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Arashi et al.

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(54) **COMPRESSOR**

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F04C 29/02 (2006.01)

(52) **U.S. Cl.**
CPC ***F04C 27/001*** (2013.01); ***F04C 29/02*** (2013.01); *F04C 2210/26* (2013.01)

(58) **Field of Classification Search**
CPC F04B 39/00; F04B 39/121; F04C 27/00
See application file for complete search history.

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(57) **ABSTRACT**

An embodiment includes: a cylindrical motor case surrounding a compression mechanism about an axis; a lower case closing an opening of the motor case, fitted to an inner circumferential face of the motor case, and defining an accommodation chamber between the motor case and the lower case where a refrigerant is introduced; a first O-ring provided about the axis at a facing portion where the motor case and the lower case fitted to each other face each other in a plane; and a second O-ring provided about the axis in the facing portion, the first O-ring is provided at a position closer to a starting point on the accommodation chamber side of the facing portion than the second O-ring, the first O-ring has better refrigerant resistance and/or oil resistance than the second O-ring, and the second O-ring has better sealing performance than the first O-ring at a temperature of −20° C. or lower.

5 Claims, 5 Drawing Sheets

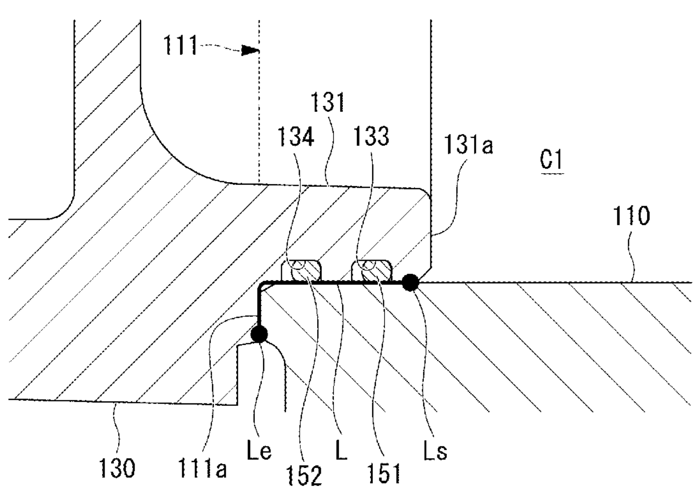

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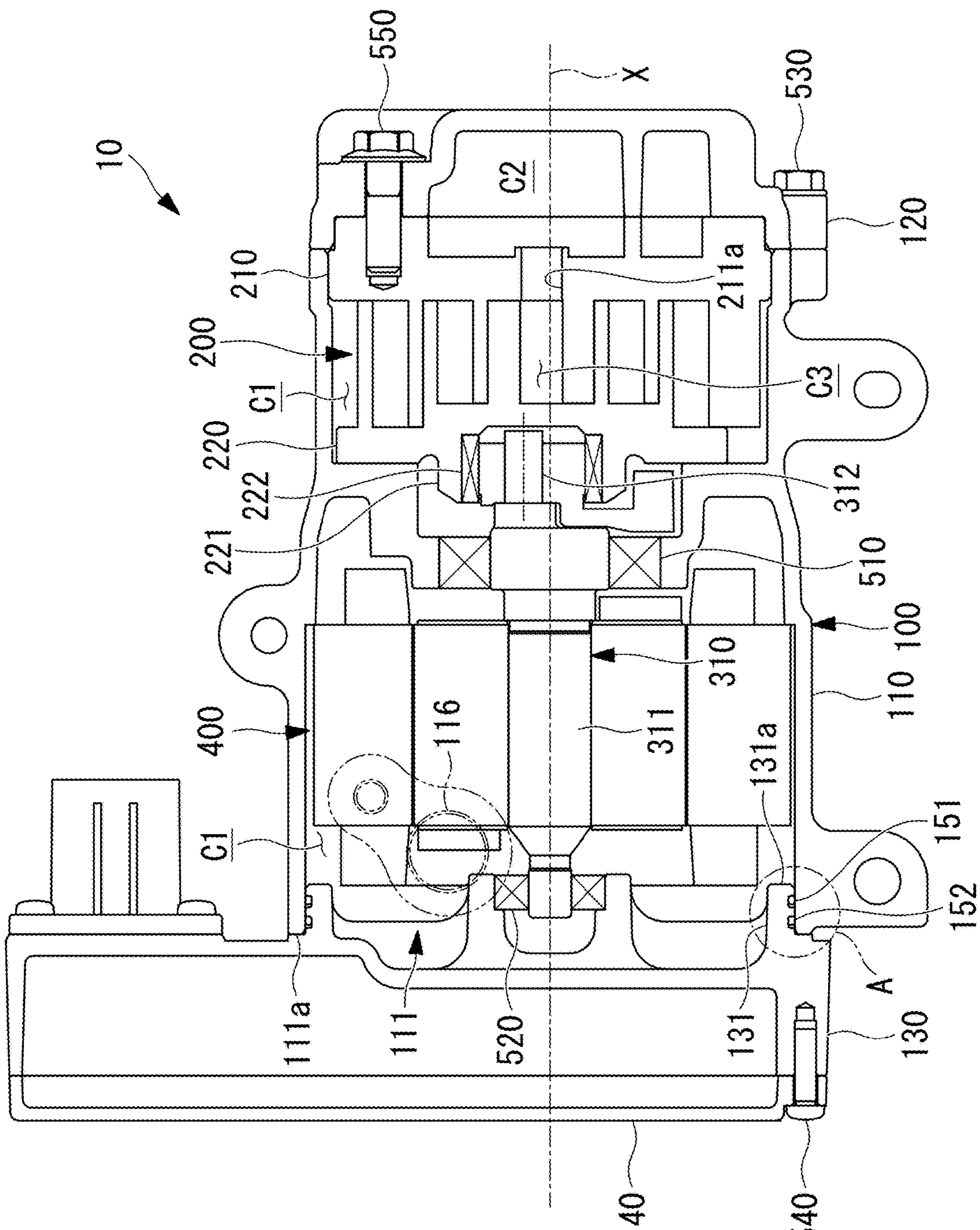
FIG. 1


10
550
X
530
C2
120
210
211a
200
C1
C3
220
222
312
221
510
100
310
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311
131a
C1
151
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111a
111
520
131
A
130
140
540

FIG. 2

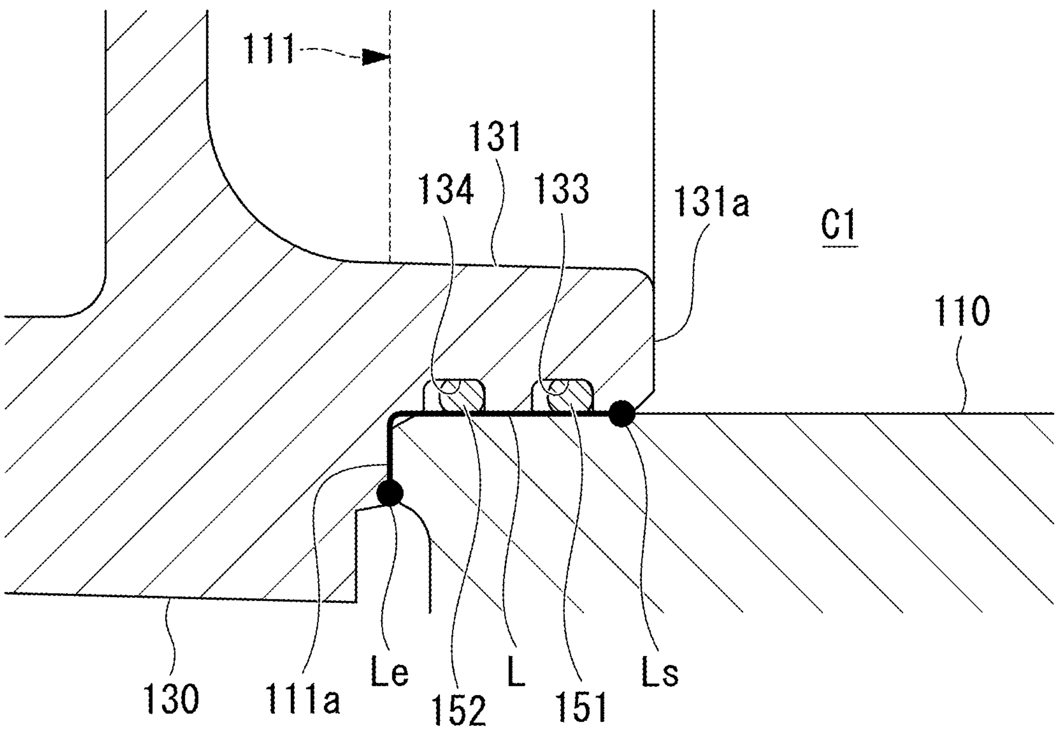


FIG. 3

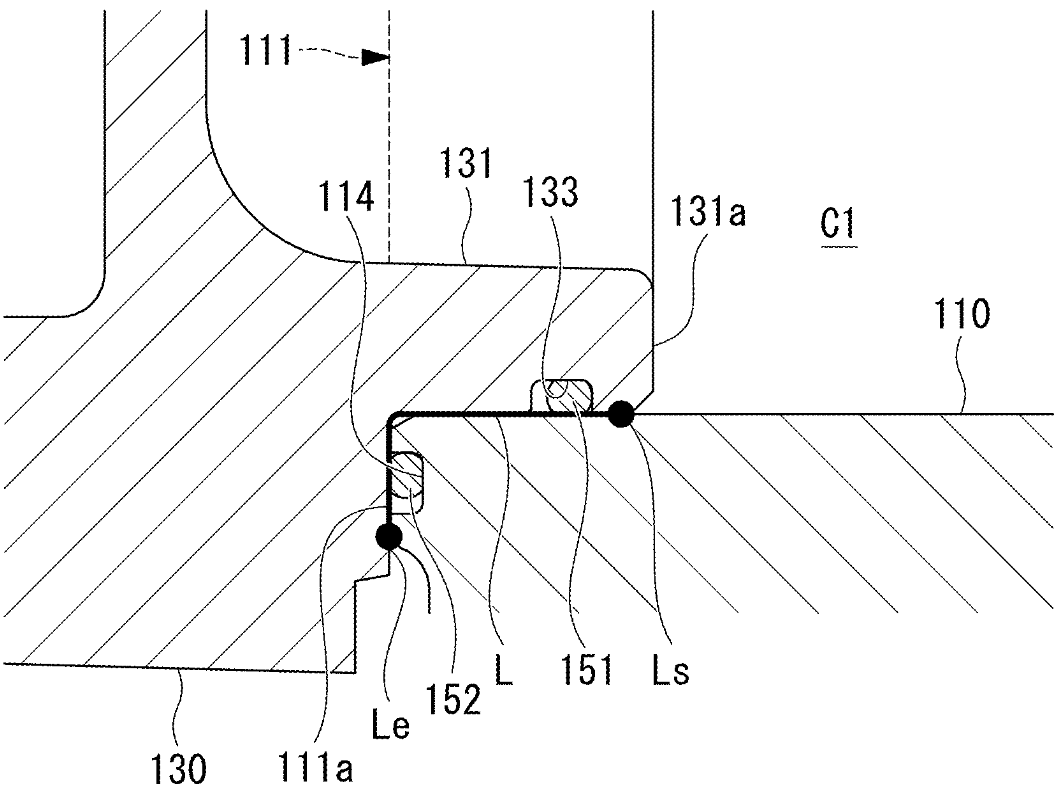


FIG. 4

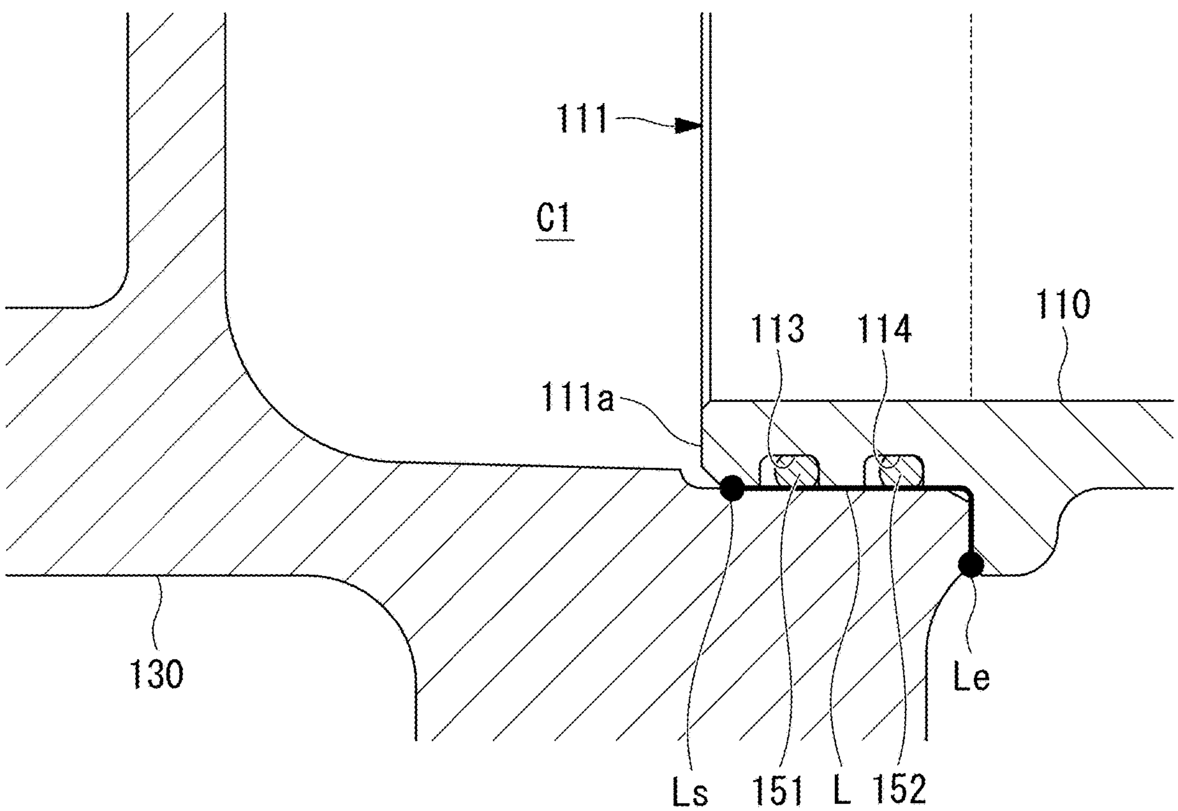
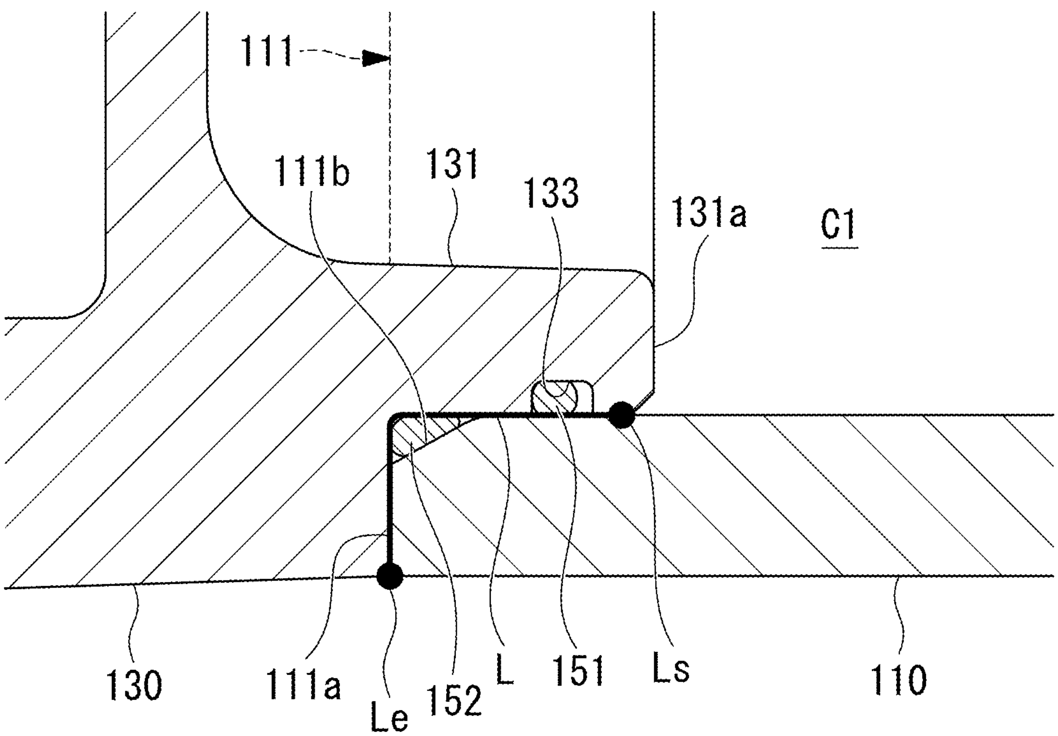


FIG. 5



COMPRESSOR

TECHNICAL FIELD

The present disclosure relates to a compressor.

BACKGROUND ART

For electric compressors in which one casing is formed of a plurality of cases, a seal member such as an O-ring may be provided between one case and another case to ensure sealing performance between the cases.

For example, in Patent Literature 1, two O-rings aligned in the axis direction are provided between one case and another case.

CITATION LIST

Patent Literature

[PTL 1]

Japanese Patent Application Laid-Open No. 2020-143650

SUMMARY OF INVENTION

Technical Problem

A seal member arranged at a position that is likely to be subjected to contact with the refrigerant is required to have refrigerant resistance and/or oil resistance, but some seal members that meet these requirements exhibit reduced sealing performance at low temperatures (when exposed to an environment at a temperature of −20° C. or lower, for example).

The present disclosure has been made in view of such circumstances and intends to provide a compressor that can maintain sealing performance at low temperatures.

Solution to Problem

To solve the above problem, the compressor of the present disclosure employs the following solution.

A compressor according to one aspect of the present disclosure includes: a cylindrical main case surrounding a compression mechanism about an axis, the compression mechanism being configured to compress a refrigerant; a sub-case closing an opening of the main case in a direction of the axis, fitted to an inner circumferential face or an outer circumferential face of the main case, and defining a space between the main case and the sub-case, the refrigerant being introduced to the space; an annular first seal member provided about the axis at a facing portion where the main case and the sub-case fitted to each other face each other in a plane; and an annular second seal member provided about the axis in the facing portion, the first seal member is provided at a position closer to a starting point on the space side of the facing portion than the second seal member, the first seal member has better refrigerant resistance and/or oil resistance than the second seal member, and the second seal member has better sealing performance than the first seal member at a temperature of −20° C. or lower.

Advantageous Effects of Invention

According to the present disclosure, it is possible to maintain sealing performance at low temperatures.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a longitudinal sectional view of a compressor according to one form of the present disclosure.

FIG. **2** is a partial enlarged view of the part A illustrated in FIG. **1**.

FIG. **3** illustrates a modified example 1 of the part A illustrated in FIG. **1**.

FIG. **4** illustrates a modified example 2 of the part A illustrated in FIG. **1**.

FIG. **5** illustrates a modified example 3 of the part A illustrated in FIG. **1**.

DESCRIPTION OF EMBODIMENTS

A compressor according to one embodiment of the present disclosure will be described below with reference to the drawings.

[Overview of Compressor]

A compressor **10** is an apparatus to compress a refrigerant (for example, R1234yf) containing a refrigeration oil (for example, POE oil).

Note that the following description uses, as an example of the compressor **10**, a scroll compressor in which a compression mechanism **200** and an electric motor **400** serving as a driving unit are accommodated in the internal space of a casing **100** that is an enclosed space, but the compressor **10** may be a so-called open-type scroll compressor in which the driving unit is arranged outside the enclosed space.

As illustrated in FIG. **1**, the compressor **10** includes the casing **100**, the compression mechanism **200**, a crankshaft **310**, and the electric motor **400**.

The casing **100** has a motor case (main case) **110**, an upper case **120**, and a lower case (sub-case) **130**.

The motor case **110** is a cylindrical member extending in the direction of an axis X and opened at both ends.

The motor case **110** surrounds the compression mechanism **200**, the crankshaft **310**, and the electric motor **400** about the axis X.

The upper case **120** is a member that closes one opening of the motor case **110**.

The upper case **120** is fixed to the motor case **110** by a bolt **530**.

The lower case **130** is a member that closes the other opening (hereinafter referred to as "opening **111**") of the motor case **110**.

The lower case **130** is fixed to the motor case **110** by a bolt (not illustrated). The detailed configuration of a portion where the motor case **110** and the lower case **130** are fitted to each other will be described later.

An inverter cover **140** is attached to the lower case **130** by a screw **540**. An inverter (not illustrated) is accommodated in a space defined by the lower case **130** and the inverter cover **140**.

In an enclosed space defined by the casing **100** (the motor case **110**, the upper case **120**, and the lower case **130**) configured as described above, the compression mechanism **200**, the crankshaft **310**, the electric motor **400**, and various other components are accommodated.

The compression mechanism **200** is a mechanism that compresses a low-pressure gas refrigerant taken in from outside of the casing **100** through a suction port **116**.

The compression mechanism **200** has a fixed scroll **210** and an orbiting scroll **220**.

The fixed scroll **210** is a member having a fixed side end plate and a spiral fixed side wall body erected from the end plate.

The fixed scroll **210** is fixed to the upper case **120** by a bolt **550**. Further, the outer circumferential face of the fixed side end plate of the fixed scroll **210** is in contact with the inner circumferential face of the motor case **110** and the inner circumferential face of the upper case **120** while maintaining its sealing performance. Accordingly, the enclosed space inside the casing **100** is divided into an accommodation chamber C**1** which is defined by the fixed scroll **210**, the motor case **110**, and the lower case **130** and a discharge chamber C**2** which is defined by the fixed scroll **210** and the upper case **120**.

Note that the sealing performance between the fixed scroll **210** and the motor case **110** and the sealing performance between the fixed scroll **210** and the upper case **120** are ensured by O-rings, for example.

The orbiting scroll **220** is a member having an orbiting side end plate and a spiral orbiting side wall body erected from the end plate.

The orbiting scroll **220** is configured to perform revolution movement with respect to the fixed scroll **210** by the crankshaft **310** rotated about the axis X (in detail, a crankpin **312** revolved about the axis X) and a known anti-rotation mechanism.

Respective wall bodies of the fixed scroll **210** and the orbiting scroll **220** are engaged with each other, and thereby the fixed scroll **210** and the orbiting scroll **220** form a compression chamber C**3**.

The crankshaft **310** is a member for transmitting driving force from the electric motor **400** to the orbiting scroll **220**.

The crankshaft **310** has a shaft body **311** and the crankpin **312**.

The shaft body **311** is a shaft-like member extending along the axis X. The shaft body **311** is driven and rotated about the axis X by the electric motor **400**.

The shaft body **311** is supported rotatably about the axis X by a main bearing **510**, which is arranged on the upper case **120** side and fixed to the motor case **110**, and by a sub-bearing **520**, which is arranged on the lower case **130** side and fixed to the lower case **130**.

The crankpin **312** is a shaft-like member provided at an end on the upper case **120** side of the shaft body **311**.

The crankpin **312** extends along another axis eccentric from the axis X. Thus, when the shaft body **311** is rotated about the axis X, the crankpin **312** is revolved about the axis X.

The crankpin **312** is connected via a bearing **222** to a boss part **221** formed in the orbiting scroll **220**.

The compressor **10** configured as described above is driven as follows.

The shaft body **311** of the crankshaft **310** is driven and rotated about the axis X by the electric motor **400**, and thereby the orbiting scroll **220** connected to the crankpin **312** is driven.

A gas refrigerant taken into the accommodation chamber C**1** on the lower case **130** side via the suction port **116** passes through a refrigerant passage or the like formed between the inner circumferential face of the motor case **110** and the outer circumferential face of the electric motor **400** (stator), and the gas refrigerant is guided to the accommodation chamber C**1** on the compression mechanism **200** side.

The refrigerant guided to the accommodation chamber C**1** on the compression mechanism **200** side is taken into the compression chamber C**3**. At this time, the compression chamber C**3** is configured so that the volume thereof is gradually reduced in accordance with the revolution movement of the orbiting scroll **220**, and thus the gas refrigerant is compressed accordingly.

The compressed high-temperature high-pressure gas refrigerant is guided to the discharge chamber C**2** via a discharge port **211***a* formed in the approximate center of the fixed side end plate of the fixed scroll **210** and the discharge valve (not illustrated) provided at the outlet of the discharge port **211***a*.

The gas refrigerant guided to the discharge chamber C**2** is discharged to outside of the compressor **10** via the discharge port (not illustrated) provided in the upper case **120**.

[Engagement Portion Between Motor Case and Lower Case]

As illustrated in FIG. **1** and FIG. **2**, an annular protruding portion **131** is formed in the lower case **130**.

The annular protruding portion **131** is a portion formed in the lower case **130** facing the opening **111** of the motor case **110**.

The annular protruding portion **131** protrudes in the direction of the axis X, is formed in an annular shape about the axis X, and is fitted to the inner circumferential face of the opening **111**. Thus, the outer diameter of the annular protruding portion **131** corresponds to the inner diameter of the opening **111**.

In a state where the motor case **110** and the lower case **130** are fitted to each other, two seal members (a first O-ring **151** and a second O-ring **152**) are provided in any range of a portion where the motor case **110** and the lower case **130** face each other in a plane. In detail, the portion means a portion where a portion on the opening **111** side of the motor case **110** and the annular protruding portion **131** of the lower case **130** face each other in a plane (hereinafter referred to as a "facing portion L").

The first O-ring **151** is a seal member having rubber elasticity and having an annular shape about the axis X. Further, the second O-ring **152** is a seal member having rubber elasticity and having an annular shape about the axis X.

Note that the first O-ring **151** and the second O-ring **152** are formed of different materials from each other. The detail thereof will be described later.

For example, the first O-ring **151** is provided in a first annular groove **133** formed in the outer circumferential face of the annular protruding portion **131**. Further, for example, the second O-ring **152** is provided in a second annular groove **134** formed in the outer circumferential face of the annular protruding portion **131**.

Note that the first O-ring **151** and the second O-ring **152** being assembled into the compressor **10** are in close contact with the motor case **110** and lower case **130**, respectively, and are compressed and squeezed between the motor case **110** and lower case **130**.

Herein, the first annular groove **133** is formed at a position closer to a starting point Ls of the facing portion L than the second annular groove **134** (a position away from an end point Le of the facing portion L). In other words, the first O-ring **151** is provided at a position closer to the starting point Ls of the facing portion L than the second O-ring **152** (a position away from the end point Le of the facing portion L).

Herein, the starting point Ls of the facing portion L is a point (portion) of the facing portion L in contact with and adjacent to the accommodation chamber C**1**. Further, the end point Le of the facing portion L is a point (portion) of the facing portion L in contact with and adjacent to the outside of the compressor **10**.

In the case of FIG. **2**, the starting point Ls of the facing portion L is located on an end face **131***a* side of the annular protruding portion **131**. Thus, the first annular groove **133** is formed at a position closer to the end face **131**a of the annular protruding portion **131** than the second annular groove **134**.

Because of such arrangement, if there is entry of a gas refrigerant from the accommodation chamber **C1** through the starting point Ls along the facing portion L, the refrigerant will first come into contact with the first O-ring **151**. Then, only if the gas refrigerant passes between the first O-ring **151** and the inner circumferential face of the motor case **110**, the refrigerant will come into contact with the second O-ring **152**.

Herein, the first O-ring **151** to be employed is an O-ring having better refrigerant resistance and/or oil resistance than the second O-ring **152**.

Further, the second O-ring **152** to be employed is an O-ring having better sealing performance than the first O-ring **151** at a temperature of, for example, −20° C. or lower.

For example, refrigerant resistance is evaluated by an immersion test using a refrigerant (R1234yf) (JIS K 6258, "Rubber, vulcanized or thermoplastic-Determination of the effect of liquids").

Further, the refrigerant resistance is evaluated by a foaming test in addition to the immersion test. The foaming test is a test to immerse the O-ring in a refrigerant, then heat the O-ring with air, and cut ten portions out of the O-ring to see if a crack is present in the cross-section.

For example, oil resistance is evaluated by an immersion test using a refrigeration oil (POE oil) (JIS K 6258, "Rubber, vulcanized or thermoplastic-Determination of the effect of liquids").

For example, the sealing performance is evaluated by a TR test (JIS K 6261, "Rubber, vulcanized or thermoplastic-Determination of low-temperature properties"). Specifically, the sealing performance is evaluated based on a TR10 value (a temperature at which the shrinkage rate is 10%). The lower this temperature is, the better the sealing performance at low temperatures is. Note that, when an O-ring is used at a temperature lower than the TR10 value, the sealing performance may not be ensured due to a reduction in the rubber elasticity of the O-ring.

An example of the material of the first O-ring **151** selected based on the above evaluation is HNBR, and an example of the material of the second O-ring **152** selected based on the above evaluation is EPDM.

Note that, when the colors of the first O-ring **151** and the second O-ring **152** are made different from each other, the first O-ring **151** and the second O-ring **152** can be easily visibly distinguished from each other.

This can prevent incorrect assembly of respective O-rings.

According to the present embodiment, the following advantageous effects are achieved.

The compressor **10** includes: the annular first O-ring **151** provided about the axis X at a facing portion L where the motor case **110** and the lower case **130** fitted to each other face each other in a plane; and the annular second O-ring **152** provided about the axis X in the facing portion L, the first O-ring **151** is provided at a position closer to the starting point Ls of the facing portion L than the second O-ring **152**, the first O-ring **151** has better refrigerant resistance and/or oil resistance than the second O-ring **152**, and the second O-ring **152** has better sealing performance than the first O-ring **151** at a temperature of −20° C. or lower. Thus, even when the first O-ring **151** and the second O-ring **152** are exposed to an environment at a temperature of −20° C. or lower due to the operation of the compressor **10**, the first O-ring **151**, which is provided at a position that is likely to be subjected to contact with the refrigerant, makes it possible to ensure a certain level of sealing performance while suppressing deterioration due to the refrigerant (containing lubricating oil) because of the excellent refrigerant resistance and/or oil resistance of the first O-ring **151**, and the second O-ring **152** makes it possible to ensure high sealing performance even in an environment at a temperature of −20° C. because of the excellent sealing performance at low temperatures of the second O-ring **152**. In this situation, while the second O-ring **152** has lower refrigerant resistance and/or oil resistance than the first O-ring **151**, the second O-ring **152** is less likely to be deteriorated by the refrigerant (less likely to be affected by the refrigerant). This is because only a small amount of the refrigerant passes by the first O-ring **151**, which has better refrigerant resistance and/or oil resistance and exhibits a certain level of sealing performance while having lower sealing performance at low temperatures than the second O-ring **152**. In short, this is because only a small amount of a refrigerant may come into contact with the second O-ring **152**.

As described above, the combination of the first O-ring **151** and the second O-ring **152** whose materials differ from each other enables sealing performance at low temperatures to be maintained for a long period of time.

Further, the use of different colors of the first O-ring **151** and the second O-ring **152** can prevent incorrect assembly of respective O-rings.

Modified Example 1

As illustrated in FIG. **3**, the second O-ring **152** may be provided in an end face **111**a of the opening **111** of the motor case **110**.

In such a case, the first annular groove **133** is formed in the outer circumferential face of the annular protruding portion **131**, and a second annular groove **114** is formed in the end face **111**a of the opening **111** of the motor case **110**.

Modified Example 2

As illustrated in FIG. **4**, the inner circumferential face of the lower case **130** may be fitted to the outer circumferential face of the motor case **110**.

In such a case, a first annular groove **113** and the second annular groove **114** are formed in the outer circumferential face in the portion on the end face **111**a side of the motor case **110**.

Further, the starting point Ls of the facing portion L is located on the end face **111**a side of the opening **111**. Thus, the first annular groove **133** is formed at a position closer to the end face **111**a of the opening **111** than the second annular groove **134**. Thus, the first O-ring **151** is provided at a position closer to the end face **111**a of the opening **111** than the second O-ring **152**.

Modified Example 3

As illustrated in FIG. **5**, the second O-ring **152** may be provided in a chamfer **111**b connected to the end face **111**a of the motor case **110**. Note that the chamfer **111**b is a part of the inner circumferential face of the motor case **110**.

In such a case, the first annular groove **133** is formed in the outer circumferential face of the annular protruding portion **131**, and the chamfer **111**b corresponds to the second annular groove **114** or the second annular groove **134**.

Note that, in all the embodiments (including modified examples), a component in which annular grooves or the like provided with two O-rings are formed can be arbitrarily selected from the motor case **110** and the lower case **130**.

Further, two annular grooves may be formed in the end face **111***a* of the motor case **110** and/or the face of the lower case **130** facing the end face **111***a*, and thereby two O-rings may be provided in these two annular grooves.

The compressor according to the present embodiment as described above is understood as follows, for example.

The compressor (**10**) according to the first aspect of the present disclosure includes: a cylindrical main case (**110**) surrounding a compression mechanism (**200**) about an axis (X), the compression mechanism being configured to compress a refrigerant; a sub-case (**130**) closing an opening (**111**) of the main case in a direction of the axis, fitted to an inner circumferential face or an outer circumferential face of the main case, and defining a space (C**1**) between the main case and the sub-case, the refrigerant being introduced to the space; an annular first seal member (**151**) provided about the axis at a facing portion (L) where the main case and the sub-case fitted to each other face each other in a plane; and an annular second seal member (**152**) provided about the axis in the facing portion, the first seal member is provided at a position closer to a starting point (Ls) on the space side of the facing portion than the second seal member, the first seal member has better refrigerant resistance and/or oil resistance than the second seal member, and the second seal member has better sealing performance than the first seal member at a temperature of −20° C. or lower.

According to the compressor of the present aspect, the compressor includes: a annular first seal member provided about the axis at a facing portion where the main case and the sub-case fitted to each other face each other in a plane; and an annular second seal member provided about the axis in the facing portion, the first seal member is provided at a position closer to a starting point on the space side of the facing portion than the second seal member, the first seal member has better refrigerant resistance and/or oil resistance than the second seal member, and the second seal member has better sealing performance than the first seal member at a temperature of −20° C. or lower. Thus, even when the first seal member and the second seal member are exposed to an environment at a temperature of −20° C. or lower due to the operation of the compressor, the first seal member, which is provided at a position that is likely to be subjected to contact with the refrigerant, makes it possible to ensure a certain level of sealing performance while suppressing deterioration due to the refrigerant (containing lubricating oil) because of the excellent refrigerant resistance and/or oil resistance of the first seal member, and the second seal member makes it possible to ensure high sealing performance even in an environment at a temperature of −20° C. because of the excellent sealing performance at low temperatures of the second seal member. In this situation, while the second seal member has lower refrigerant resistance and/or oil resistance than the first seal member, the second seal member is less likely to be deteriorated by the refrigerant (less likely to be affected by the refrigerant). This is because only a small amount of the refrigerant passes by the first seal member, which has better refrigerant resistance and/or oil resistance and exhibits a certain level of sealing performance while having lower sealing performance at low temperatures than the second seal member. In short, this is because only a small amount of a refrigerant may come into contact with the second seal member.

In such a way, the combination of the first seal member and the second seal member whose materials differ from each other enables sealing performance at low temperatures to be maintained for a long period of time.

Further, in the compressor according to the second aspect of the present disclosure, in the first aspect, the first seal member may be arranged to be in contact with the inner circumferential face or the outer circumferential face of the main case, and the second seal member may be arranged to be in contact with the inner circumferential face or the outer circumferential face of the main case.

According to the compressor of the present aspect, the first seal member is arranged to be in contact with the inner circumferential face or the outer circumferential face of the main case, and the second seal member is arranged to be in contact with the inner circumferential face or the outer circumferential face of the main case. Thus, the seal can be ensured with the inner circumferential face or the outer circumferential face of the main case.

Further, in the compressor according to the third aspect of the present disclosure, in the first aspect, the first seal member may be arranged to be in contact with the inner circumferential face or the outer circumferential face of the main case, and the second seal member may be arranged to be in contact with an opening end face of the main case.

According to the compressor of the present aspect, the first seal member is arranged to be in contact with the inner circumferential face or the outer circumferential face of the main case, and the second seal member is arranged to be in contact with an opening end face of the main case. Thus. the seal can be ensured with the inner circumferential face or the outer circumferential face of the main case and the opening end face of the main case.

Further, in the compressor according to the fourth aspect of the present disclosure, in the first aspect, the first seal member may be arranged to be in contact with an opening end face of the main case, and the second seal member may be arranged to be in contact with the opening end face of the main case.

According to the compressor of the present aspect, the first seal member is arranged to be in contact with an opening end face of the main case, and the second seal member is arranged to be in contact with the opening end face of the main case. Thus, the seal can be ensured with the opening end face of the main case.

Further, in the compressor according to the fifth aspect of the present disclosure, in any one of the first aspect to the fourth aspect, the first seal member and the second seal member differ in color from each other.

According to the compressor of the present aspect, the first seal member and the second seal member differ in color from each other, and thus incorrect assembly of respective seal members can be prevented.

REFERENCE SIGNS LIST

10 compressor
100 casing
110 motor case (main case)
111 opening
111*a* end face
111*b* chamfer
113 first annular groove
114 second annular groove
116 suction port
120 upper case
130 lower case (sub-case)

131 annular protruding portion
131*a* end face
133 first annular groove
134 second annular groove
140 inverter cover
151 first O-ring (first seal member)
152 second O-ring (second seal member)
200 compression mechanism
210 fixed scroll
211*a* discharge port
220 orbiting scroll
221 boss part
222 bearing
310 crankshaft
311 shaft body
312 crankpin
400 electric motor
510 main bearing
520 sub-bearing
530 bolt: for upper case
540 screw: for inverter cover
550 bolt: for fixed scroll
C**1** accommodation chamber
C**2** discharge chamber
C**3** compression chamber
X axis

The invention claimed is:

1. A compressor comprising:

a cylindrical main case surrounding a compression mechanism about an axis, the compression mechanism being configured to compress a refrigerant;

a sub-case closing an opening of the main case in a direction of the axis, fitted to an inner circumferential face or an outer circumferential face of the main case, and defining a space between the main case and the sub-case, the refrigerant being introduced to the space;

an annular first seal member provided about the axis at a facing portion where the main case and the sub-case fitted to each other face each other in a plane; and

an annular second seal member provided about the axis in the facing portion,

wherein the first seal member is provided at a position closer to a starting point on the space side of the facing portion than the second seal member,

wherein the first seal member has better refrigerant resistance and/or oil resistance than the second seal member, and

wherein the second seal member has better sealing performance than the first seal member at a temperature of −20° C. or lower.

2. The compressor according to claim **1**,

wherein the first seal member is arranged to be in contact with the inner circumferential face or the outer circumferential face of the main case, and

wherein the second seal member is arranged to be in contact with the inner circumferential face or the outer circumferential face of the main case.

3. The compressor according to claim **1**,

wherein the first seal member is arranged to be in contact with the inner circumferential face or the outer circumferential face of the main case, and

wherein the second seal member is arranged to be in contact with an opening end face of the main case.

4. The compressor according to claim **1**,

wherein the first seal member is arranged to be in contact with an opening end face of the main case, and

wherein the second seal member is arranged to be in contact with the opening end face of the main case.

5. The compressor according to claim **1**, wherein the first seal member and the second seal member differ in color from each other.

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