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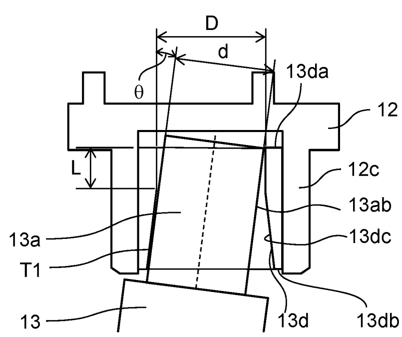
(54) SCROLL COMPRESSOR

(57) In scroll compressor (100), eccentric shaft (13a) is fit in orbiting bearing (13d) of orbiting scroll (12) to make orbiting scroll (12) rotate, and orbiting bearing (13d) or eccentric shaft (13a) has a tapered shape. This shortens the distance between a point at which orbiting scroll (12) receives a compression load and a point at which eccentric shaft (13a) presses orbiting bearing (13d) while rotating to reduce a turning moment that acts on orbiting scroll (12), and thereby the behavior of orbiting scroll is stabilized and a highly efficient and highly reliable scroll compressor can be provided.

FIG. 5A



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a scroll compressor used for, in particular, an air conditioner, a water heater, or a freezing machine of a refrigerator or the like.

BACKGROUND ART

[0002] PTL 1 discloses a scroll compressor used for an air conditioner or the like. In the scroll compressor, a back pressure region is provided on an anti-wrap surface of an orbiting scroll end plate, and an orbiting scroll is pressed against a fixed scroll, thereby suppressing turning of the orbiting scroll and reducing leakage loss to improve theoretical efficiency and capability of cooling and heating.

Citation List

Patent Literature

[0003] PTL 1: Japanese Patent No. 4892238

SUMMARY OF THE INVENTION

[0004] The present disclosure provides a highly efficient and highly reliable scroll compressor in which turning of an orbiting scroll is further reliably suppressed.

[0005] In the scroll compressor of the present disclosure, a back pressure region is formed on an anti-wrap surface of an orbiting scroll end plate, and an orbiting scroll is pressed against a fixed scroll. The wrap side of an orbiting bearing of the orbiting scroll is closed by an end plate, and the crank shaft side is opened. In the scroll compressor, the orbiting bearing of the orbiting scroll has a tapered shape of which diameter gradually increases toward an open side of the orbiting bearing, or an eccentric shaft inserted in the orbiting bearing has a tapered shape of which diameter gradually decreases toward the open side of the orbiting bearing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

Fig. 1 is a longitudinal sectional view of a scroll compressor according to a first exemplary embodiment.
Fig. 2 is an enlarged sectional view of an essential part of a compression mechanism unit of the scroll compressor.
Fig. 3A is a view illustrating a volumetric change of a compression chamber that happens with an orbiting motion of the scroll compressor.
Fig. 3B is another view illustrating the volumetric change of the compression chamber that happens with the orbiting motion of the scroll compressor.
Fig. 3C is yet another view illustrating the volumetric change of the compression chamber that happens with the orbiting motion of the scroll compressor.
Fig. 3D is yet another view illustrating the volumetric change of the compression chamber that happens with the orbiting motion of the scroll compressor.
Fig. 4A is a view illustrating a rotary shaft where the scroll compressor is performing a compression operation.
Fig. 4B is a view illustrating a tilt of the rotary shaft where the scroll compressor is performing a compression operation.
Fig. 5A is a view illustrating an exemplary tapered shape provided to an orbiting bearing of the scroll compressor and a tilt of the rotary shaft.
Fig. 5B is an explanatory view illustrating a load and a turning moment acting on an eccentric bearing in a gas compression process of the scroll compressor.
Fig. 6A is an explanatory view illustrating a load and a turning moment acting on the eccentric bearing in a gas compression process in a configuration in which an orbiting bearing or an eccentric shaft of the scroll compressor is tapered;
Fig. 6B is an explanatory view illustrating a turning moment being suppressed by a tapered shape provided to the orbiting bearing or the eccentric shaft of the scroll compressor.

DESCRIPTION OF EMBODIMENT

(Knowledge and the like underlying the present disclosure)

[0007] At the time when the inventors have arrived at the present disclosure, scroll compressors have been configured to press an orbiting scroll against a fixed scroll using back pressure to further stabilize the behavior of the orbiting scroll. The inventors have found that such a configuration has a disadvantage in that the orbiting scroll may separate from the fixed scroll when the turning moment created by the tangential gas load acting on the side surface of the wrap of the orbiting scroll becomes larger than the stabilizing moment created by the back pressure acting on the orbiting scroll. When the orbiting scroll separates from the fixed scroll, the performance of the scroll compressor is deteriorated due to leakage of refrigerant between adjacent compression chambers or between an intermediate pressure region and a compression chamber. The inventors have come to construct the subject matter of the present disclosure in order to solve the problem.

[0008] The present disclosure provides a highly efficient and highly reliable scroll compressor that suppresses turning of an orbiting scroll.

[0009] Hereinafter, an exemplary embodiment will be described in detail with reference to the accompanying drawings. Unnecessary detailed description may be omitted. For example, detailed description of already well-known matters and repeated description of substantially the same configuration may be omitted. This is to avoid an unnecessary redundancy in the following description and to facilitate understanding of a person skilled in the art.

[0010] Note that, the accompanying drawings and the following description are merely presented to help those skilled in the art fully understand the present disclosure, and are not intended to limit the subject matters described in the claims.

(First exemplary embodiment)

[0011] A first exemplary embodiment will be described below with reference to Figs. 1 to 6B.

[1-1. Configuration]

[0012] As illustrated in Fig. 1, scroll compressor 100 includes compression mechanism unit 10 that compresses a refrigerant and motor mechanism unit 20 that drives compression mechanism unit 10, compression mechanism unit 10 and motor mechanism unit 20 being disposed in hermetic container 1.

[0013] Hermetic container 1 includes barrel 1a having a cylindrical shape extending in the up-down direction, lower lid 1b closing a lower opening of barrel 1a, and upper lid 1c closing an upper opening of barrel 1a. Hermetic container 1 is provided with refrigerant suction pipe 2 for introducing the refrigerant into compression mechanism unit 10, and refrigerant discharge pipe 3 for discharging the refrigerant compressed by compression mechanism unit 10 to the outside of hermetic container 1.

[0014] Compression mechanism unit 10 includes fixed scroll 11, orbiting scroll 12, and rotary shaft 13 for driving orbiting scroll 12 to orbit.

[0015] Motor mechanism unit 20 includes stator 21 fixed to hermetic container 1, and rotor 22 disposed inside stator 21. Rotary shaft 13 is fixed to rotor 22. Eccentric shaft 13a is provided at an upper end of rotary shaft 13 to be eccentric to rotary shaft 13. On eccentric shaft 13a, an oil reservoir which is a recess opened to an upper surface of eccentric shaft 13a is provided.

[0016] Main bearing 30 that supports fixed scroll 11 and orbiting scroll 12 is provided below fixed scroll 11 and orbiting scroll 12.

[0017] Main bearing 30 includes bearing 31 that rotatably supports rotary shaft 13, and boss housing 32. Main bearing 30 is fixed to hermetic container 1 by welding, shrink fit, or the like.

[0018] Fixed scroll 11 includes fixed scroll end plate 11a having a disk shape, fixed spiral wrap 11b having a spiral shape and erecting from fixed scroll end plate 11a, and outer peripheral wall portion 11c erecting so as to surround the circumference of fixed spiral wrap 11b. Discharge port 14 is provided substantially at a center portion of fixed scroll end plate 11a.

[0019] Orbiting scroll 12 includes orbiting scroll end plate 12a having a disk shape, orbiting spiral wrap 12b erecting from one surface (wrap-side end surface) of orbiting scroll end plate 12a, and cylindrical boss portion 12c formed on the other surface (anti-wrap-side end surface) of orbiting scroll end plate 12a. The other surface of orbiting scroll end plate 12a is a surface opposite to the wrap-side end surface of orbiting scroll end plate 12a.

[0020] As illustrated in Fig. 2, orbiting bearing 13d is fit in cylindrical boss portion 12c. The wrap side of orbiting bearing 13d is closed by orbiting scroll end plate 12a, and the anti-wrap side is opened. Eccentric shaft 13a of rotary shaft 13 is inserted from the open side of orbiting bearing 13d. In the following description, the end on the wrap side of orbiting bearing 13d may be referred to as first end 13da, and the end on the open side may be referred to as second end 13db.

[0021] Fixed spiral wrap 11b of fixed scroll 11 and orbiting spiral wrap 12b of orbiting scroll 12 mesh with each other, and a plurality of compression chambers 15 is formed between fixed spiral wrap 11b and orbiting spiral wrap 12b.

[0022] Boss portion 12c is formed substantially at the center of orbiting scroll end plate 12a. Boss portion 12c is accommodated in boss housing 32 with eccentric shaft 13a inserted in boss portion 12c.

[0023] Fixed scroll 11 is fixed to main bearing 30 by outer peripheral wall 11c using a plurality of bolts (not shown). Meanwhile, the movement of orbiting scroll 12 with respect to fixed scroll 11 is restricted by spin-restraining member 17 such as an Oldham ring. Spin-restraining member 17 that restrains spinning of orbiting scroll 12 is provided between fixed scroll 11 and main bearing 30. This makes orbiting scroll 12 to orbit without spinning with respect to fixed scroll 11 as eccentric shaft 13a of rotary shaft 13 orbits.

[0024] Oil storage part 4 that stores lubricating oil is formed at the bottom of hermetic container 1. Lower end 13b of rotary shaft 13 is rotatably supported by sub-bearing 18 disposed at the lower portion of hermetic container 1.

[0025] Oil pump 5 of a displacement type is provided at the lower end of rotary shaft 13. Oil pump 5 is disposed so as a suction port of oil pump 5 to be in oil storage part 4. Oil pump 5 is driven by rotary shaft 13 and reliably sucks up lubricating oil in oil storage part 4 provided at the bottom of hermetic container 1 at any pressure condition and operating speed, which eliminates concern about loss of oil.

[0026] Rotary shaft oil supply hole 13c extending from lower end 13b of rotary shaft 13 to eccentric shaft 13a is formed in rotary shaft 13. The lubricating oil sucked up by oil pump 5 is supplied to a bearing of sub-bearing 18 and bearing 31, and into boss portion 12c through rotary shaft oil supply hole 13c in rotary shaft 13.

[0027] The refrigerant suctioned from refrigerant suction pipe 2 is introduced from suction port 15a to compression chamber 15. Compression chamber 15 moves from the outer peripheral side toward the central portion while reducing its volume. The refrigerant that has reached a predetermined pressure in compression chamber 15 is discharged to discharge chamber 6 from discharge port 14 provided at the central portion of fixed scroll 11. Discharge port 14 is provided with a discharge reed valve (not shown). The refrigerant that has reached a predetermined pressure in compression chamber 15 pushes open the discharge reed valve and is discharged to discharge chamber 6. The refrigerant discharged to discharge chamber 6 is led out to the upper portion of hermetic container 1, and is then discharged through refrigerant discharge pipe 3.

[0028] In scroll compressor 100 according to the present exemplary embodiment, as shown in the enlarged sectional view of the essential part in Fig. 2, boss housing 32 serves as high-pressure region A, and the outer peripheral portion of orbiting scroll 12 in which spin-restraining member 17 is disposed serves as intermediate-pressure region B. Orbiting scroll 12 is pressed against fixed scroll 11. The configuration will be described below.

[0029] Eccentric shaft 13a is inserted in boss portion 12c via orbiting bearing 13d so as to be driven to orbit. Oil groove 13e is formed in an outer peripheral surface of eccentric shaft 13a.

[0030] Sealing member 33 having a ring shape is provided on a thrust surface of main bearing 30 that receives a thrust force from orbiting scroll end plate 12a. Sealing member 33 is disposed on the outer periphery of boss housing 32.

[0031] The inside of hermetic container 1 is filled with refrigerant of the same high pressure as the refrigerant discharged to discharge chamber 6. Rotary shaft oil supply hole 13c is opened at the upper end of eccentric shaft 13a. Thus, the inside of boss portion 12c serves as a high-pressure region A of which pressure is equivalent to the pressure of the discharged refrigerant.

[0032] The lubricating oil introduced into boss portion 12c through rotary shaft oil supply hole 13c is supplied to orbiting bearing 13d and boss housing 32 through oil groove 13e formed in the outer peripheral surface of eccentric shaft 13a. Since sealing member 33 is provided at the outer periphery of boss housing 32, the inside of boss housing 32 serves as high-pressure region A.

[0033] Orbiting scroll end plate 12a is provided with first oil introduction hole 51 directed to the inside of boss portion 12c, first oil lead-out hole 52 which is a through hole in the outer peripheral portion of the wrap-side end surface, and first end plate oil communication passage 53 that provides communication between first oil introduction hole 51 and first oil lead-out hole 52.

[0034] Orbiting scroll end plate 12a is provided with second oil introduction hole 61 that opens to intermediate-pressure region B at the outer peripheral portion of orbiting scroll 12, second oil lead-out hole 62 that opens to compression chamber 15, and second end plate oil communication passage 63 that provides communication between second oil introduction hole 61 and second oil lead-out hole 62. In the example of the present exemplary embodiment, second oil introduction hole 61 opens at the upper surface of orbiting scroll end plate 12a.

[0035] In this configuration, second oil lead-out hole 62 of orbiting scroll 12 intermittently provides communication between intermediate-pressure region B and compression chamber 15. This introduces the intermediate pressure in compression chamber 15 to intermediate-pressure region B, and orbiting scroll 12 can be pressed against fixed scroll 11 with a minimum necessary load under various operating conditions. Accordingly, separation of orbiting scroll 12 from fixed scroll 11 can be prevented while reducing friction loss of the compressor, and thereby the airtightness of compression chamber 15 can be improved.

[0036] Figs. 3A to 3D are views illustrating the volumetric change of the compression chamber caused by the orbiting motion in the scroll compressor according to the present exemplary embodiment, where the views each illustrates a meshing state of orbiting scroll 12 and fixed scroll 11 looking from the back surface of orbiting scroll 12. Fig. 3B illustrates a state in which the rotation is advanced by 90 degrees from Fig. 3A, Fig. 3C illustrates a state in which the rotation is further advanced by 90 degrees from Fig. 3B, and Fig. 3D illustrates a state in which the rotation is further advanced by 90 degrees from Fig. 3C.

[0037] Fixed scroll 11 and orbiting scroll 12 form a plurality of compression chambers 15. As illustrated in Fig. 3A, first compression chamber 15A is formed on an outer wall side of orbiting spiral wrap 12b, and as illustrated in Fig. 3C, second compression chamber 15B is formed on an inner wall side of orbiting spiral wrap 12b.

[0038] Outer peripheral end portion 11be of fixed spiral wrap 11b is extended so as outer peripheral end 11be of fixed spiral wrap 11b and outer peripheral end 12be of orbiting spiral wrap 12b to be at the same position when fixed scroll 11 and orbiting scroll 12 mesh with each other. Accordingly, first compression chamber 15A confines the refrigerant in a place that is shifted by approximately 180 degrees from the place where second compression chamber 15B confines the refrigerant. The suction volume of first compression chamber 15A is larger than the suction volume of second compression chamber 15B.

[0039] In scroll compressor 100 according to the present exemplary embodiment, bore surface 13dc of orbiting bearing 13d has a tapered shape (first tapered shape T1) of which diameter increases toward the open end (second end 13db) as illustrated in Fig. 5A. Alternatively, in scroll compressor 100, eccentric shaft 13a may have a tapered shape (second tapered shape T2) of which diameter decreases toward the open side of orbiting bearing 13d as illustrated in Fig. 5B. In a sectional view of orbiting bearing 13d in a plane including the axis of orbiting bearing 13d, an angle θ between first tapered shape T1 or second tapered shape T2 and the axis of orbiting bearing 13d may be set to an angle equal to or larger than the maximum angle at which rotary shaft 13 can tilt and to satisfy the following relational expression where L is the distance between the upper end of orbiting bearing 13d (first end 13da) and the start point of taper, d is the diameter of the eccentric shaft, and D is the diameter of the inner wall of an eccentric bearing.

[Formula 1]

$$L \tan \theta + d/\cos\theta < D$$

[0040] In the present exemplary embodiment, the maximum angle at which rotary shaft 13 can tilt is defined by the clearance between main bearing 30 and rotary shaft 13 and the clearance between sub-bearing 18 and rotary shaft 13 illustrated in Figs. 4A and 4B.

[0041] As illustrated in Figs. 5A and 5B, the tapered shape of orbiting bearing 13d or the tapered shape of eccentric shaft 13a may start from a position at a midway within a range along the axial direction of eccentric bearing 13d, in which range inner wall 13dc of eccentric bearing 13d and outer periphery 13ab of eccentric shaft 13a slide against each other. The tapered shape of orbiting bearing 13d or eccentric shaft 13a may include a straight line, a continuous curve, or a combination thereof.

[1-2. Operation]

[0042] Operations and advantageous effects of scroll compressor 100 configured as described above will be described below.

[0043] Figs. 4A and 4B illustrate the rotating state of rotary shaft 13 that makes the orbiting scroll orbit. Fig. 4A illustrates a state with no compression load, and Fig. 4B illustrates a state with a compression load. When gas is compressed in scroll compressor 100, eccentric shaft 13a located at an end of rotary shaft 13 rotates while pushing orbiting bearing 13d of orbiting scroll 12. During this motion, the back pressure acting on the anti-wrap surface of orbiting scroll end plate 12a of orbiting scroll 12 keeps orbiting scroll 12 pressed against fixed scroll 11. Thus, as illustrated in Fig. 4B, eccentric shaft 13a receives a force in a direction substantially opposite to the direction in which the refrigerant is compressed, and rotary shaft 13 rotates with a tilt allowed by the clearance between rotary shaft 13 and main bearing 30 and the clearance between rotary shaft 13 and sub-bearing 18.

[0044] The load and turning moment acting on orbiting bearing 13d in the gas compression process are as shown in Figs. 6A and 6B. Fig. 6A illustrates a case where orbiting bearing 13d has no taper, and Fig. 6B illustrates a case where orbiting bearing 13d has a taper. Illustrated in a lower left area in each of Figs. 6A and 6B is the magnitude of reaction force by gas compression (bearing load) acting on orbiting bearing 13d for each case.

[0045] For the case in Fig. 6B where orbiting bearing 13d has a tapered shape, concentration of the reaction force by gas compression at the lower end of orbiting bearing 13d (second end 13db) can be avoided even when rotary shaft 13 rotates with a tilt with respect to the axis. Accordingly, turning moment Z that causes orbiting scroll 12 to turn can be suppressed. That is, shortening the distance between the point of effort at which the side surface of the wrap of the orbiting scroll receives the tangential gas load acting on orbiting scroll 12 and the point at which orbiting bearing 13d receives the reaction force suppresses the turning moment that causes orbiting scroll 12 to turn. This stabilizes the behavior of orbiting scroll 12 and thereby improves reliability of the compressor, making the scroll compressor highly efficient.

[0046] For the case in Fig. 6A, concentration of the reaction force by gas compression at the lower end of orbiting bearing 13d (second end 13db) makes the clearance between eccentric shaft 13a and orbiting bearing 13d become larger toward the upper end of orbiting bearing 13d (first end 13da). This makes it difficult to form a uniform oil film in the gap between eccentric shaft 13a and orbiting bearing 13d. Meanwhile, for the case in Fig. 6B, an appropriate clearance is formed between eccentric shaft 13a and orbiting bearing 13d, which prevents metal contact and promotes formation of an oil film at the sliding portion. That is, the gap between eccentric shaft 13a that is tilted and orbiting bearing 13d can be appropriately set, and an oil film can be formed in the gap to prevent local metal contact. Accordingly, the compressor is made further highly efficient.

[0047] Furthermore, in the present exemplary embodiment, the tapered shape of orbiting bearing 13d starts from a midway of the sliding surface of eccentric shaft 13a or the tapered shape of eccentric shaft 13a starts from a midway of the sliding surface of orbiting bearing 13d, so that the gap between eccentric shaft 13a and orbiting bearing 13d can be minimized at the start point of the taper. This prevents the surface pressure locally becoming large at the lower end on the open side of orbiting bearing 13d (second end 13db), which promotes formation of an oil film at the sliding portion.

[0048] The tapered shape of orbiting bearing 13d or eccentric shaft 13a may include a straight line, a continuous curve, or a combination thereof. This further distributes surface pressure to moderate a local surface pressure, and a scroll compressor with further lower input and higher efficiency can be provided.

[1-3. Effects and the like]

[0049] As described above, the scroll compressor according to the present exemplary embodiment includes compression mechanism unit 10 that compresses the refrigerant, motor mechanism unit 20 that drives compression mechanism unit 10, and hermetic container 1 that accommodates compression mechanism unit 10 and motor mechanism unit 20. Compression mechanism unit 10 includes fixed scroll 11, orbiting scroll 12, and rotary shaft 13 that drives orbiting scroll 12 to orbit. Fixed scroll 11 includes fixed scroll end plate 11a having a disk shape and fixed spiral wrap 11b erecting from fixed scroll end plate 11a, and orbiting scroll 12 includes orbiting scroll end plate 12a having a disk shape and orbiting spiral wrap 12b erecting from the wrap-side end surface of orbiting scroll end plate 12a. Fixed spiral wrap 11b and orbiting spiral wrap 12b mesh with each other, and a plurality of compression chambers 15 is formed between fixed spiral wrap 11b and orbiting spiral wrap 12b. Compression chamber 15 includes first compression chamber 15A formed on the outer wall side of the orbiting spiral wrap and second compression chamber 15B formed on the inner wall side of orbiting spiral wrap 12b. Orbiting scroll 12 is pressed against fixed scroll 11 by back pressure created on the anti-wrap surface side of orbiting scroll end plate 12a. The wrap side of orbiting bearing 13d of orbiting scroll 12 is closed by an end plate, and eccentric shaft 13a side of rotary shaft 13 is opened. In scroll compressor 100, orbiting bearing 13d has a tapered shape of which diameter gradually increases toward the open side of orbiting bearing 13d, or eccentric shaft 13a of rotary shaft 13 inserted in orbiting bearing 13d has a tapered shape of which diameter gradually decreases toward the open side of orbiting bearing 13d.

[0050] In the exemplary embodiment, the tapered shape of orbiting bearing 13d or eccentric shaft 13a shortens the distance between the point of effort, when the side surface of the wrap of the orbiting scroll receives a tangential gas load, and the point at which the orbiting bearing receives the reaction force, and thereby the turning moment that causes orbiting scroll 12 to turn can be suppressed. This stabilizes the behavior of orbiting scroll 12 and thereby makes the scroll compressor highly efficient. In a case where the behavior of orbiting scroll 12 easily becomes unstable due to, for example, first compression chamber 15A having a larger suction volume than second compression chamber 15B as in the present exemplary embodiment, the behavior of orbiting scroll 12 can be stabilized more effectively.

[0051] In the example of the present exemplary embodiment, the tapered shape of orbiting bearing 13d or eccentric shaft 13a starts from a midway of the sliding surface between orbiting bearing 13d and eccentric shaft 13a. This prevents the surface pressure from locally becoming large at the lower end on the opened side of orbiting bearing 13d (second end 13db), and promotes formation of an oil film between the sliding portions.

[0052] In the example of the present exemplary embodiment, the tapered shape of orbiting bearing 13d or eccentric shaft 13a includes a straight line, a continuous curve, or a combination thereof. This further distributes surface pressure to moderate a local surface pressure, and a scroll compressor with further lower input and higher efficiency can be provided.

[0053] In scroll compressor 100 according to the present exemplary embodiment, orbiting bearing 13d has a tapered shape of which diameter increases toward the open side of orbiting bearing 13d. In a cross section of orbiting bearing 13d in a plane including the axis of eccentric bearing 13d, the angle θ between the tapered shape and the axis of orbiting bearing 13d is set so as to satisfy the following relational expression, where L is the distance between the upper end of orbiting bearing 13d (first end 13da) and the start point of the taper, d is the diameter of the eccentric shaft, and D is the diameter of the orbiting bearing.

[Formula 1]

$$L\tan\theta + d/\cos\theta < D$$

[0054] As a result, an appropriate clearance can be formed between the eccentric shaft and the orbiting bearing, and thereby metal contact can be prevented and formation of an oil film at the sliding portion can be promoted.

[0055] The present disclosure has been described using the exemplary embodiment described above. Since the exemplary embodiment is for illustrating the technology in the present disclosure, various modifications, replacements, additions, omissions, or the like, can be made within the scope of the claims or equivalents thereof.

[0056] As the refrigerant of the scroll compressor of the present disclosure, R32, carbon dioxide, or a refrigerant having a double bond between carbons can be used.

INDUSTRIAL APPLICABILITY

[0057] A scroll compressor according to the present disclosure can achieve high efficiency, and is therefore useful for various refrigeration cycle devices such as a hot water heating device, an air conditioner, a water heater, a freezing machine, or the like.

REFERENCE MARKS IN THE DRAWINGS

[0058]

1	hermetic container
1a	barrel
1b	lower lid
1c	upper lid
2	refrigerant suction pipe
3	refrigerant discharge pipe
4	oil storage part
5	oil pump
6	discharge chamber
10	compression mechanism unit
11	fixed scroll
11a	fixed scroll end plate
11b	fixed spiral wrap
11be	outer peripheral end portion
12	orbiting scroll

12a	orbiting scroll end plate
12b	orbiting spiral wrap
12be	outer peripheral end portion
12c	boss portion
13	rotary shaft
13a	eccentric shaft
13ab	outer periphery
13b	lower end
13c	rotary shaft oil supply hole
13d	orbiting bearing
13da	first end
13db	second end
13dc	inner wall (bore surface)
13e	oil groove
14	discharge port
15	compression chamber
15A	first compression chamber
15B	second compression chamber
15a	suction port
17	spin-restraining member
18	sub-bearing
20	motor mechanism unit
21	stator
22	rotor
30	main bearing
31	bearing
32	boss housing
33	sealing member
51	first oil introduction hole
52	first oil lead-out hole
53	first end plate oil communication passage
61	second oil introduction hole
62	second oil lead-out hole
63	second end plate oil communication passage
100	scroll compressor

Claims

1. A scroll compressor comprising:

a compression mechanism unit that compresses a refrigerant and includes a fixed scroll, an orbiting scroll, and a rotary shaft that has an eccentric shaft to drive the orbiting scroll to orbit;
a motor mechanism unit that drives the compression mechanism unit; and
a hermetic container accommodating the compression mechanism unit and the motor mechanism unit,
wherein the fixed scroll includes a fixed scroll end plate having a disk shape and a fixed spiral wrap erecting from the fixed scroll end plate,
the orbiting scroll includes an orbiting scroll end plate having a disk shape, an orbiting spiral wrap erecting from one surface of the orbiting scroll end plate, a boss portion having a cylindrical shape and disposed on another surface of the orbiting scroll end plate, and an orbiting bearing that is fit in the boss portion and receives the eccentric shaft,
the fixed spiral wrap and the orbiting spiral wrap mesh with each other to form a plurality of compression chambers between the fixed spiral wrap and the orbiting spiral wrap,
the orbiting scroll is pressed against the fixed scroll by a back pressure from a side of the other surface of the orbiting scroll end plate,
the orbiting bearing has a first end on a side of the orbiting scroll end plate and a second end on an opposite side of the first end, the eccentric shaft being inserted in the orbiting bearing from the second end, and
the scroll compressor is configured that
an inner wall of the orbiting bearing has a first tapered shape of which diameter increases from a first end side toward a second end side or
an outer periphery of the eccentric shaft inserted in the orbiting bearing has a second tapered shape of which diameter decreases from the first end side toward the second end side.

2. The scroll compressor according to Claim 1, wherein the first tapered shape or the second tapered shape starts from a position at a midway within a range along an axial direction of the eccentric bearing in which range the inner wall of the eccentric bearing and the outer periphery of the eccentric shaft slide against each other.

3. The scroll compressor according to Claim 1 or 2, wherein the first tapered shape or the second tapered shape includes a straight line, a continuous curve, or a combination of the straight line and the continuous curve.

4. The scroll compressor according to any one of Claims 1 to 3, wherein in a sectional view in a plane including an axis of the orbiting bearing, the first tapered shape or the second tapered shape is configured that

an angle θ between a surface of the first tapered shape or the second tapered shape and the axis is larger than an angle at which the rotary shaft is allowed to tilt, and
satisfies a relational expression expressed below where L is a distance between the first end of the orbiting bearing and a start point of the first tapered shape or the second tapered shape, d is a diameter of the eccentric shaft, and D is a diameter of the inner wall of the orbiting bearing,

[Formula 1]

$$L \tan\theta + d/\cos\theta < D$$

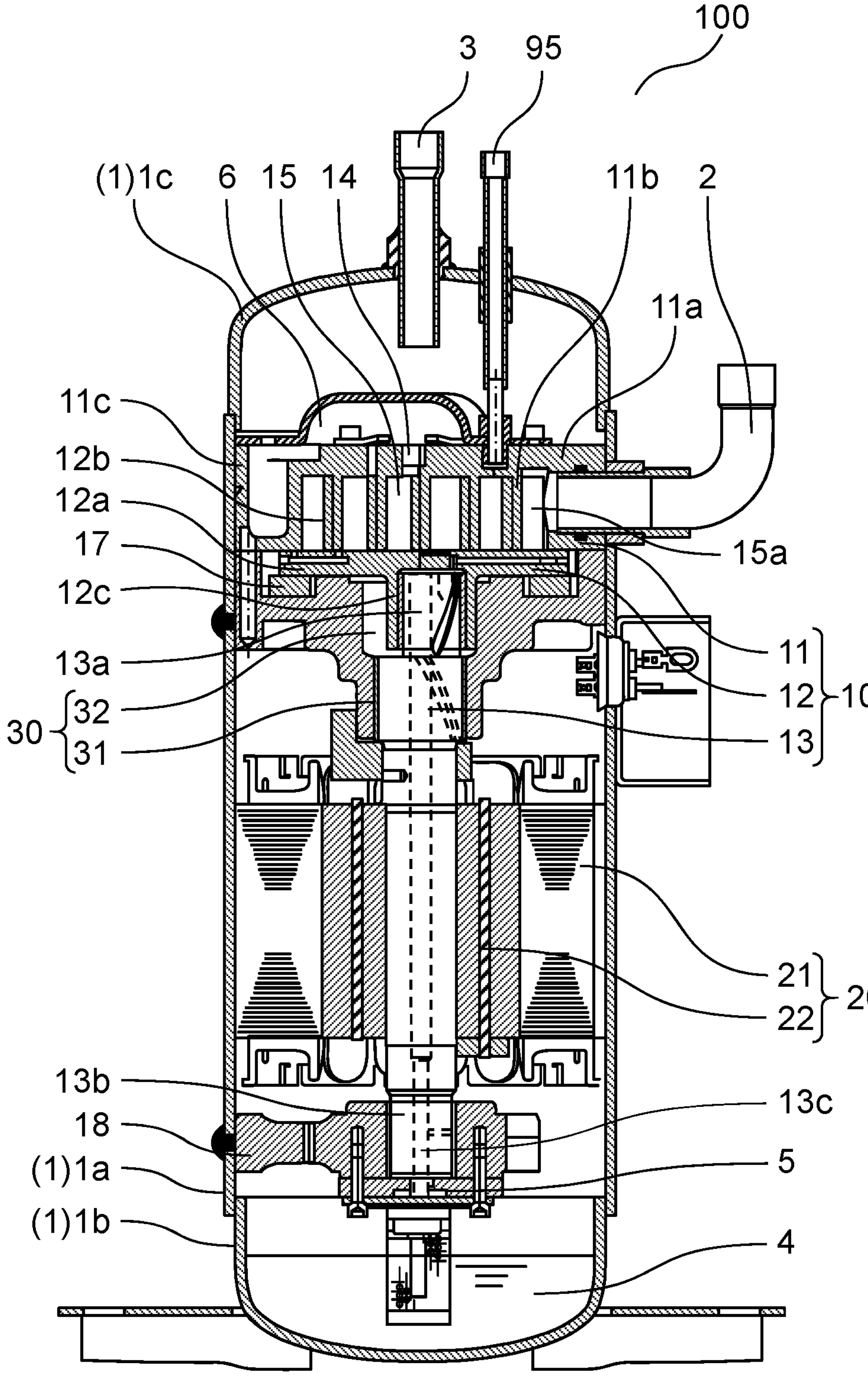
5. The scroll compressor according to Claim 4, wherein

the scroll compressor includes a main bearing and a sub-bearing that rotatably support the rotary shaft, and
the angle at which the rotary shaft is allowed to tilt is defined by a clearance between the main bearing and the rotary shaft and a clearance between the sub-bearing and the rotary shaft.

6. The scroll compressor according to any one of Claims 1 to 5, wherein

the plurality of compression chambers includes a first compression chamber disposed on an outer wall side of the orbiting spiral wrap and a second compression chamber disposed on an inner wall side of the orbiting spiral wrap, and
a suction volume of the first compression chamber is larger than a suction volume of the second compression chamber.

FIG. 1


100
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11c
12b
12a
17
12c
13a
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32
31
15a
11
12
10
13
21
22
20
13b
18
(1)1a
(1)1b
13c
5
4

FIG. 2

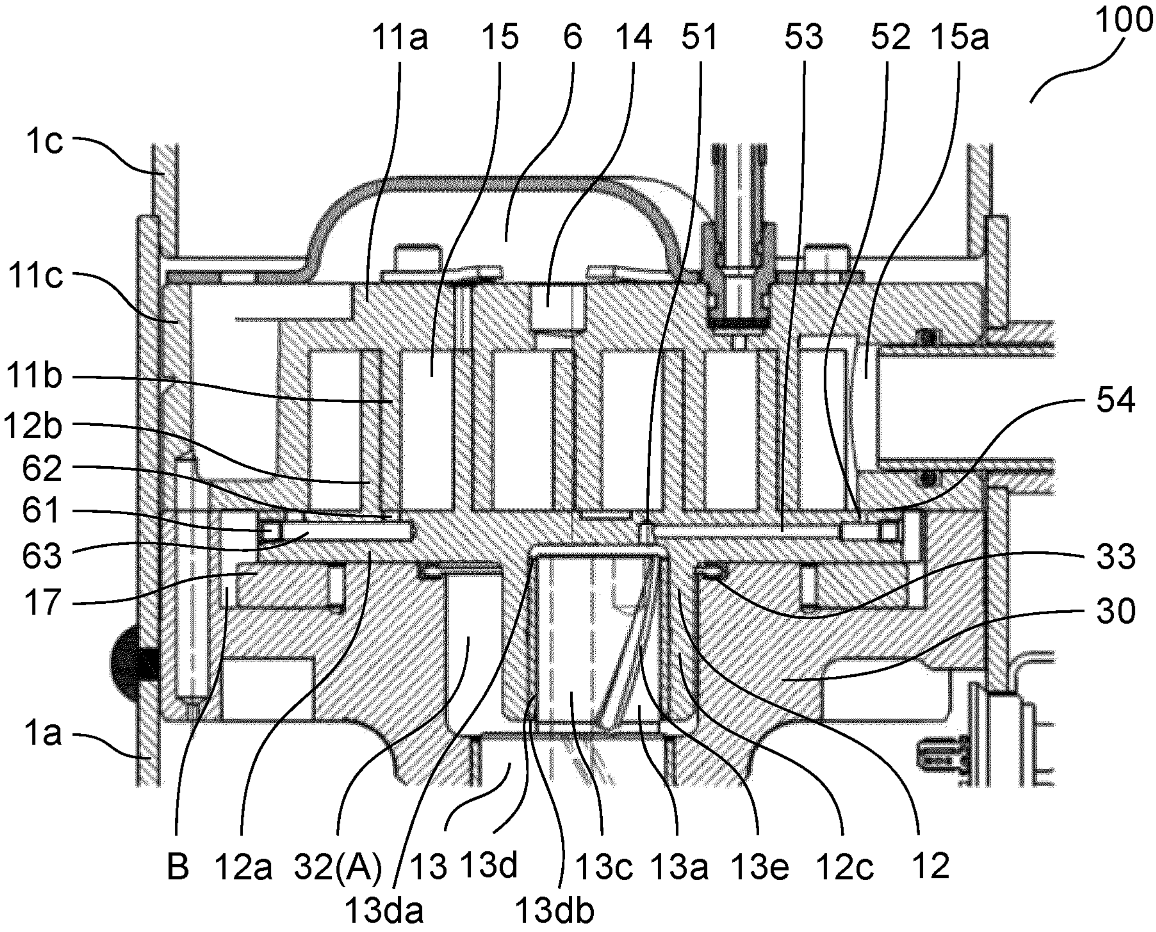
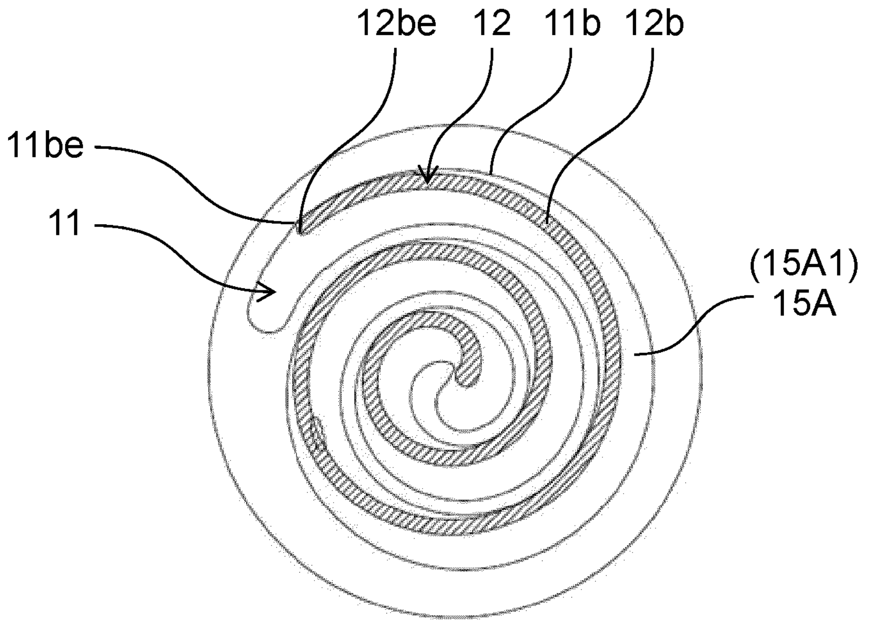
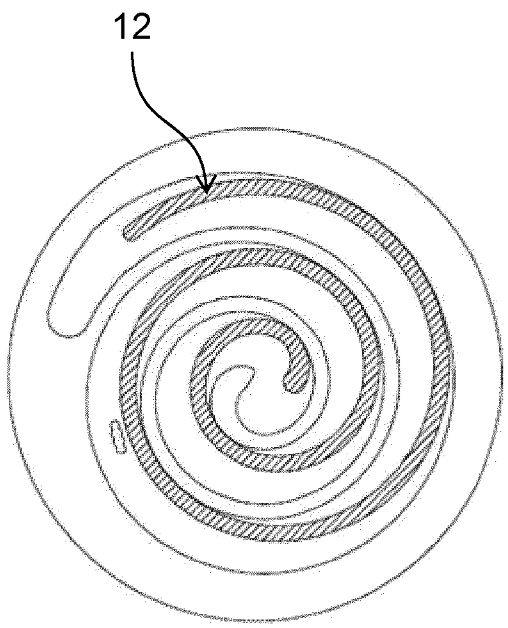

11a
15
6
14
51
53
52
15a
100
1c
11c
11b
12b
62
61
63
17
1a
54
33
30
B
12a
32(A)
13
13d
13c
13a
13e
12c
12
13da
13db

FIG. 3A



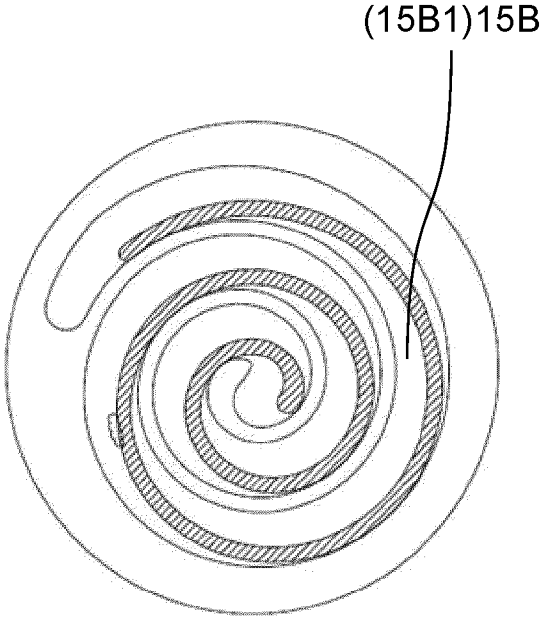
0°

FIG. 3B



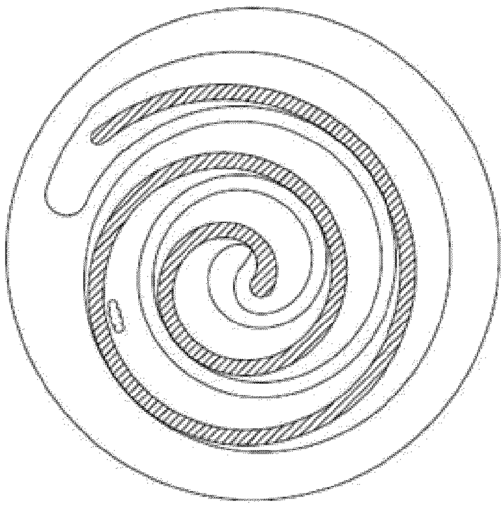
90°

FIG. 3C



180°

FIG. 3D



270°

FIG. 4A

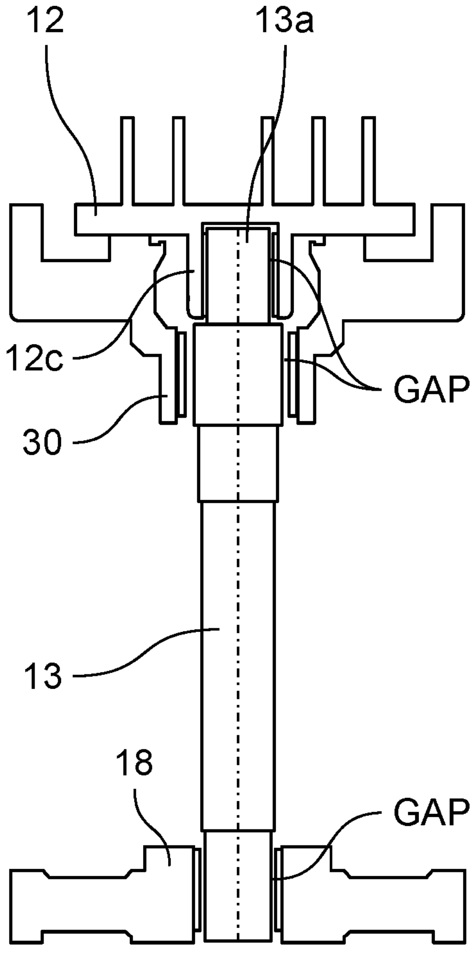


FIG. 4B

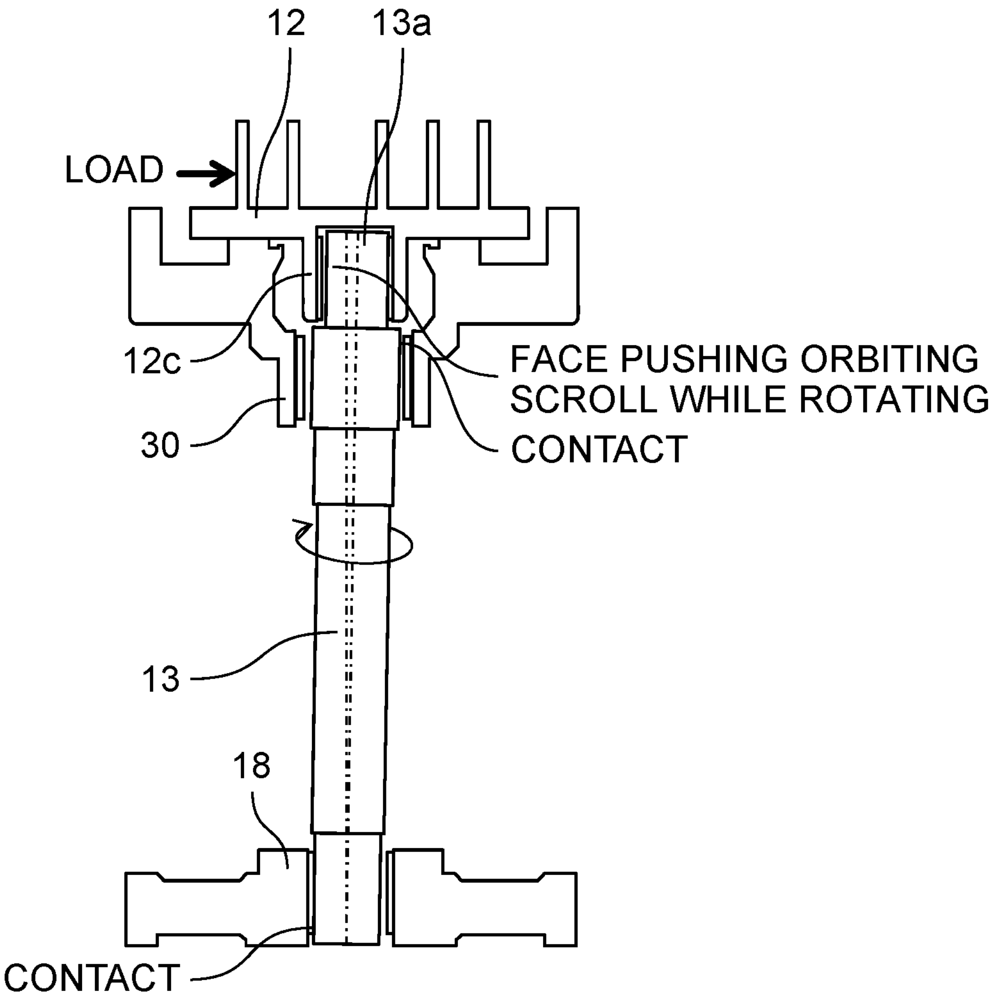

12
13a
LOAD
12c
FACE PUSHING ORBITING
SCROLL WHILE ROTATING
30
CONTACT
13
18
CONTACT

FIG. 5A

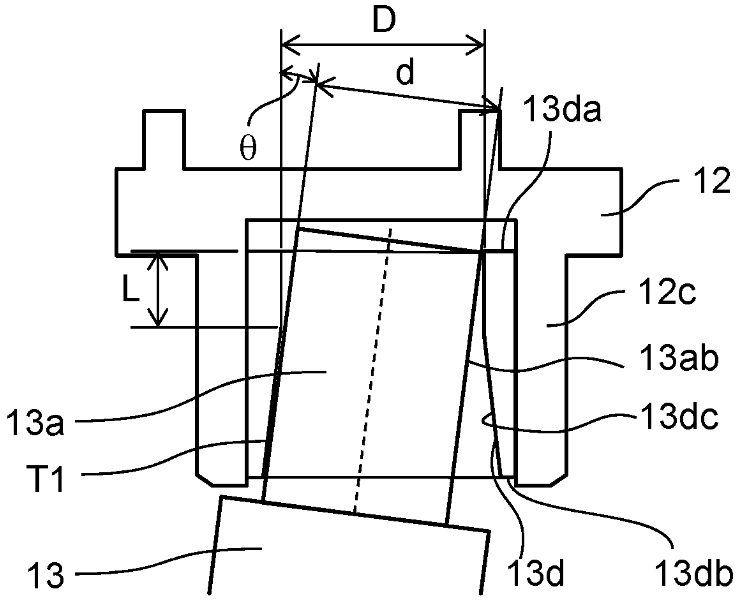

D
d
θ
13da
12
12c
L
13ab
13a
13dc
T1
13
13d
13db

FIG. 5B

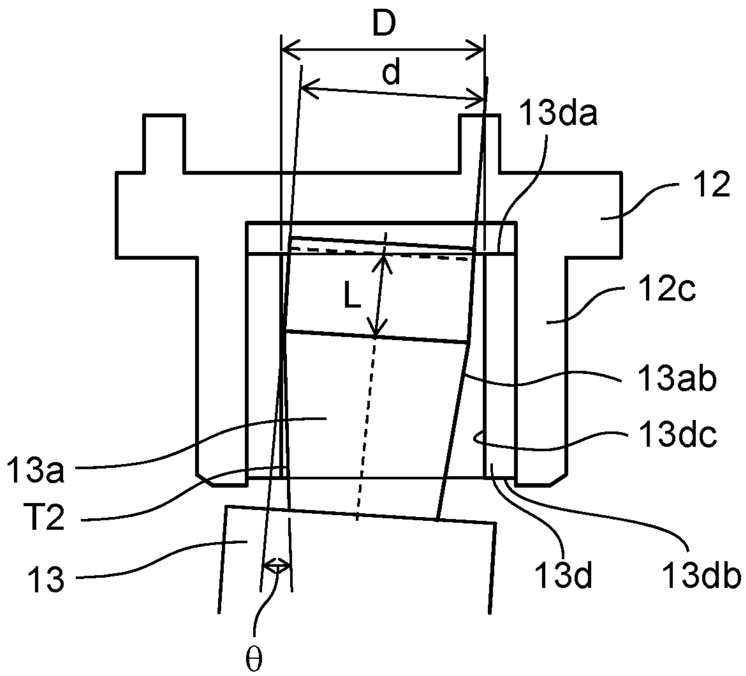

D
d
13da
12
12c
L
13ab
13a
13dc
T2
13
13d
13db
θ

FIG. 6A

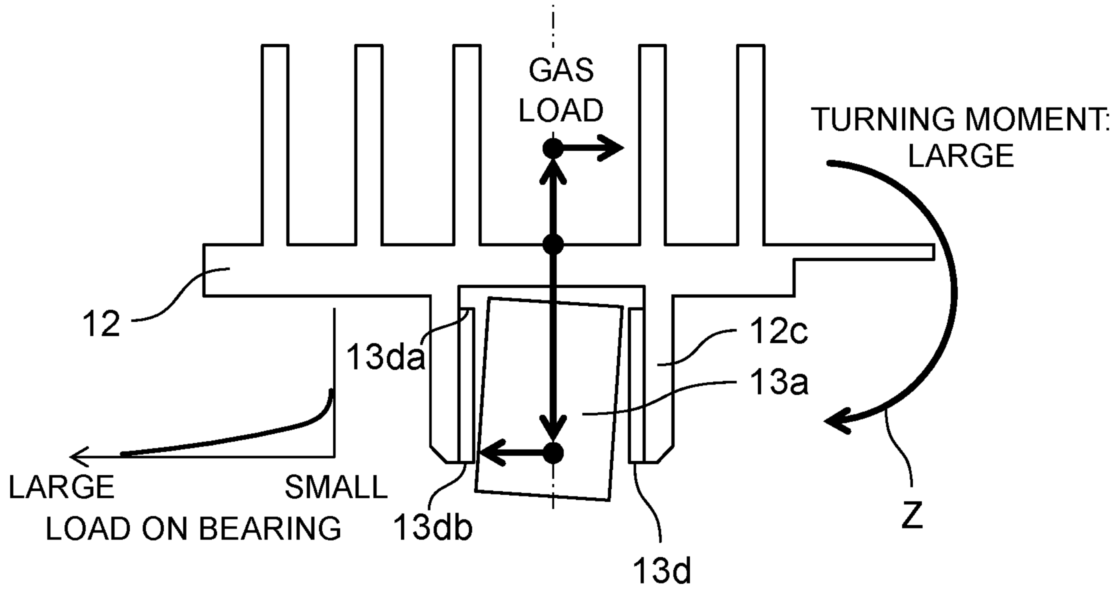
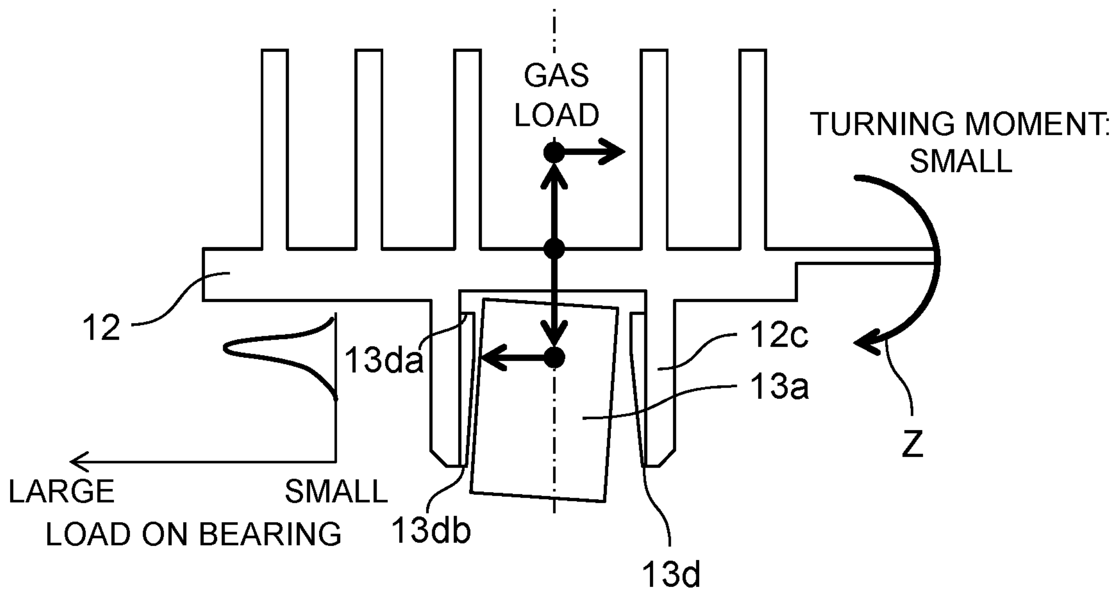

GAS
LOAD
TURNING MOMENT:
LARGE
12
13da
12c
13a
LARGE
SMALL
LOAD ON BEARING
13db
Z
13d

FIG. 6B


GAS
LOAD
TURNING MOMENT:
SMALL
12
13da
12c
13a
Z
LARGE
SMALL
LOAD ON BEARING
13db
13d

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2021/001571

A. CLASSIFICATION OF SUBJECT MATTER
F04C 18/02(2006.01)i
FI: F04C18/02 311J; F04C18/02 311M
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)
F04C18/02

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

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 2017-82840 A (DAIKIN INDUSTRIES, LTD.) 18 May 2017 (2017-05-18) paragraphs [0034]-[0064], [0088]-[0092], fig. 1-2, 9-10	1-5 6
Y	WO 2018/096823 A1 (PANASONIC IP MANAGEMENT CO., LTD.) 31 May 2018 (2018-05-31) paragraph [0018]	6
A	JP 2000-179481 A (HITACHI, LTD.) 27 June 2000 (2000-06-27)	1-6
A	JP 11-141472 A (DAIKIN INDUSTRIES, LTD.) 25 May 1999 (1999-05-25)	1-6
A	JP 9-195956 A (MITSUBISHI ELECTRIC CORP.) 29 July 1997 (1997-07-29)	1-6

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 March 2021 (18.03.2021)	06 April 2021 (06.04.2021)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/001571

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2017-82840 A	18 May 2017	(Family: none)	
WO 2018/096823 A1	31 May 2018	US 2020/0063737 A1 paragraph [0018] EP 3546755 A1 CN 109996962 A	
JP 2000-179481 A	27 Jun. 2000	US 2001/0026766 A1 KR 10-2000-0048095 A CN 1257163 A	
JP 11-141472 A	25 May 1999	(Family: none)	
JP 9-195956 A	29 Jul. 1997	(Family: none)	

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

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 4892238 B **[0003]**