067] A centrifugal lubrication pump (not illustrated) is disposed in the lower end portion of the crankshaft 67, and the lubricant 15 filling in the bottom portion of the housing 62 is suctioned via the centrifugal lubrication pump. The lubricant 15 is configured to be discharged to a circulation passage (not illustrated) drilled into the crankshaft 67 along the axial direction. The lubricant 15 can be supplied via the circulation passage to portions requiring lubrication, such as the upper bearing 70 and the lower bearing 71.

[0068] In the thrust plate 40, the groove 42 is formed in the sliding region between the crankshaft 67 and the thrust plate 40. The groove 42 is formed in a recess shape in the thrust plate 40, and the lubricant 15 is supplied from the through-hole 41. That is, the groove 42 communicates with the centrifugal lubrication pump and the circulation passage formed in the crankshaft 67. Even in a case of the rotary compressor 61, the thrust plate 40 hav-

ing the same configuration as that described in the scroll compressor 1 is disposed. Then, the crankshaft 67 and the sliding region of the thrust plate 40 are filled with the lubricant 15 so as to form the oil film. In this manner, the friction loss can be reduced. In addition, the outer end portion 42a of the groove 42 in the radial direction is located inward of the outermost peripheral portion in the above-described sliding region. Accordingly, the lubricant 15 supplied to the groove 42 is less likely to leak from the inner peripheral side to the outer peripheral side of the sliding region.

[0069] Therefore, the friction loss can be reduced. Moreover, without reducing the amount of the lubricant 15, it is possible to sufficiently supply the lubricant 15 to the journal bearing or the compression mechanism. As a result, it is possible to achieve the highly efficient compressor and to improve the reliability of the compressor. Detailed configurations and operation effects will be omitted since these have repeated content described in the scroll compressor 1.

Reference Signs List

[0070]

- | | |
|------|-----------------------------------|
| 1: | HERMETIC SCROLL COMPRESSOR |
| 2: | HERMETIC HOUSING |
| 3: | DISCHARGE COVER |
| 4: | UPPER COVER |
| 5: | DISCHARGE CHAMBER |
| 6: | UPPER BEARING MEMBER |
| 6A: | JOURNAL BEARING PORTION |
| 6B: | THRUST BEARING PORTION |
| 7: | SCROLL COMPRESSION MECHANISM |
| 7A: | LOWER MUFFLER |
| 8: | STATOR |
| 8A: | STATOR WINDING |
| 9: | ROTOR |
| 10: | ELECTRIC MOTOR |
| 11: | CRANKSHAFT |
| 12: | CRANK PIN |
| 13: | LOWER JOURNAL BEARING |
| 14: | DISPLACEMENT-TYPE OIL SUPPLY PUMP |
| 15: | LUBRICANT |
| 16: | SUCTION PIPE |
| 17: | CIRCULATION PASSAGE |
| 18: | FIXED SCROLL |
| 18A: | END PLATE |
| 18B: | SPIRAL WRAP |
| 19: | ORBITING SCROLL |
| 19A: | END PLATE |
| 19B: | SPIRAL WRAP |
| 19C: | BEARING BOSS |
| 20: | COMPRESSION CHAMBER |
| 21: | ROTATION PREVENTION MECHANISM |
| 22: | DRIVE BUSH |
| 24: | DISCHARGE PORT |
| 25: | TIP SEAL |

26:	TIP SEAL		radial direction is located outward of an intermediate position between an innermost peripheral portion and the outermost peripheral portion in the sliding region.
27:	SUCTION PIPE		
28:	SUCTION PORT		
29:	DISCHARGE VALVE		
30:	DISCHARGE PIPE	5	
40:	THRUST PLATE		3. The fluid machine according to Claim 1 or 2, wherein an area of a region having the groove in the sliding region is 50% to 80% of a total area located inward of the outer end portion of the groove in the radial direction in the sliding region.
41:	THROUGH-HOLE		
42:	GROOVE		
42a:	OUTER END PORTION		
45:	PUMP ROTOR	10	
51:	CIRCULATION PASSAGE		
61:	ROTARY COMPRESSOR		4. The fluid machine according to any one of Claims 1 to 3, wherein an inner portion of the groove in the radial direction or a portion facing the inner portion of the groove in the radial direction in the crankshaft or the plate part has a tapered surface.
62:	HOUSING		
62A:	CENTER HOUSING		
62B:	UPPER HOUSING	15	
62C:	LOWER HOUSING		
63:	ROTARY COMPRESSION MECHANISM		
64:	ELECTRIC MOTOR		
65:	STATOR		5. The fluid machine according to any one of Claims 1 to 4, wherein the groove has a stepped shape, a tapered shape, or a dimple shape.
66:	ROTOR	20	
67:	CRANKSHAFT		
67A:	ECCENTRIC PART		
68:	CYLINDER CHAMBER		
69:	CYLINDER MAIN BODY		
70:	UPPER BEARING	25	
71:	LOWER BEARING		
72:	ROTOR		
73:	SUCTION PIPE		
74:	ACCUMULATOR		
75:	UPPER MUFFLER CHAMBER	30	
75A:	AN UPPER MUFFLER		
76:	LOWER MUFFLER CHAMBER		
76A:	LOWER MUFFLER		
77:	DISCHARGE PIPE		
78:	BOLT	35	

Claims

1. A fluid machine comprising:
 - an annular plate part that has a through-hole through which a lubricant is circulated; and
 - a crankshaft that is placed on an upper surface of the plate part, and that internally has a circulation passage for circulating the lubricant passing through the through-hole of the plate part, wherein in sliding region between the crankshaft and the plate part, at least one of the crankshaft and the plate part has a recess groove to which the lubricant is supplied from the through-hole, and
 - wherein an outer end portion of the groove in a radial direction is located inward of an outermost peripheral portion in the sliding region.
2. The fluid machine according to Claim 1, wherein the outer end portion of the groove in the

FIG. 1

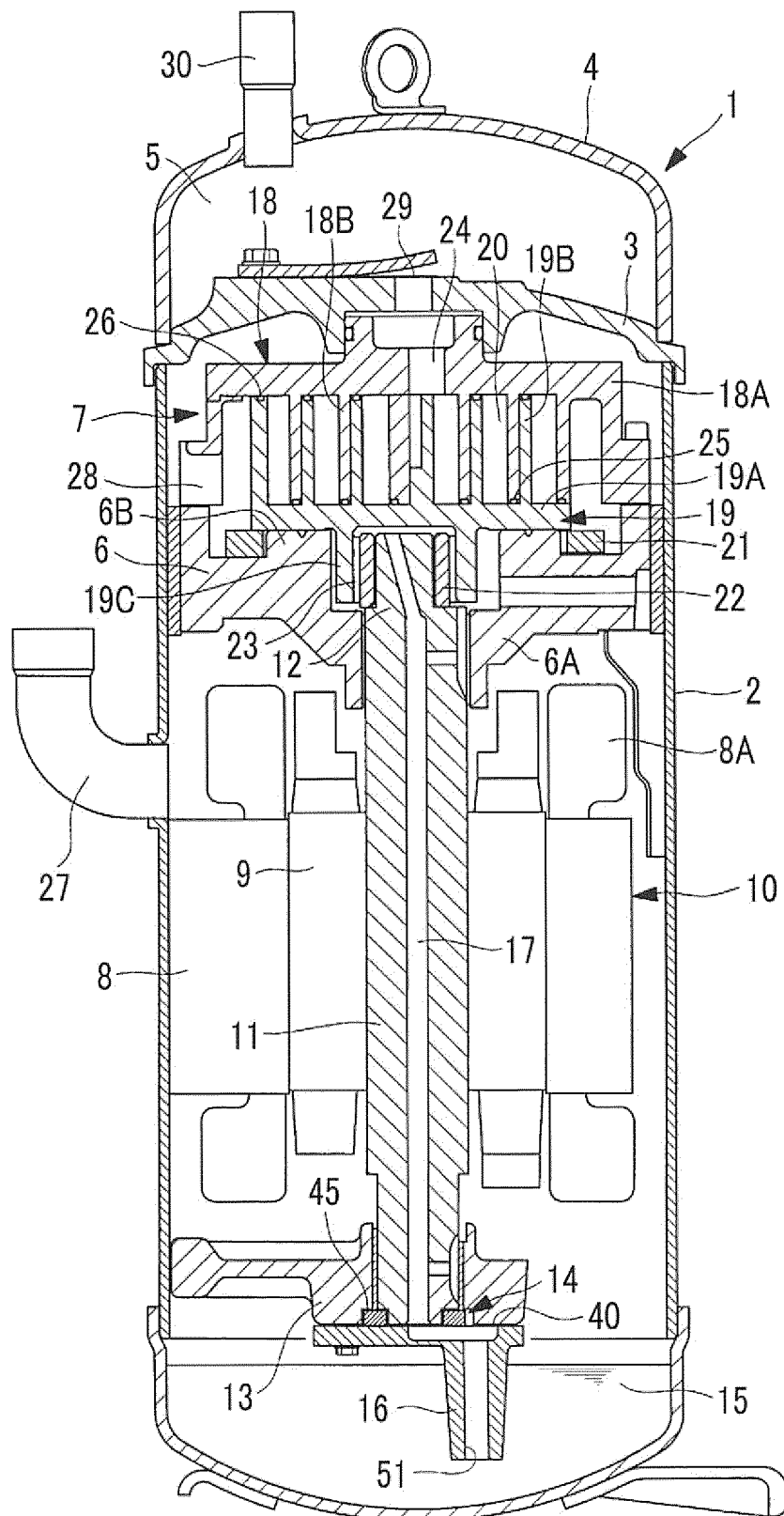


FIG. 2

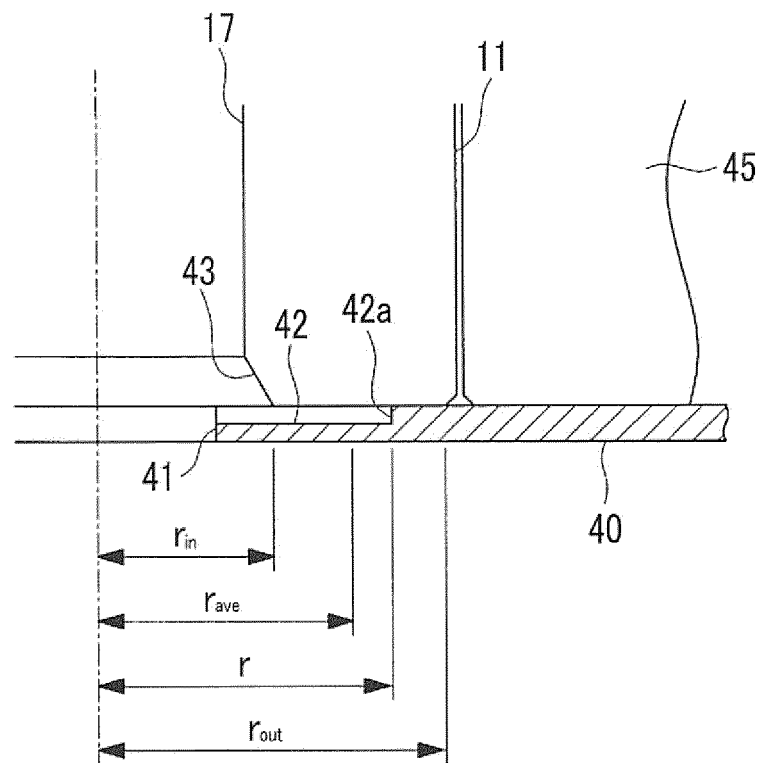


FIG. 3

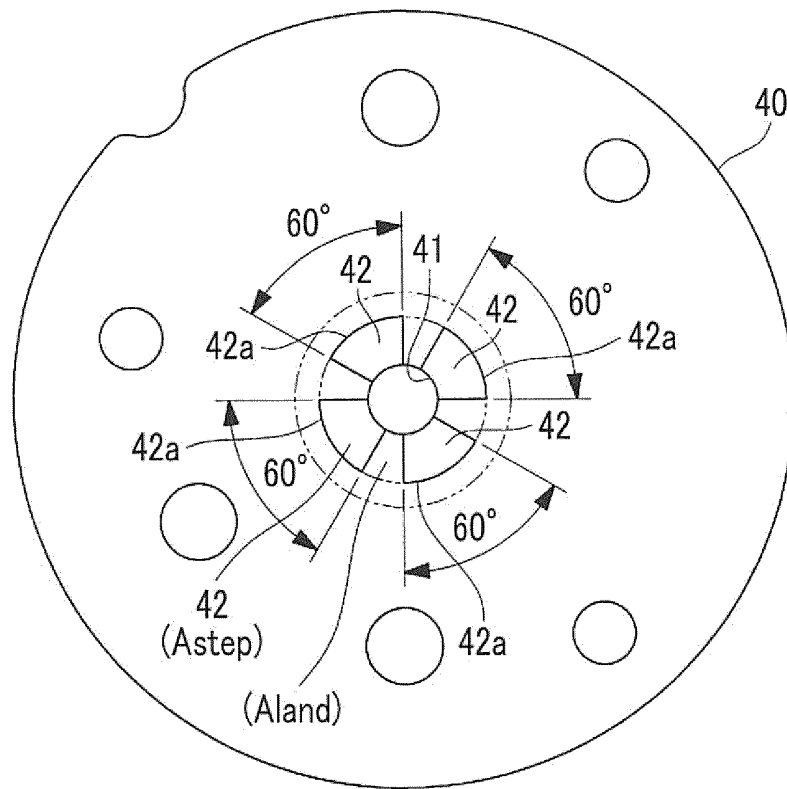


FIG. 4

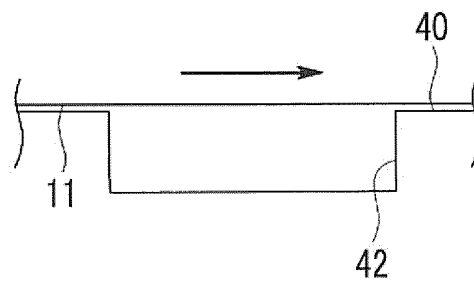


FIG. 5

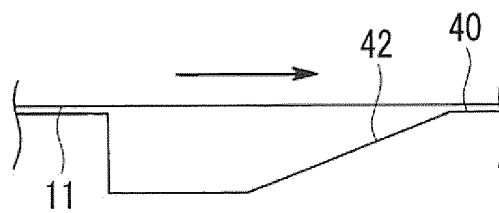


FIG. 6

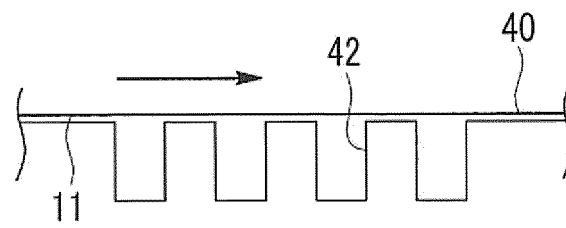


FIG. 7

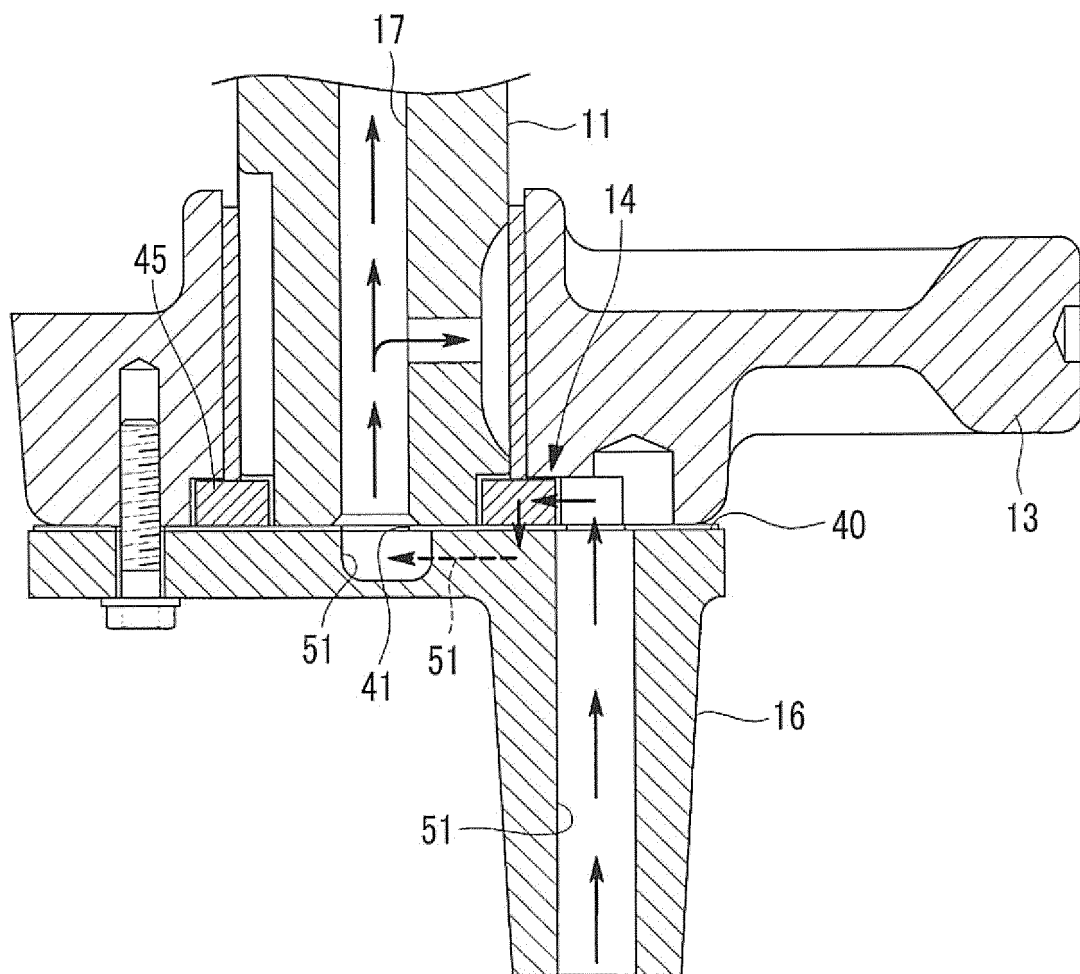


FIG. 8

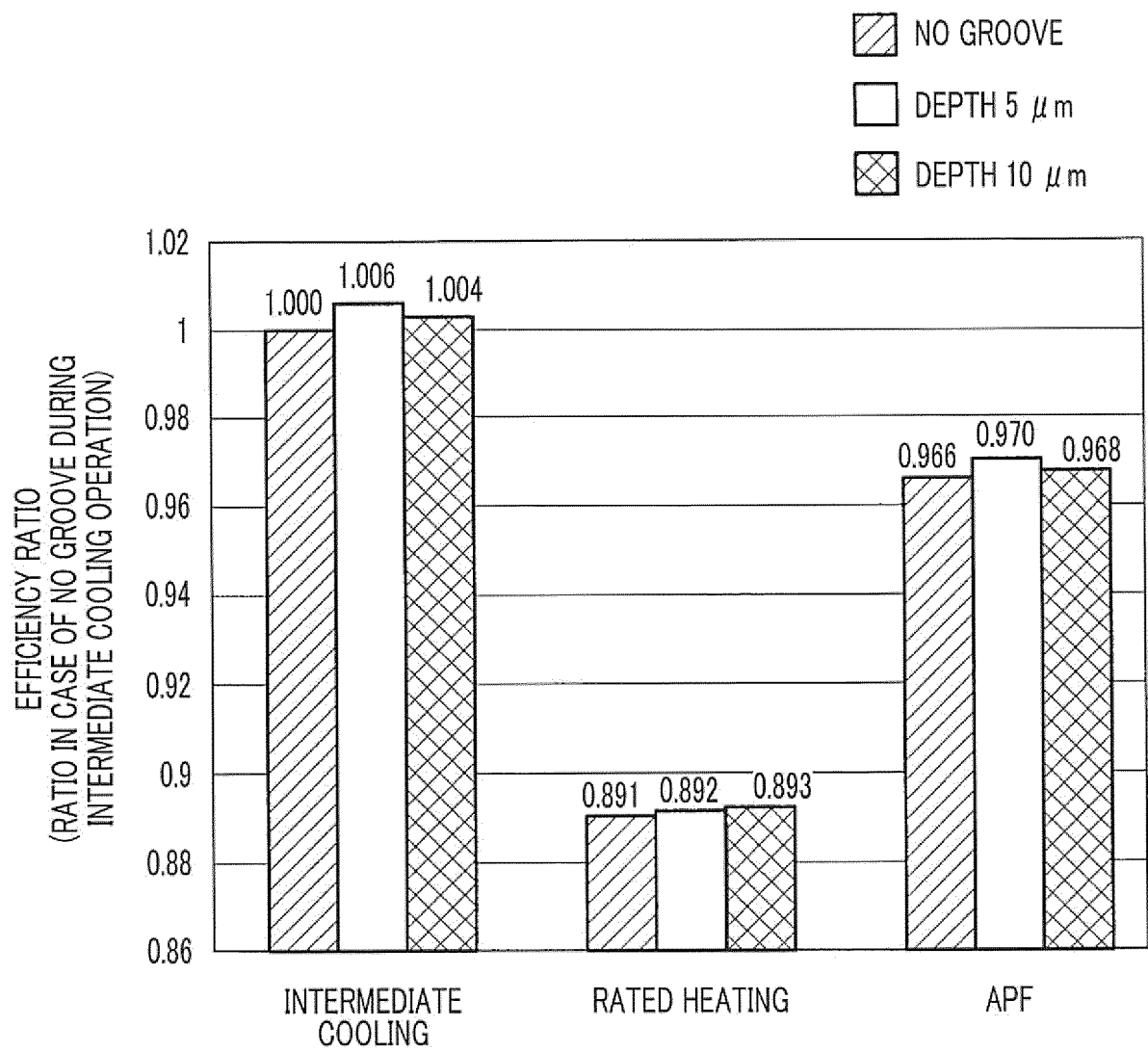
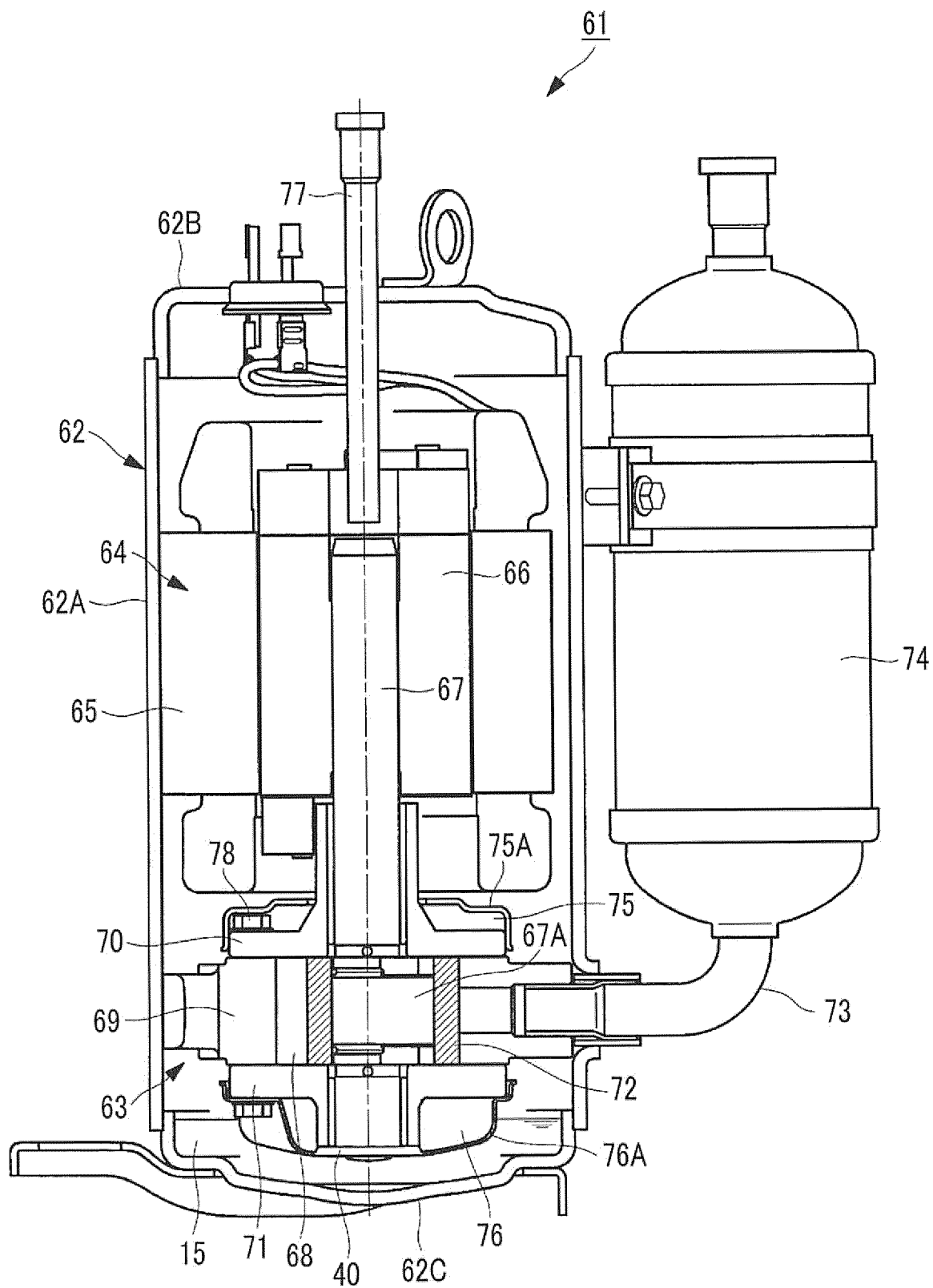


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/008086

A. CLASSIFICATION OF SUBJECT MATTER

F04B39/02(2006.01)i, F04C29/02(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)

F04B39/02, F04C29/02

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 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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 A	JP 51-18486 Y2 (Tokyo Shibaura Electric Co., Ltd.), 17 May 1976 (17.05.1976), page 1, right column, line 12 to page 2, left column, line 2; fig. 1, 3 (Family: none)	1-2, 4-5 3
A	JP 53-10683 B2 (Carrier Corp.), 15 April 1978 (15.04.1978), entire text; all drawings & US 3830341 A & FR 2208460 A5	1-5
A	US 3926281 A (HANNIBAL, Billy B.), 16 December 1975 (16.12.1975), entire text; all drawings (Family: none)	1-5

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Date of the actual completion of the international search
09 May 2017 (09.05.17)Date of mailing of the international search report
23 May 2017 (23.05.17)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/008086

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 62-45097 Y2 (Daikin Industries, Ltd.), 01 December 1987 (01.12.1987), entire text; all drawings (Family: none)	1-5

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REFERENCES CITED IN THE DESCRIPTION

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- JP 62078389 A [0004]
- JP 2014152747 A [0004]