(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 477 888 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
18.12.2024 Bulletin 2024/51

(21) Application number: **23779600.8**

(22) Date of filing: **15.03.2023**

(51) International Patent Classification (IPC):
F04C 29/06 *(2006.01)* ***F04B 39/00*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F04B 39/00; F04C 29/06

(86) International application number:
PCT/JP2023/010007

(87) International publication number:
WO 2023/189582 (05.10.2023 Gazette 2023/40)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **28.03.2022 JP 2022051868**

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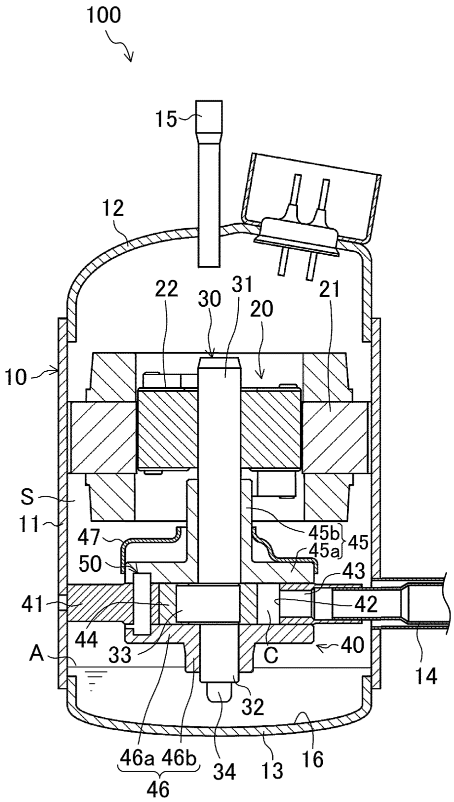
(54) COMPRESSOR AND REFRIGERATION DEVICE

(57) A compressor (100) includes a casing (10) having a reservoir (16) configured to store oil, an electric motor (20), a compression mechanism (40) disposed between the electric motor (20) and the reservoir (16), and a resonance muffler (50) provided in the compression mechanism (40). The muffler (50) includes a cavity (51) in which a resonance chamber (R) is formed, and a first opening (53) communicating with the resonance chamber (R) and opening to a refrigerant space (S). The first opening (53) is formed on a lower surface or an outer peripheral surface of the compression mechanism (40).

FIG.2



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a compressor and a refrigeration apparatus.

BACKGROUND ART

[0002] Patent Document 1 discloses a compressor having a Helmholtz muffler. The compressor of Patent Document 1 has a drive shaft extending in the top-bottom direction in a casing, a motor attached to an upper portion of the drive shaft, and a compression mechanism attached to a lower portion of the drive shaft.

[0003] The Helmholtz muffler of Patent Document 1 has a resonance chamber having an opening which is open between the compression mechanism and a rotor of the motor. At least part of an inner wall surface of the resonance chamber is formed by an outer peripheral surface of the drive shaft. The opening is formed near the drive shaft, and thus resonance with a high frequency generated near the drive shaft in the casing can be reduced.

CITATION LIST

PATENT DOCUMENTS

[0004] Patent Document 1: Japanese Unexamined Patent Publication No. 2014-118862

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0005] The casing of the compressor has a bottom portion in which a reservoir for storing oil is formed. In such a compressor, resonance is likely to be generated near an oil surface in the reservoir. Thus, noise is produced by this resonance.

[0006] In addition, a frequency of that resonance decreases when the position of the oil surface in the reservoir lowers. Thus, when the position of the oil surface in the reservoir lowers, noise with a low frequency, which is not produced when the compressor is in a normal operation, is produced.

[0007] It is an object of the present disclosure to reduce noise of a compressor produced by resonance in a casing.

SOLUTION TO THE PROBLEM

[0008] A first aspect is directed to a compressor including: a casing (10) having a bottom portion in which a reservoir (16) configured to store oil is provided; an electric motor (20) housed in the casing (10); a compression mechanism (40) disposed between the electric motor (20) and the reservoir (16) and configured to compress sucked gas refrigerant and discharge the compressed gas refrigerant into the casing (10); and a resonance muffler (50) provided in the compression mechanism (40), wherein in the casing (10), a refrigerant space (S) through which the gas refrigerant discharged from the compression mechanism (40) flows is formed above the reservoir (16), the muffler (50) includes a cavity (51) in which a resonance chamber (R) is formed, and a first opening (53) communicating with the resonance chamber (R) and opening to the refrigerant space (S), and the first opening (53) is formed on a lower surface or an outer peripheral surface of the compression mechanism (40).

[0009] In the first aspect, the first opening (53) of the resonance muffler (50) is formed on a lower surface or an outer peripheral surface of the compression mechanism near an oil surface, and thus noise of the compressor (100) produced by resonance in the casing (10) can be reduced.

[0010] A second aspect is an embodiment of the first aspect. In the second aspect, the muffler (50) further includes a first communication passage (52) communicating with the resonance chamber (R), and the first opening (53) is formed at an end portion of the first communication passage (52).

[0011] In the second aspect, the first opening (53) is formed on an end portion of the first communication passage (52), and thus the position of the first opening (53) can be adjusted by the first communication passage (52).

[0012] A third aspect is an embodiment of the first or second aspect. In the third aspect, the compression mechanism (40) has a plurality of members overlapping with each other, the plurality of members includes a first member (E1), the first member (E1) includes a recess (61, 62) formed at an end surface of the first member (E1) in a direction in which the plurality of members overlap with each other, and an internal space of the recess (61, 62) constitutes part of the cavity (51).

[0013] In the third aspect, part of the cavity (51) is constituted by the internal space of the recess (61, 62), and thus the cavity (51) can be formed in the first member (E1) by simple processing.

[0014] A fourth aspect is an embodiment of any one of the first to third aspects. In the fourth aspect, the compression mechanism (40) has a plurality of members overlapping with each other, the plurality of members includes a second member (E2), the second member (E2) includes a through hole (63) penetrating the second member (E2) in a direction in which the plurality of members overlap with each other, and an internal space of the through hole (63) constitutes part of the cavity (51).

[0015] In the fourth aspect, part of the cavity (51) is constituted by the internal space of the through hole (63), and thus the cavity (51) can be formed in the second member (E2) by simple processing.

[0016] A fifth aspect is an embodiment of any one of the first to fourth aspects. In the fifth aspect, the compression mechanism (40) includes a cylinder (41), a first closing member (45) configured to cover an opening surface of one end of the cylinder (41) in an axial direction, and a second closing member (46) configured to cover an opening surface on another end of the cylinder (41) in the axial direction, and the cavity (51) is formed by at least one of the cylinder (41), the first closing member (45), or the second closing member (46).

[0017] In the fifth aspect, the cavity (51) is formed by at least one of the cylinder (41), the first closing member (45), or the second closing member (46) that constitute the compression mechanism (40), and thus the cavity (51) can be formed without additional members.

[0018] A sixth aspect is an embodiment of any one of the first to fifth aspects. In the sixth aspect, the muffler (50) further includes a second opening (55) which communicates with the cavity (51) and through which the oil flows in and out, and the second opening (55) is formed below the first opening (53).

[0019] In the sixth aspect, the second opening (55) through which the oil flows in and out is formed below the first opening (53), and thus when the oil level in the reservoir (16) rises, the oil flows into the cavity (51) through the second opening (55). When the oil flows into the cavity (51), the bottom surface of the resonance chamber (R) is constituted by the oil surface, and the volume of the resonance chamber (R) decreases. Accordingly, the resonance frequency of the muffler (50) increases. In contrast, when the oil level in the reservoir (16) lowers, the oil in the cavity (51) flows out through the second opening (55), and the volume of the resonance chamber (R) increases. When the volume of the resonance chamber (R) increases, the resonance frequency of the muffler (50) decreases. In this manner, by the oil flowing in and out of the cavity (51) through the second opening (55), the resonance frequency of the muffler (50) changes, and thus noise with a wide range of resonance frequency can be reduced by a single muffler (50).

[0020] A seventh aspect is an embodiment of the sixth aspect. In the seventh aspect, the first opening (53) is formed below an initial supply position (A1) which is a position of an oil surface in the reservoir (16) reached at a time of shipment, and communicates with the refrigerant space (S) when an oil level in the reservoir (16) lowers.

[0021] In the seventh aspect, the first opening (53) is formed below an initial supply position (A1) which is a position of a oil surface reached at the time of shipment, and thus when the oil surface is at the initial supply position (A1), the oil flows into the cavity (51) of the muffler (50) through the first opening (53). Then, when the position of the oil surface in the reservoir (16) lowers as the compressor operates, the first opening (53) communicates with the refrigerant space (S), whereby the cavity (51) of the muffler (50) communicates with the refrigerant space (S) and the muffler (50) serves a silencing function. Accordingly, noise with a low frequency that is produced as the oil level in the reservoir (16) lowers can be reduced.

[0022] An eighth aspect is an embodiment of the sixth aspect. In the eighth aspect, the muffler (50) further includes a second communication passage (54) communicating with the cavity (51), and the second opening (55) is formed at an end portion of the second communication passage (54).

[0023] In the eighth aspect, the second opening (55) is formed at an end portion of the second communication passage (54), the position of the second opening can be adjusted by the second communication passage (54). Accordingly, the level at which the oil flows in and out can be adjusted, and thus the volume of the resonance chamber (R) can be adjusted.

[0024] A ninth aspect is an embodiment of the sixth aspect. In the ninth aspect, the compression mechanism (40) has a plurality of members overlapping with each other, the plurality of members includes a third member (E3) which is a lowermost one of the plurality of members, the cavity (51) is formed in the third member (E3), and the second opening (55) is formed on a lower surface of the third member (E3).

[0025] In the ninth aspect, the second opening (55) is formed on a lower surface of the third member (E3). The second opening (55) is formed when the cavity (51) is formed in the compression mechanism (40). Accordingly, the second opening (55) can be formed easily.

[0026] A tenth aspect is an embodiment of any one of the first to ninth aspects. In the tenth aspect, the muffler (50) includes a first muffler (50a) and a second muffler (50b), the first opening (53) of the first muffler (50a) is formed below the first opening (53) of the second muffler (50b), and a resonance frequency of the first muffler (50a) is lower than a resonance frequency of the second muffler (50b).

[0027] In the compressor (100), when the oil level in the reservoir (16) is low, the resonance frequency in the casing (10) is low. In contrast, when the oil level in the reservoir (16) is high, the resonance frequency in the casing (10) is high. In the tenth aspect, the first opening (53) of the first muffler (50a) is formed below the first opening (53) of the second muffler (50b), and the resonance frequency of the first muffler (50a) is lower than the resonance frequency of the second muffler (50b). Thus, when the oil level in the reservoir (16) is low, noise in the casing (10) can be reduced by the first muffler (50a). In contrast, when the oil level in the reservoir (16) is high, noise in the casing (10) can be reduced by the second muffler (50b).

[0028] An eleventh aspect is directed to a refrigeration apparatus including the compressor (100) of any one of the first to tenth aspects.

[0029] In the eleventh aspect, the compressor (100) including the resonance muffler (50) can be applied to the refrigeration apparatus (1).

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

FIG. 1 is a schematic piping system diagram of a refrigeration apparatus including a compressor according to a first embodiment.

FIG. 2 is a longitudinal sectional view illustrating the schematic configuration of the compressor.

FIG. 3 is an enlarged sectional view of a periphery of a muffler.

FIG. 4 corresponds to FIG. 3 and shows a second variation of the first embodiment.

FIG. 5 corresponds to FIG. 3 and shows a second embodiment.

FIG. 6 corresponds to FIG. 3 and shows a first variation of the second embodiment.

FIG. 7 corresponds to FIG. 3 and shows a third embodiment.

FIG. 8 corresponds to FIG. 3 and shows a second variation of the third embodiment.

FIG. 9 is an enlarged sectional view of a periphery of a compression mechanism where an oil level is low according to a fourth embodiment.

FIG. 10 corresponds to FIG. 9 and shows a case where the oil level is high according to the fourth embodiment.

FIG. 11 corresponds to FIG. 3 and shows another embodiment.

DESCRIPTION OF EMBODIMENTS

[0031] Embodiments of the present disclosure will be described in detail below with reference to the drawings. The present disclosure is not limited to the embodiments shown below, and various changes can be made within the scope without departing from the technical concept of the present disclosure. Each of the drawings is intended to illustrate the present disclosure conceptually, and dimensions, ratios, or numbers may be exaggerated or simplified as necessary for the sake of ease of understanding.

<<First Embodiment>>

[0032] A compressor (100) of a first embodiment will be described.

(1) Overview of Refrigeration Apparatus

[0033] The compressor (100) of this embodiment is provided in a refrigeration apparatus (1). As illustrated in FIG. 1, the refrigeration apparatus (1) has a refrigerant circuit (1a) filled with refrigerant. The refrigerant circuit (1a) has the compressor (100), a radiator (3), a decompression mechanism (4), and an evaporator (5). The decompression mechanism (4) is an expansion valve. The refrigerant circuit (1a) performs a vapor compression refrigeration cycle.

[0034] In the refrigeration cycle, the refrigerant compressed by the compressor (100) dissipates heat to air in the radiator (3). The refrigerant having dissipated heat is decompressed by the decompression mechanism (4) and evaporates in the evaporator (5). The evaporated refrigerant is sucked into the compressor (100).

[0035] The refrigeration apparatus (1) is an air conditioner. The air conditioner may be a cooling apparatus, a heating apparatus, or an air conditioner switchable between cooling and heating. In this case, the air conditioner has a switching mechanism (e.g., four-way switching valve) that switches the direction of circulation of the refrigerant. The refrigeration apparatus (1) may be a water heater, a chiller unit, or a cooling apparatus that cools air in an internal space. The cooling apparatus cools air in a refrigerator, a freezer, or a container, for example.

(2) Compressor

[0036] As illustrated in FIG. 2, the compressor (100) of this embodiment is a hermetic compressor. The compressor (100) is a one-cylinder rotary compressor. The compressor (100) sucks a low-pressure gas refrigerant and compresses the sucked gas refrigerant. The compressor (100) discharges the compressed high-pressure gas refrigerant.

[0037] The compressor (100) includes a casing (10), an electric motor (20), a drive shaft (30), and a compression mechanism (40). The casing (10) houses the electric motor (20), the drive shaft (30), and the compression mechanism (40).

(2-1) Casing

[0038] The casing (10) is a hermetically-closed container standing upright and formed in a cylindrical shape. The casing (10) includes a barrel (11), an upper end plate (12), and a lower end plate (13). The barrel (11) has a cylindrical shape. The upper end plate (12) closes the upper end of the barrel (11). The lower end plate (13) closes the lower end of the barrel (11).

[0039] A suction pipe (14) is attached to a lower portion of the barrel (11). The suction pipe (14) passes through the barrel (11) of the casing (10), and is connected to the compression mechanism (40). A discharge pipe (15) is attached to the upper end plate (12). The discharge pipe (15) passes through the top of the casing (10), and is open to the inside of the casing (10).

[0040] A reservoir (16) for storing oil for lubricating sliding portions of the compression mechanism (40) etc. is formed in the bottom part of the casing (10).

[0041] A refrigerant space (S) through which a gas refrigerant discharged from the compression mechanism (40) flows is formed inside the casing (10). The refrigerant space (S) is formed above the reservoir (16) in the casing (10). In other words, the bottom surface facing the refrigerant space (S) is an oil surface of the reservoir (16).

(2-2) Electric Motor

[0042] The electric motor (20) is disposed at an upper portion in the casing (10). The electric motor (20) includes a stator (21) and a rotor (22). The stator (21) is fixed to the barrel (11) of the casing. The drive shaft (30) is inserted into the rotor (22).

(2-3) Drive Shaft

[0043] The drive shaft (30) extends in the axial direction (the top-bottom direction) of the casing (10) from an upper portion of the barrel (11) of the casing (10) to the bottom portion of the casing (10). The drive shaft (30) is rotated by the electric motor (20). The drive shaft (30) has a main shaft portion (31), a secondary shaft portion (32), and an eccentric portion (33). In the drive shaft (30), the main shaft portion (31), the eccentric portion (33), and the secondary shaft portion (32) are arranged in sequence from top to bottom. In the drive shaft (30), the main shaft portion (31), the eccentric portion (33), and the secondary shaft portion (32) are integrated with each other.

[0044] The main shaft portion (31) and the secondary shaft portion (32) each have a circular columnar shape. The main shaft portion (31) and the secondary shaft portion (32) are arranged coaxially with each other. The rotor (22) of the electric motor (20) is attached to an upper portion of the main shaft portion (31). A lower portion of the main shaft portion (31) is inserted into a front head (45) described later. The secondary shaft portion (32) is inserted into a rear head (46) described later. The drive shaft (30) is configured so that the main shaft portion (31) is rotatably supported by the front head (45) and the secondary shaft portion (32) is rotatably supported by the rear head (46).

[0045] The eccentric portion (33) has a circular columnar shape. The eccentric portion (33) has a larger diameter than those of the main shaft portion (31) and the secondary shaft portion (32). The center axis of the eccentric portion (33) is parallel with the center axis of rotation of the main shaft portion (31) and the secondary shaft portion (32). The center axis of the eccentric portion (33) is eccentric with respect to the main shaft portion (31) and the secondary shaft portion (32). The eccentric portion (33) is inserted into a piston (44). The eccentric portion (33) supports the piston (44).

[0046] A centrifugal pump (34) is provided at the lower end of the secondary shaft portion (32). The centrifugal pump (34) is immersed in the reservoir (16). An oil supply passage (not shown) is formed in the drive shaft (30). When the drive shaft (30) rotates, the oil in the reservoir (16) is supplied to a bearing of the drive shaft (30) and the sliding portions of the compression mechanism (40) through the oil supply passage.

(2-4) Compression Mechanism

[0047] The compression mechanism (40) is a so-called oscillating-piston rotary compression mechanism. The compression mechanism (40) is driven by the electric motor (20) through the drive shaft (30). The compression mechanism (40) is disposed between the electric motor (20) and the reservoir (16) in the casing (10). In other words, the compression mechanism (40) is disposed below the electric motor (20).

[0048] The compression mechanism (40) has one front head (45), one rear head (46), one cylinder (41), and one piston (44). In the compression mechanism (40), the front head (45), the cylinder (41), and the rear head (46) are arranged in sequence from top to bottom so as to overlap with each other. In other words, in the compression mechanism (40), a plurality of members is arranged so as to overlap with each other. The front head (45), the cylinder (41), and the rear head (46) are fastened to each other by a plurality of bolts (not shown). The compression mechanism (40) is fixed to the casing (10) by the cylinder (41) being fixed to the inner peripheral surface of the barrel (11) through a mounting plate (not shown).

(2-4-1) Cylinder and Piston

[0049] The cylinder (41) has a thick disk shape. The cylinder (41) is disposed concentrically with the barrel (11) of the casing (10). A cylinder bore (42) is formed in a center portion of the cylinder (41). The piston (44) is disposed in the cylinder bore (42). The piston (44) has a thick cylindrical shape. The eccentric portion (33) of the drive shaft (30) is inserted into the piston (44).

[0050] In the compression mechanism (40), a compression chamber (C) is formed between the wall surface of the cylinder bore (42) and the outer peripheral surface of the piston (44). The compression mechanism (40) is provided with a blade partitioning the compression chamber (C) into a high-pressure chamber and a low-pressure chamber.

[0051] The cylinder (41) has a suction port (43). The suction port (43) extends in the radially outward direction of the cylinder from the wall surface of the cylinder bore (42). The suction port (43) is a hole having a circular section. The suction port (43) communicates with the low-pressure chamber of the compression chamber (C). The suction port (43) opens on the outer surface of the cylinder (41). The suction pipe (14) is inserted into the suction port (43).

(2-4-2) Front Head and Rear Head

[0052] The front head (45) is a member that covers the opening surface of the upper end of the cylinder (41) (one end of the cylinder (41) in the axial direction). The front head (45) has a first end plate portion (45a) and a first boss portion (45b). The first end plate portion (45a) has a disk shape. The first end plate portion (45a) is disposed so as to face the electric motor (20) in the axial direction. The first boss portion (45b) has a cylindrical shape. The first boss portion (45b) extends upward (toward the electric motor (20)) from the first end plate portion (45a) along the outer peripheral surface of the drive shaft (30). A circular hole is formed in a center portion of the front head (45). In the hole of the front head (45), the main shaft portion (31) of the drive shaft (30) is disposed with a sliding bearing sandwiched between the front head (45) and the main shaft portion (31).

[0053] The rear head (46) is a member that covers the opening surface of the lower end of the cylinder (41) (the other end of the cylinder (41) in the axial direction). The rear head (46) has a second end plate portion (46a) and a second boss portion (46b). The second end plate portion (46a) has a disk shape. The second end plate portion (46a) is disposed so as to face the first end plate portion (45a) in the axial direction. The second boss portion (46b) has a cylindrical shape. The second boss portion (46b) extends downward from the second end plate portion (46a) along the outer peripheral surface of the drive shaft (30). A circular hole is formed in a center portion of the rear head (46). In the hole of the rear head (46), the secondary shaft portion (32) of the drive shaft (30) is disposed with a sliding bearing sandwiched between the rear head (46) and the secondary shaft portion (32).

[0054] In this embodiment, the front head (45) corresponds to a first closing member of the present disclosure, and the rear head (46) corresponds to a second closing member of the present disclosure.

[0055] A discharge passage (not shown) is formed in the first end plate portion (45a) of the front head (45). The discharge passage is a passage for discharging the refrigerant compressed in the compression chamber (C) of the cylinder (41) to a space present above the compression mechanism (40). The discharge passage communicates with the high-pressure chamber of the compression chamber (C). A cover member (47) is provided on an upper portion of the front head (45). The cover member (47) is provided to cover the upper surface of the first end plate portion (45a) and the outer peripheral surface of a lower portion of the first boss portion (45b). A muffler space for reducing pulsation of the refrigerant discharged through the discharge passage is formed inside the cover member (47).

(3) Muffler

[0056] As illustrated in FIGS. 2 and 3, the compression mechanism (40) has a resonance muffler (50). The resonance muffler (50) is provided to reduce noise produced by resonance in the casing (10). The resonance muffler (50) of this embodiment is a Helmholtz muffler (50). The muffler (50) of this embodiment has a cavity (51), a first communication passage (52), and a first opening (53).

[0057] The cavity (51) is a space formed in a vertically-long circular columnar shape. The cavity (51) extends in the direction in which the plurality of members constituting the compression mechanism (40) overlap with each other (the top-bottom direction). The cavity (51) is formed across the first end plate portion (45a) of the front head (45), the cylinder (41), and the second end plate portion (46a) of the rear head (46).

[0058] Specifically, the lower end surface of the first end plate portion (45a) of the front head (45) has a first recess (61) that is recessed upward. The upper end surface of the second end plate portion (46a) of the rear head (46) has a second recess (62) that is recessed downward. The cylinder (41) has a through hole (63) penetrating therethrough in the top-bottom direction (the axial direction). The first recess (61) of the front head (45), the through hole (63) of the cylinder (41), and the second recess (62) of the rear head (46) have the same diameter and are arranged coaxially.

[0059] Internal spaces of the first recess (61) of the front head (45), the through hole (63) of the cylinder (41), and the second recess (62) of the rear head (46) constitute the cavity (51). In other words, each internal space of the first recess (61) of the front head (45), the through hole (63) of the cylinder (41), and the second recess (62) of the rear head (46) constitutes part of the cavity (51). In this embodiment, the front head (45) and the rear head (46) correspond to a first member (E1) of the present disclosure, and the cylinder (41) corresponds to a second member (E2) of the present disclosure.

[0060] A resonance chamber (R) is formed in the cavity (51). In this embodiment, the cavity (51) as a whole constitutes the resonance chamber (R).

[0061] The first communication passage (52) communicates with the resonance chamber (R). In this embodiment, the first communication passage (52) communicates with the cavity (51). The first communication passage (52) has a circular section. The first communication passage (52) has a sectional area smaller than that of the cavity (51). The first communication passage (52) extends radially outward from the cavity (51) toward the outer peripheral surface of the compression mechanism (40). Specifically, the first communication passage (52) consists of a groove extending radially outward from the inner peripheral surface of the second recess (62) of the second end plate portion (46a) of the rear head (46) toward the outer peripheral surface of the second end plate portion (46a). This groove is formed on the upper end surface of the second end plate portion (46a). The first communication passage (52) is formed by the groove formed on the upper end surface of the second end plate portion (46a) and the lower end surface of the cylinder (41). The first communication passage (52) communicates with a lower part of the cavity (51).

[0062] The first opening (53) is formed at an end portion of the first communication passage (52) opposite to the cavity (51). The first opening (53) is formed on the outer peripheral surface of the rear head (46). In other words, the first opening (53) is formed on the outer peripheral surface of the compression mechanism (40). The first opening (53) is open to the inside of the casing (10). Specifically, the first opening (53) is open to the refrigerant space (S). The first opening (53) is open to a portion below the cylinder (41) in the casing (10). The first opening (53) faces radially outward.

[0063] The first communication passage (52) allows the cavity (51) to communicate with the refrigerant space (S). In other words, the first communication passage (52) allows the cavity (51) to communicate with a space below the cylinder (41) in the casing (10). The cavity (51) does not communicate with the discharge passage formed in the compression mechanism (40).

[0064] In the muffler (50) of this embodiment, the volume of the resonance chamber (R), the sectional area of the first communication passage (52) (the area of a section parallel with the drive shaft (30)), and the length of the first communication passage (52) (the length in the direction perpendicular to the drive shaft (30)) are set so that the resonance frequency (natural frequency) of the muffler (50) is equal to the frequency of resonance produced near the oil surface in the reservoir (16).

(4) Operation of Compressor

[0065] Next, operation of the compressor (100) will be described.

[0066] When electric power is supplied to the electric motor (20), the rotor (22) is rotated by a rotating magnetic field produced inside the stator (21). When the rotor (22) rotates, the drive shaft (30) rotates. When the drive shaft (30) rotates, the piston (44) of the compression mechanism (40) coupled to the drive shaft (30) oscillates in the compression chamber (C). Accordingly, the volumes of the low-pressure chamber and high-pressure chamber of the compression chamber (C) change periodically, and the compression chamber (C) performs a suction operation, a compression operation, and a discharge operation of refrigerant continuously.

[0067] The refrigerant sucked into the low-pressure chamber of the compression chamber (C) through the suction pipe (14) is compressed in the high-pressure chamber of the compression chamber (C), and then is discharged into the muffler space in the cover member (47) through the discharge passage. The refrigerant discharged into the muffler space is discharged into a space between the compression mechanism (40) and the electric motor (20) in the casing (10) through the through hole formed in the cover member (47). The refrigerant discharged from the cover member (47) passes through a space between the stator (21) and rotor (22) (a so-called air gap) of the electric motor (20), reaches a space above the electric motor (20), and is discharged to the outside of the casing (10) through the discharge pipe (15).

[0068] In the hermetically-closed compressor (100) of this embodiment, pressure considerably fluctuates near both axial end portions of the casing (10), and noise is likely to be produced by resonance. The oil surface in the reservoir (16) formed in the bottom portion of the casing (10) is usually positioned at a level that allows part or whole of the compression mechanism (40) to be immersed in the oil in order to lubricate the sliding portion and the like of the compression mechanism (40). Thus, noise is likely to be produced by resonance around the compression mechanism (40), that is, near the oil surface in the casing (10). In contrast, in this embodiment, the first opening (53) of the Helmholtz muffler (50) formed in the compression mechanism (40) is formed on the outer peripheral surface of the compression mechanism (40). Accordingly, noise produced by resonance near the oil surface can be efficiently reduced.

(5) Features

[0069] (5-1)

The first opening (53) of the muffler (50) of this embodiment is formed on the outer peripheral surface of the compression mechanism (40). Accordingly, vibration by resonance near the oil surface in the casing (10) can be reduced. As a result, noise produced by this vibration can be reduced.

[0070] (5-2)

The front head (45) of this embodiment has the first recess (61), and the rear head (46) has the second recess (62). The internal spaces of the first recess (61) and the second recess (62) constitute part of the cavity (51). Part of the cavity (51) is constituted by the internal spaces of the first recess (61) and the second recess (62), and thus the cavity (51) can be formed in the front head (45) and the rear head (46) by simple processing.

[0071] (5-3)

The cylinder (41) of this embodiment has the through hole (63) penetrating the cylinder (41) in the top-bottom direction. The internal space of the through hole (63) constitutes part of the cavity (51). Part of the cavity (51) is constituted by the through hole (63), and thus the cavity (51) can be formed in the cylinder by simple processing.

[0072] (5-4)

The cavity (51) of this embodiment is formed across the cylinder (41), the front head (45), and the rear head (46). Accordingly, the cavity (51) can be formed without additional members for the compression mechanism (40).

(6) Variations

[0073] The above embodiment may be modified to the following variations. Basically, differences from the above embodiment will be described below.

(6-1) First Variation

[0074] In the compressor (100) of this embodiment, the groove constituting the first communication passage (52) of the muffler (50) may be formed on the lower end surface of the first end plate portion (45a) of the front head (45), the upper end surface of the cylinder (41), or the lower end surface of the rear head (46).

(6-2) Second Variation

[0075] In the compressor (100) of this embodiment, the first communication passage (52) of the muffler (50) may communicate with a lower end portion of the cavity (51). Specifically, for example, as illustrated in FIG. 4, if the cavity (51) consists of the internal spaces of the first recess (61) of the front head (45) and the through hole (63) of the cylinder (41), the first communication passage (52) may be constituted by a groove formed on the lower end surface of the cylinder (41).

<<Second Embodiment>>

[0076] A second embodiment will be described. A compressor (100) of this embodiment has a first communication passage (52) and a first opening (53) different from those of the compressor (100) of the first embodiment. Here, the differences between the first communication passage (52) and the first opening (53) of this embodiment and the first communication passage (52) and the first opening (53) of the first embodiment will be described.

(1) First Communication Passage and First Opening

[0077] As illustrated in FIG. 5, the first communication passage (52) of this embodiment extends downward from the cavity (51) toward the lower surface of the compression mechanism (40). Specifically, the first communication passage (52) consists of a hole extending downward from the bottom surface of the second recess (62) in the second end plate portion (46a) of the rear head (46) toward the lower end surface of the second end plate portion (46a). The hole opens on the lower end surface of the second end plate portion (46a). The first communication passage (52) communicates with the lower surface of the cavity (51).

[0078] The first opening (53) is formed at an end portion of the first communication passage (52) opposite to the cavity (51). The first opening (53) is formed on the lower surface of the rear head (46). In other words, the first opening (53) is formed on the lower surface of the compression mechanism (40). The first opening (53) faces the oil surface in the reservoir (16).

(2) Features

[0079] The first opening (53) of the muffler (50) of this embodiment is formed on the lower surface of the compression mechanism (40). Accordingly, vibration by resonance near the oil surface in the casing (10) can be reduced. As a result, noise produced by this vibration can be reduced.

(3) Variations

[0080] The above embodiment may be modified to the following variations. Basically, differences from the above embodiment will be described below.

(3-1) First Variation

[0081] As illustrated in FIG. 6, in the compressor (100) of this embodiment, the resonance muffler (50) may be a side-branch muffler. Specifically, the muffler (50) of this embodiment may consist of the cavity (51) and the first opening (53). In other words, the muffler (50) of this variation does not have the first communication passage (52) unlike the above embodiment. The first opening (53) is open to the lower surface of the compression mechanism (40). The first opening (53) faces downward. The first opening (53) faces the oil surface in the reservoir (16).

[0082] If the first opening (53) facing downward is formed on a member other than the lowermost member among the members constituting the compression mechanism (40) as in this variation, the first opening (53) is formed on a portion where the member on which the first opening (53) is formed does not overlap a member disposed below the member on which the first opening (53) is formed.

(3-2) Second Variation

[0083] In the compressor (100) of this embodiment, the hole constituting the first communication passage (52) of the muffler (50) may be formed across a plurality of members constituting the compression mechanism (40). For example, if the cavity (51) is formed across the front head (45) and the cylinder (41), the first communication passage (52) may be formed across the cylinder (41) and the rear head (46). In this case, the first opening (53) is formed on the lower end surface of the rear head (46).

<<Third Embodiment>>

[0084] A third embodiment will be described. A compressor (100) of this embodiment has a muffler (50) different from that of the compressor (100) of the first embodiment. Here, the differences between the muffler (50) of this embodiment and the muffler (50) of the first embodiment will be described.

(1) Muffler

[0085] As illustrated in FIG. 7, the muffler (50) of this embodiment has the cavity (51), the first communication passage (52), the first opening (53), a second communication passage (54), and a second opening (55). In other words, the muffler (50) of this embodiment further has the second communication passage (54) and the second opening (55) unlike the muffler (50) of the first embodiment. Similarly to the first embodiment, the cavity (51) of this embodiment is formed across the first end plate portion (45a) of the front head (45), the cylinder (41), and the second end plate portion (46a) of the rear head (46). Specifically, internal spaces of the first recess (61) of the front head (45), the through hole (63) of the cylinder (41), and the second recess (62) of the rear head (46) constitute the cavity (51).

[0086] The first communication passage (52) consists of a groove extending radially outward from the inner peripheral surface of the first recess (61) of the first end plate portion (45a) of the front head (45) toward the outer peripheral surface of the first end plate portion (45a). This groove is formed on the lower end surface of the first end plate portion (45a). The first communication passage (52) is formed by the groove formed on the lower end surface of the first end plate portion (45a) and the upper end surface of the cylinder (41). The first communication passage (52) communicates with the upper part of the cavity (51).

[0087] The first opening (53) is formed on the outer peripheral surface of the front head (45). In other words, the first opening (53) is formed on the outer peripheral surface of the compression mechanism (40). The first opening (53) is open to the inside of the casing (10). Specifically, the first opening (53) is open to the refrigerant space (S). The first opening (53) is open to a portion above the cylinder (41) in the casing (10). The first opening (53) faces radially outward.

[0088] The first communication passage (52) allows the cavity (51) to communicate with the refrigerant space (S). In other words, the first communication passage (52) allows the cavity (51) to communicate with a space between the compression mechanism (40) and the electric motor (20) in the casing (10).

[0089] The second communication passage (54) communicates with the cavity (51). The second communication passage (54) is a passage through which the oil in the reservoir (16) flows in and out. The second communication passage (54) has a circular section. The second communication passage (54) has a sectional area smaller than that of the cavity (51). The second communication passage (54) extends radially outward from the cavity (51) toward the outer peripheral surface of the compression mechanism (40). Specifically, the second communication passage (54) consists of a groove extending radially outward from the inner peripheral surface of the second recess (62) of the second end plate portion (46a) of the rear head (46) toward the outer peripheral surface of the second end plate portion (46a). The groove is formed on the upper end surface of the second end plate portion (46a). The first communication passage (54) is formed by the groove formed on the upper end surface of the second end plate portion (46a) and the lower end surface of the cylinder (41). The second communication passage (54) communicates with the lower part of the cavity (51).

[0090] The second opening (55) is formed at an end portion of the second communication passage (54) opposite to the cavity (51). The second opening (55) is formed on the outer peripheral surface of the rear head (46). In other words, the second opening (55) is formed on the outer peripheral surface of the compression mechanism (40). The second opening (55) faces radially outward.

[0091] The second communication passage (54) allows the cavity (51) to communicate with a space below the cylinder (41) in the casing (10). The second opening (55) is formed below the first opening (53).

[0092] Here, the level of oil stored in the reservoir (16) of the casing (10) changes according to the operation state of the compressor (100). As illustrated in FIG. 7, if the oil level A in the reservoir (16) is above the second opening (55), the oil in the reservoir (16) flows into the cavity (51) through the second opening (55). The oil having flowed into the cavity (51) flows to the same level as that of oil in the reservoir (16). In this case, the bottom surface of the resonance chamber (R) in the cavity (51) consists of the oil surface. Accordingly, the Helmholtz muffler (50) of this embodiment serves a silencing function using the first communication passage (52) and the resonance chamber (R) that has the bottom surface consisting of the oil surface.

[0093] When the oil level A in the reservoir (16) rises, the oil further flows into the cavity (51) through the second opening (55), and the volume of the resonance chamber (R) of the muffler (50) decreases. When the volume of the resonance chamber (R) decreases, the resonance frequency of the muffler (50) increases. In contrast, when the oil level in the reservoir (16) lowers, the oil flows out of the cavity (51) through the second opening (55), and the volume of the resonance chamber (R) increases. When the volume of the resonance chamber (R) increases, the resonance frequency of the muffler (50) decreases. In this manner, the muffler (50) has the second opening (55), and thus the resonance frequency of the muffler (50) changes as the oil level in the reservoir (16) changes. If the oil level in the reservoir (16) is below the second opening (55), the muffler (50) does not serve a silencing function.

[0094] In the hermetically-closed compressor (100), the resonance frequency in the casing (10) changes as the oil level in the reservoir (16) changes. Specifically, for example, if the oil level is low, such as if the oil level is below the compression mechanism (40), resonance with a low frequency (about 830 Hz) is generated in the casing (10). In contrast, for example, if the oil level is high, such as if the oil level is at a substantially middle part of the cylinder (41) of the compression mechanism (40), resonance with a high frequency (about 1.3 kHz to 1.4 kHz) is generated in the casing (10).

[0095] In this embodiment, the compression mechanism (40) of the hermetically-closed compressor (100) includes the muffler (50) having the second opening (55). Accordingly, if the oil level in the reservoir (16) is low, resonance with a low frequency in the casing (10) can be reduced by the muffler (50) having the resonance chamber (R) that has a larger volume due to fluctuation in the oil level. In contrast, if the oil level in the reservoir (16) is high, resonance with a high frequency in the casing (10) can be reduced by the muffler (50) having the resonance chamber (R) that has a smaller volume due to fluctuation in the oil level.

[0096] Here, as described above, the level of oil stored in the reservoir (16) of the casing (10) changes according to the operation state of the compressor (100). The first opening (53) of this embodiment is formed below an initial supply position (A1) illustrated in FIG. 7, which is a position of the oil surface in the reservoir (16) reached at the time of shipment of the compressor

[0097] (100). This initial supply position (A1) is a position of the oil surface reached by the amount of oil initially supplied to the casing (10) at the time of shipment of the compressor (100). When the oil surface in the reservoir (16) is at the initial supply position (A1), the oil flows into the cavity (51) also through the first opening (53), and the cavity (51) is filled with the oil. At this time, the muffler (50) does not serve a silencing function.

[0098] When the position of the oil surface in the reservoir (16) lowers to a position below the first opening (53) as the compressor (100) operates, the first opening (53) communicates with the refrigerant space (S). By the first opening (53) communicating with the refrigerant space (S), the cavity (51) of the muffler (50) communicates with the refrigerant space (S) and the muffler (50) serves a silencing function. Accordingly, noise with a low frequency that is produced as the oil level in the reservoir (16) lowers can be reduced.

(2) Features

[0099] (2-1)
The muffler (50) of this embodiment has the second opening (55) which communicates with the cavity (51) and through which the oil flows in and out. The second opening (55) is formed below the first opening (53).

[0100] When the oil level in the reservoir (16) rises and the oil flows into the cavity (51) through the second opening (55), the bottom surface of the resonance chamber (R) is constituted by the oil surface. The second opening (55) is formed below the first opening (53), and thus the Helmholtz muffler (50) serves a silencing function using the first communication passage (52) and the resonance chamber (R).

[0101] When the oil level in the reservoir (16) rises, the oil flows into the cavity (51) through the second opening (55), and the volume of the resonance chamber (R) decreases. When the volume of the resonance chamber (R) decreases, the resonance frequency of the muffler (50) increases. In contrast, when the oil level in the reservoir (16) lowers, the oil flows out of the cavity (51) through the second opening (55), and the volume of the resonance chamber (R) increases. When the volume of the resonance chamber (R) increases, the resonance frequency of the muffler (50) decreases. In this manner, since the muffler (50) has the second opening (55), the oil flows in and out through the second opening (55), and the resonance frequency of the muffler (50) changes. Accordingly, noise with a wide range of resonance frequency can be reduced by the single muffler (50).

[0102] (2-2)
The first opening (53) of this embodiment is formed below the initial supply position (A1) which is a position of the oil surface in the reservoir (16) reached at the time of shipment, and communicates with the refrigerant space (S) when the oil level in the reservoir (16) lowers.

[0103] Since the first opening (53) is formed below the initial supply position (A1) which is a position of the oil surface reached at the time of shipment, the oil flows into the cavity (51) of the muffler (50) through the first opening (53) when the oil surface is at the initial supply position (A1). Then, when the position of the oil surface in the reservoir (16) lowers as the compressor operates, the first opening (53) communicates with the refrigerant space (S), whereby the cavity (51) of the muffler (50) communicates with the refrigerant space (S) and the muffler (50) serves a silencing function. Accordingly, noise with a low frequency that is produced as the oil level in the reservoir (16) lowers can be reduced.

[0104] (2-3)
The muffler (50) of this embodiment has the second communication passage (54) communicating with the cavity (51). The second opening (55) is formed at the end portion of the second communication passage (54).

[0105] Since the second opening (55) is formed at the end portion of the second communication passage (54), the position of the second opening can be adjusted by the position of the second communication passage (54). Accordingly, the level at which the oil flows in and out can be adjusted, and thus the volume of the resonance chamber (R) can be adjusted.

(3) Variations

(3-1) First Variation

[0106] In the compressor (100) of this embodiment, the second opening (55) only has to be formed below the first opening (53). Thus, the grooves constituting the first communication passage (52) and the second communication passage (54) may be formed on any of the lower end surface of the first end plate portion (45a) of the front head (45), the upper end surface of the cylinder (41), the lower end surface of the rear head (46), and the upper end surface of the second end plate portion (46a) of the rear head (46).

(3-2) Second Variation

[0107] As illustrated in FIG. 8, in the compressor (100) of this embodiment, the second opening (55) may be formed on the lower end surface of the rear head (46). In other words, in this variation, the muffler (50) does not have the second communication passage (54).

[0108] Here, the cavity (51) is formed across the front head (45), the cylinder (41), and the rear head (46). The rear head (46) is the lowermost one of the plurality of members constituting the compression mechanism (40). In this embodiment, the rear head (46) corresponds to a third member of the present disclosure.

[0109] The rear head (46) of this variation has a through hole (63) penetrating therethrough in the top-bottom direction (the axial direction). Internal spaces of the first recess (61) of the front head (45), the through hole (63) of the cylinder (41), and the through hole (63) of the rear head (46) constitute the cavity (51).

[0110] The second opening (55) is formed on the lower end surface of the rear head (46). In other words, the second opening (55) is formed on the lower surface of the compression mechanism (40). The second opening (55) is open toward the reservoir (16). The second opening (55) faces downward. The second opening (55) is formed below the first opening (53).

[0111] As illustrated in FIG. 8, if the oil level A in the reservoir (16) is above the second opening (55), the oil in the reservoir (16) flows into the cavity (51) through the second opening (55). The oil having flowed into the cavity (51) flows to the same level as that of oil in the reservoir (16). In this case, the bottom surface of the resonance chamber (R) in the cavity (51) consists of the oil surface. In this manner, the Helmholtz muffler (50) of this variation also serves a silencing function using the first communication passage (52) and the resonance chamber (R) that has the bottom surface consisting of the oil surface.

[0112] Since the second opening (55) is formed on the lower end surface of the rear head (46) which is the lowermost one of the plurality of members constituting the compression mechanism (40), the second opening (55) is also formed when the cavity (51) is formed in the compression mechanism (40). Accordingly, the second opening (55) can be formed easily.

<<Fourth Embodiment>>

[0113] A fourth embodiment will be described below. A compressor (100) of this embodiment has a muffler (50) different from that of the compressor (100) of the first embodiment. Here, the differences between the muffler (50) of this embodiment and the muffler (50) of the first embodiment will be described.

[0114] The muffler (50) of this embodiment includes a plurality of mufflers (50). In other words, the compression mechanism (40) of this embodiment includes the plurality of mufflers (50). The plurality of mufflers (50) are spaced at predetermined intervals in the circumferential direction so as to surround the drive shaft (30). In this embodiment, the compression mechanism (40) has two mufflers (50). The first muffler (50a) and the second muffler (50b) are disposed apart from each other by approximately 180°. The number of mufflers (50) described herein is merely one example.

[0115] As illustrated in FIGS. 9 and 10, each of the first muffler (50a) and the second muffler (50b) has the cavity (51), the first communication passage (52), and the first opening (53). The configurations of the cavity (51), the first communication passage (52), and the first opening (53) of the first muffler (50a) are the same as those of the muffler (50) of the first embodiment.

[0116] The cavity (51) of the second muffler (50b) is constituted by the internal spaces of the first recess (61) formed in the front head (45) and the second recess (62) formed in the cylinder (41). In this embodiment, the front head (45) and the cylinder (41) correspond to the first member of the present disclosure. The first recess (61) of the front head (45) and the second recess (62) of the cylinder (41) have the same diameter and are arranged coaxially. The first communication passage (52) of the second muffler (50b) is formed by the groove formed on the lower end surface of the first end plate portion (45a) of the front head (45) and the upper end surface of the cylinder (41). The first opening (53) of the second muffler (50b) is formed on the outer peripheral surface of the front head (45).

[0117] The first opening (53) of the first muffler (50a) is positioned below the first opening (53) of the second muffler (50b). The volume of the cavity (51) of the first muffler (50a) is larger than the volume of the cavity (51) of the second muffler (50b). In other words, the volume of the resonance chamber (R) of the first muffler (50a) is larger than the volume of the resonance chamber (R) of the second muffler (50b). Thus, the resonance frequency of the first muffler (50a) is lower than the resonance frequency of the second muffler (50b).

[0118] If as illustrated in FIG. 9, the oil level A in the reservoir (16) is below the first opening (53) of the first muffler (50a) (or if the oil level A in the reservoir (16) is low), resonance with a low frequency is generated in the casing (10). However, the first muffler (50a), whose resonance frequency is low, can muffle resonance with a low frequency generated in the casing (10). Accordingly, if the oil level in the reservoir (16) is low, noise produced by resonance in the casing (10) can be reduced by the first muffler (50a).

[0119] If as illustrated in FIG. 10, the oil level A in the reservoir (16) is above the first opening (53) of the first muffler (50a) and below the first opening (53) of the second muffler (50b) (or if the oil level A in the reservoir (16) is high), resonance with a high frequency is generated in the casing (10). In this case, the first muffler (50a) does not serve a silencing function because the oil flows into the cavity (51) through the first opening (53). On the other hand, since the first opening (53) of the second muffler (50b) is above the oil level A, the oil does not flow into the cavity (51), and the second muffler (50b) serves a silencing function. Specifically, the second muffler (50b), whose resonance frequency is high, can muffle resonance a high frequency generated in the casing (10). Accordingly, if the oil level in the reservoir (16) is high, noise produced by resonance in the casing (10) can be reduced by the second muffler (50b).

[0120] In this manner, the plurality of mufflers (50) provided in the compression mechanism (40) can cope with resonance frequency changing in the casing (10) as the oil level in the reservoir (16) changes. Accordingly, noise with a wide range of frequency that is produced in the casing (10) as the oil level changes can be reduced. The first muffler (50a) and the second muffler (50b) may have any of the structures of the first to third embodiments.

<<Other embodiments>>

[0121] The above embodiments may be modified as follows.

[0122] In the compressor (100) of each embodiment, the cavity (51) of the muffler (50) is formed across the plurality of members constituting the compression mechanism (40), but may be formed in one single member.

[0123] In the compressor (100) of each embodiment, if the cavity (51) of the muffler (50) is formed across the plurality of members constituting the compression mechanism (40), the cavity (51) may be formed across any of the plurality of members constituting the compression mechanism (40). For example, the cavity (51) may be formed across the cylinder (41) and the rear head (46).

[0124] In the compressor (100) of each embodiment, the cavity (51) of the muffler (50) may be constituted only by the internal spaces of the recesses (61, 62) formed in any of the members constituting the compression mechanism (40). Specifically, for example, as illustrated in FIG. 9, the cavity (51) of the second muffler (50b) may be constituted by the first recess (61) recessed upward that is formed on the lower end surface of the first end plate portion (45a) of the front head (45) and the second recess (62) recessed downward that is formed on the upper end surface of the cylinder (41).

[0125] In the compressor (100) of each embodiment, the cavity (51) of the muffler (50) may be constituted only by the internal space of the through hole (63) formed in any of the members constituting the compression mechanism (40). Specifically, for example, as illustrated in FIG. 11, the cavity (51) may be formed by the through hole (63) penetrating the front head (45) in the top-bottom direction. If the through hole (63) constituting the cavity (51) is formed in the front head as illustrated in FIG. 11, the upper opening of the through hole (63) is closed by the cover member (47).

[0126] In the compressor (100) of each embodiment, the compression mechanism (40) may further include a cavity formation member constituting the cavity (51) of the muffler (50). In other words, the cavity (51) may be formed by a member other than the front head (45), the cylinder (41), and the rear head (46). The cavity formation member is, for example, a plate-shaped member and is disposed so as to cover part of the side surface of the front head (45). The cavity (51) is formed inside the cavity formation member. A through hole is formed on the side surface of the cavity formation member and constitutes the first opening (53).

[0127] The muffler (50) of each embodiment is applied to a one-cylinder rotary compressor but may be applied to a two-cylinder rotary compressor.

[0128] The muffler (50) of each embodiment may be applied to a compressor other than a rotary compressor.

[0129] While the embodiment and variations thereof have been described above, it will be understood that various changes in form and details may be made without departing from the spirit and scope of the claims. The embodiments, the variations, and the other embodiments may be combined and replaced with each other without deteriorating intended functions of the present disclosure.

[0130] The ordinal numbers such as "first," "second," "third," ... , described above are used to distinguish the terms to which these expressions are given, and do not limit the number and order of the terms.

INDUSTRIAL APPLICABILITY

[0131] As described above, the present disclosure is useful for a compressor and a refrigeration apparatus.

DESCRIPTION OF REFERENCE CHARACTERS

[0132]

1	Refrigeration Apparatus
10	Casing
16	Reservoir
20	Electric Motor
40	Compression Mechanism
41	Cylinder
45	Front Head (First Closing Member)
46	Rear Head (Second Closing Member)
50	Muffler
50a	First Muffler
50b	Second Muffler
51	Cavity
52	First Communication Passage
53	First Opening
54	Second Communication Passage
55	Second Opening
61, 62	Recess
63	Through Hole
100	Compressor
E1	First Member
E2	Second Member
E3	Third Member
R	Resonance Chamber
S	Refrigerant Space
A1	Initial Supply Position

Claims

1. A compressor comprising:

a casing (10) having a bottom portion in which a

reservoir (16) configured to store oil is provided;
an electric motor (20) housed in the casing (10);
a compression mechanism (40) disposed between the electric motor (20) and the reservoir (16) and configured to compress sucked gas refrigerant and discharge the compressed gas refrigerant into the casing (10); and
a resonance muffler (50) provided in the compression mechanism (40),
wherein
in the casing (10), a refrigerant space (S) through which the gas refrigerant discharged from the compression mechanism (40) flows is formed above the reservoir (16),
the muffler (50) includes

a cavity (51) in which a resonance chamber (R) is formed, and
a first opening (53) communicating with the resonance chamber (R) and opening to the refrigerant space (S), and

the first opening (53) is formed on a lower surface or an outer peripheral surface of the compression mechanism (40).

2. The compressor of claim 1, wherein

the muffler (50) further includes a first communication passage (52) communicating with the resonance chamber (R), and
the first opening (53) is formed at an end portion of the first communication passage (52).

3. The compressor of claim 1 or 2, wherein

the compression mechanism (40) includes a plurality of members arranged so as to overlap with each other,
the plurality of members includes a first member (E1),
the first member (E1) includes a recess (61, 62) formed at an end surface of the first member (E1) in a direction in which the plurality of members overlap with each other, and
an internal space of the recess (61, 62) constitutes part of the cavity (51).

4. The compressor of any one of claims 1 to 3, wherein

the compression mechanism (40) includes a plurality of members arranged so as to overlap with each other,
the plurality of members includes a second member (E2),
the second member (E2) includes a through hole (63) penetrating the second member (E2) in a direction in which the plurality of members overlap with each other, and
an internal space of the through hole (63) constitutes part of the cavity (51).

5. The compressor of any one of claims 1 to 4, wherein

the compression mechanism (40) includes

a cylinder (41),
a first closing member (45) configured to cover an opening surface of one end of the cylinder (41) in an axial direction, and
a second closing member (46) configured to cover an opening surface on another end of the cylinder (41) in the axial direction, and

the cavity (51) is formed by at least one of the cylinder (41), the first closing member (45), or the second closing member (46).

6. The compressor of any one of claims 1 to 5, wherein

the muffler (50) further includes a second opening (55) which communicates with the cavity (51) and through which the oil flows in and out, and
the second opening (55) is formed below the first opening (53).

7. The compressor of claim 6, wherein
the first opening (53) is formed below an initial supply position (A1) which is a position of an oil surface in the reservoir (16) reached at a time of shipment, and communicates with the refrigerant space (S) when an oil level in the reservoir (16) lowers.

8. The compressor of claim 6, wherein

the muffler (50) further includes a second communication passage (54) communicating with the cavity (51), and
the second opening (55) is formed at an end portion of the second communication passage (54).

9. The compressor of claim 6, wherein

the compression mechanism (40) has a plurality of members overlapping with each other,
the plurality of members includes a third member (E3) which is a lowermost one of the plurality of members,
the cavity (51) is formed in the third member (E3), and
the second opening (55) is formed on a lower surface of the third member (E3).

10. The compressor of any one of claims 1 to 9, wherein

the muffler (50) includes a first muffler (50a) and a second muffler (50b),
the first opening (53) of the first muffler (50a) is formed below the first opening (53) of the second muffler (50b), and
a resonance frequency of the first muffler (50a) is lower than a resonance frequency of the second muffler (50b).

11. A refrigeration apparatus comprising: the compressor (100) of any one of claims 1 to 10.

FIG.1

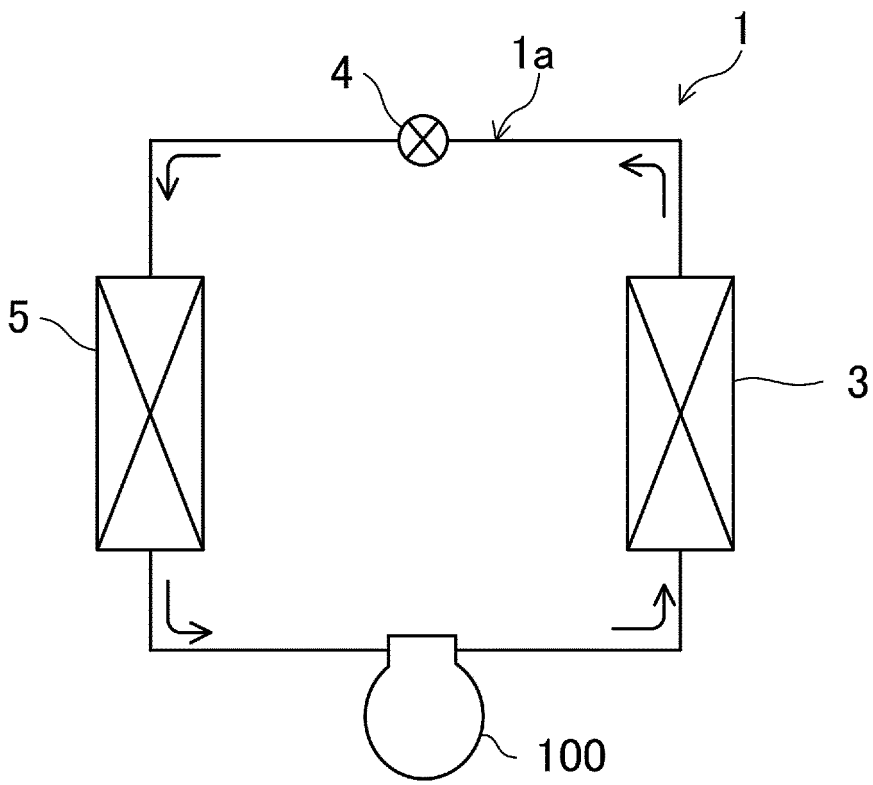


FIG.2

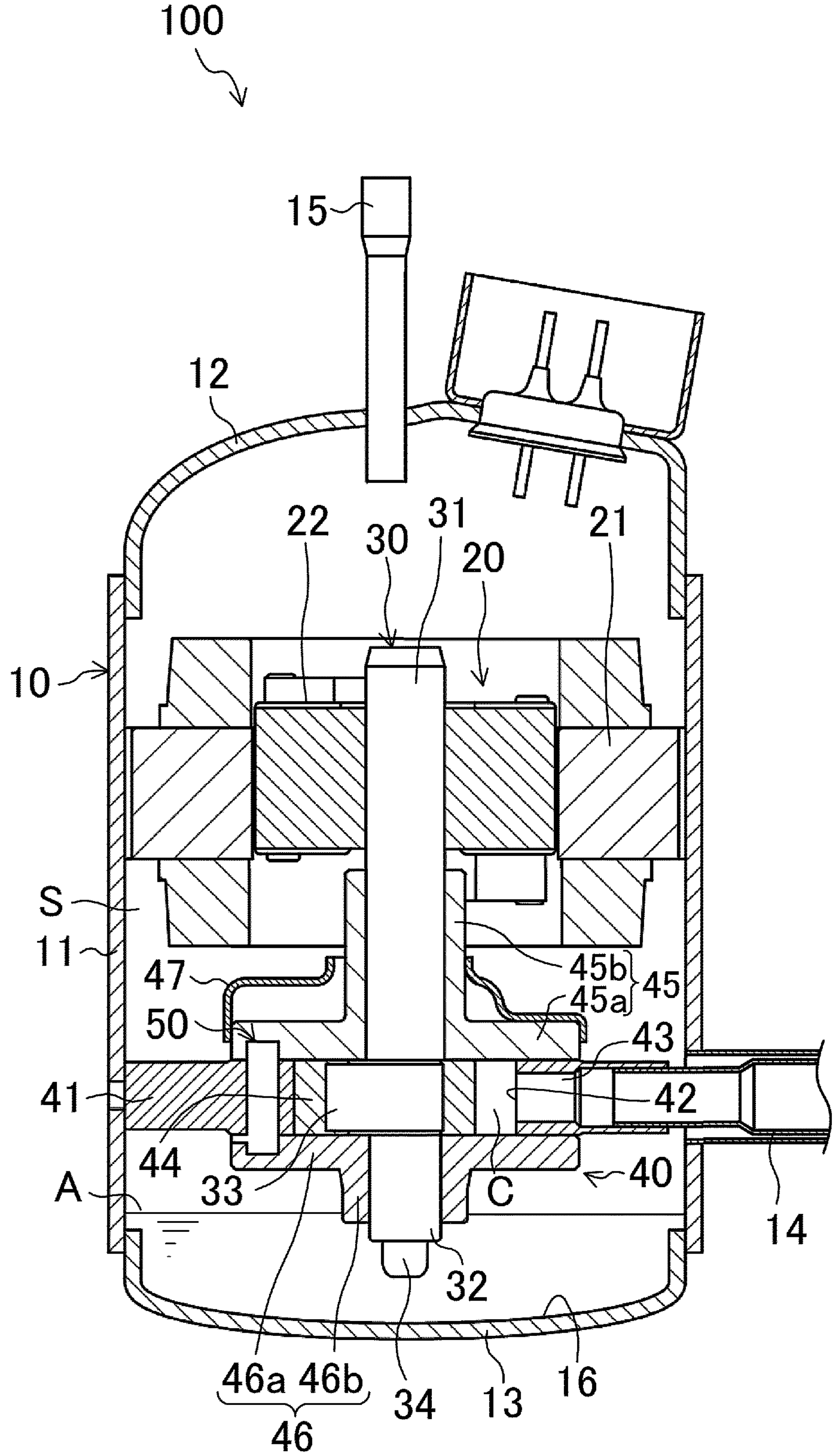

100
15
12
22
30
31
20
21
10
S
11
47
50
45b
45
45a
43
41
42
44
33
40
A
C
14
32
46a
46b
46
34
13
16

FIG.3

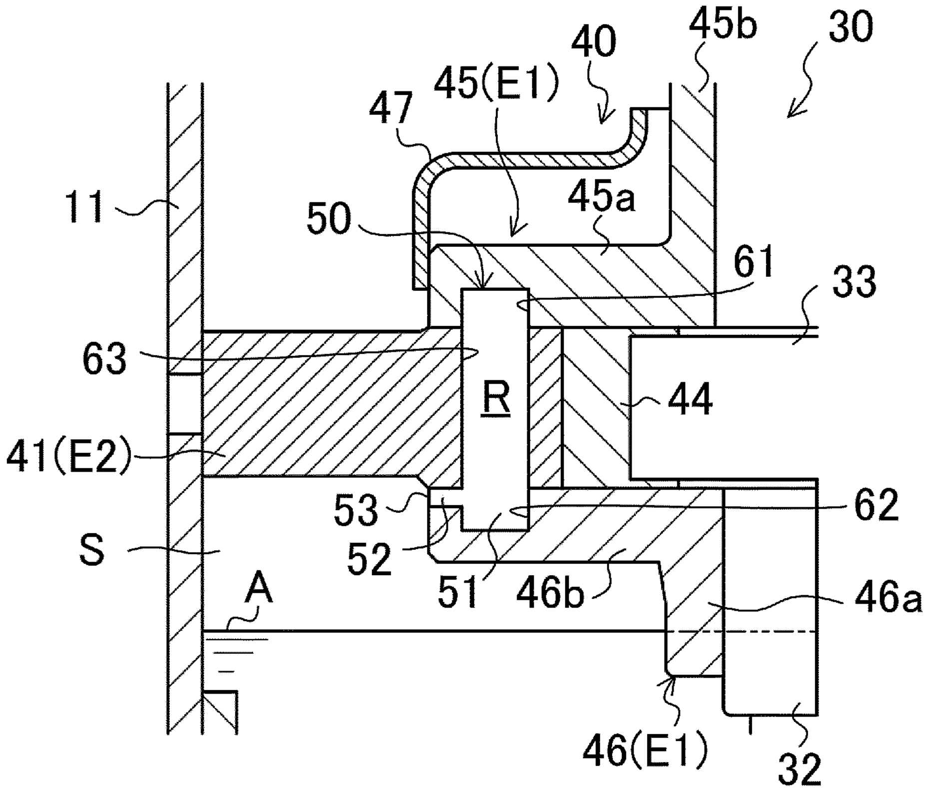

30
40
45b
45(E1)
47
45a
11
50
61
33
63
R
44
41(E2)
53
62
S
52
51
46b
46a
A
46(E1)
32

FIG.4

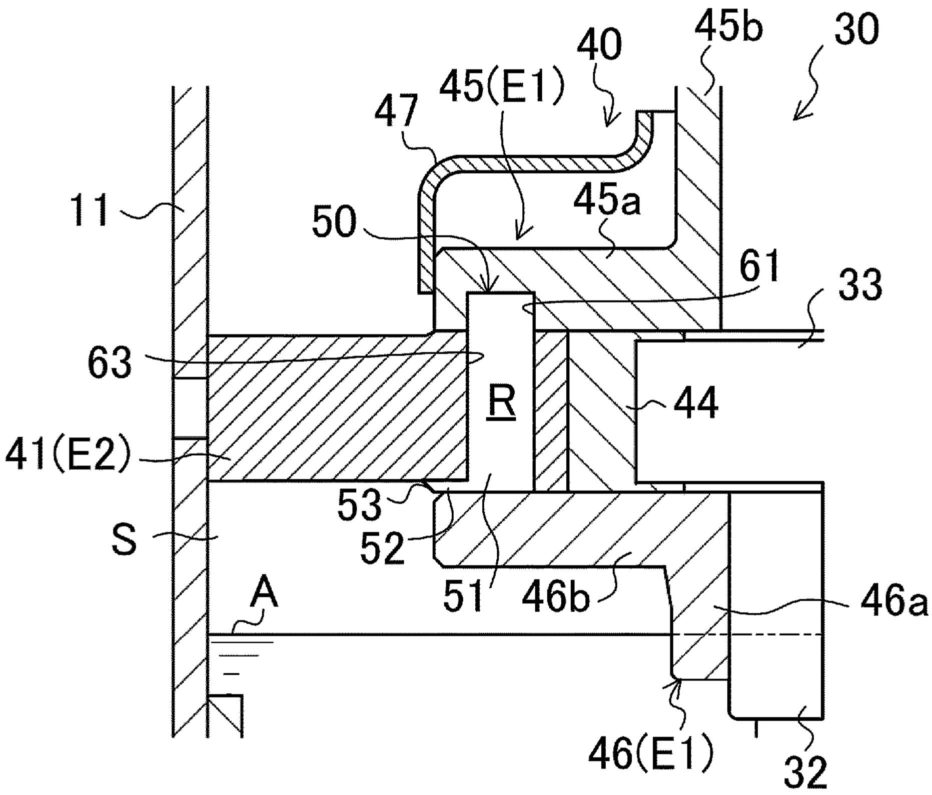
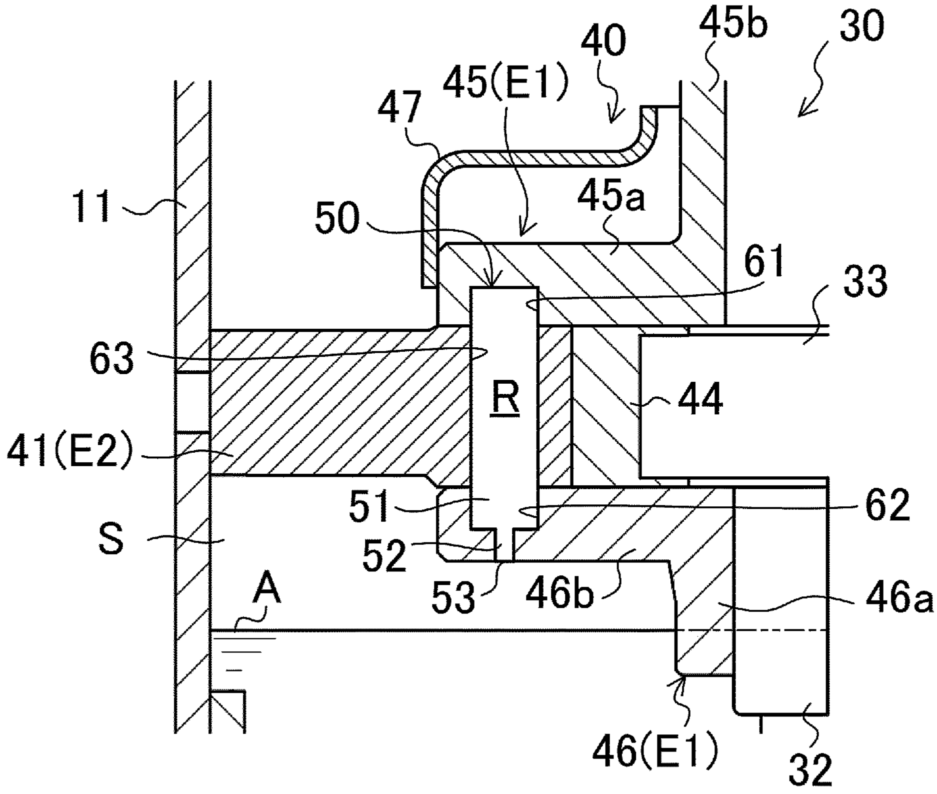
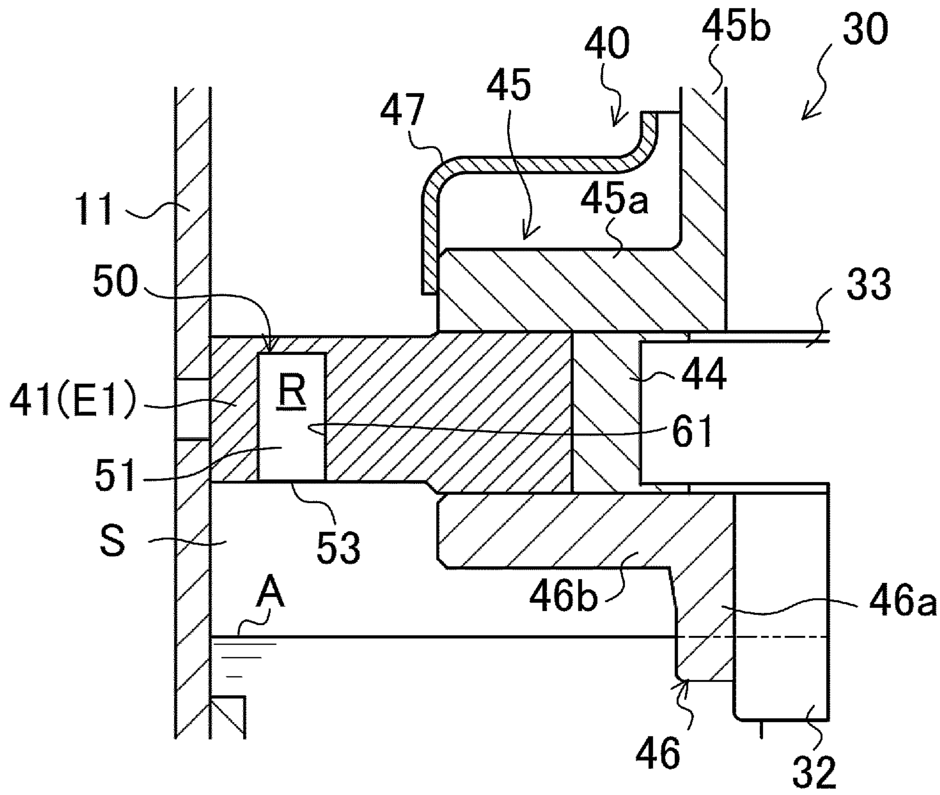

30
40
45b
45(E1)
47
45a
11
50
61
33
63
R
44
41(E2)
53
S
52
51
46b
46a
A
46(E1)
32

FIG.5



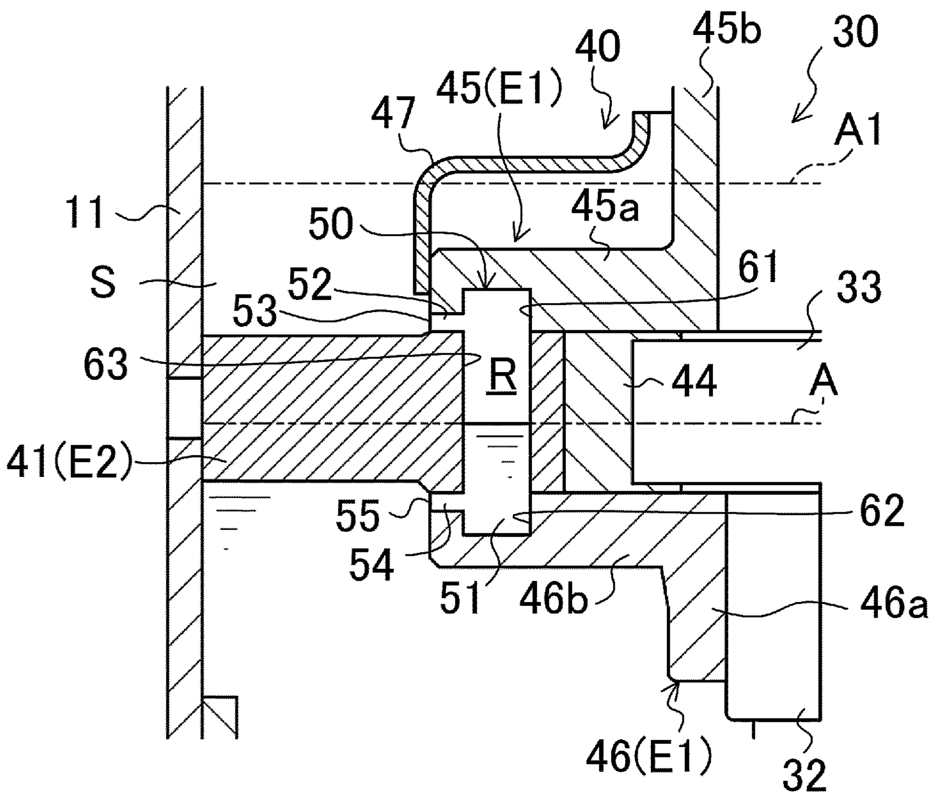
40
45b
30
47
45(E1)
11
45a
50
61
33
63
R
44
41(E2)
51
62
S
52
53
46b
46a
A
46(E1)
32

FIG.6



40
45b
30
47
45
11
45a
33
50
R
44
41(E1)
61
51
S
53
46b
46a
A
46
32

FIG.7


40
45b
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47
45(E1)
A1
11
45a
50
S
52
61
33
53
63
R
44
A
41(E2)
55
62
54
51
46b
46a
46(E1)
32

FIG.8

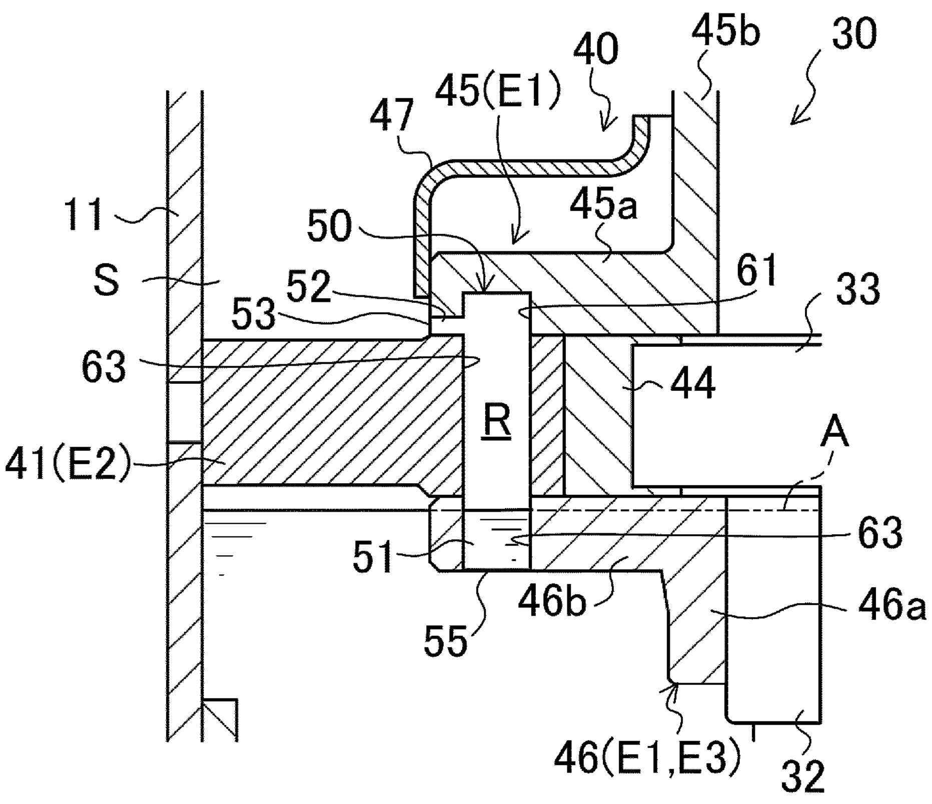

40
45b
30
47
45(E1)
11
45a
50
S
52
61
33
53
63
44
R
A
41(E2)
63
51
46b
46a
55
46(E1,E3)
32

FIG.9

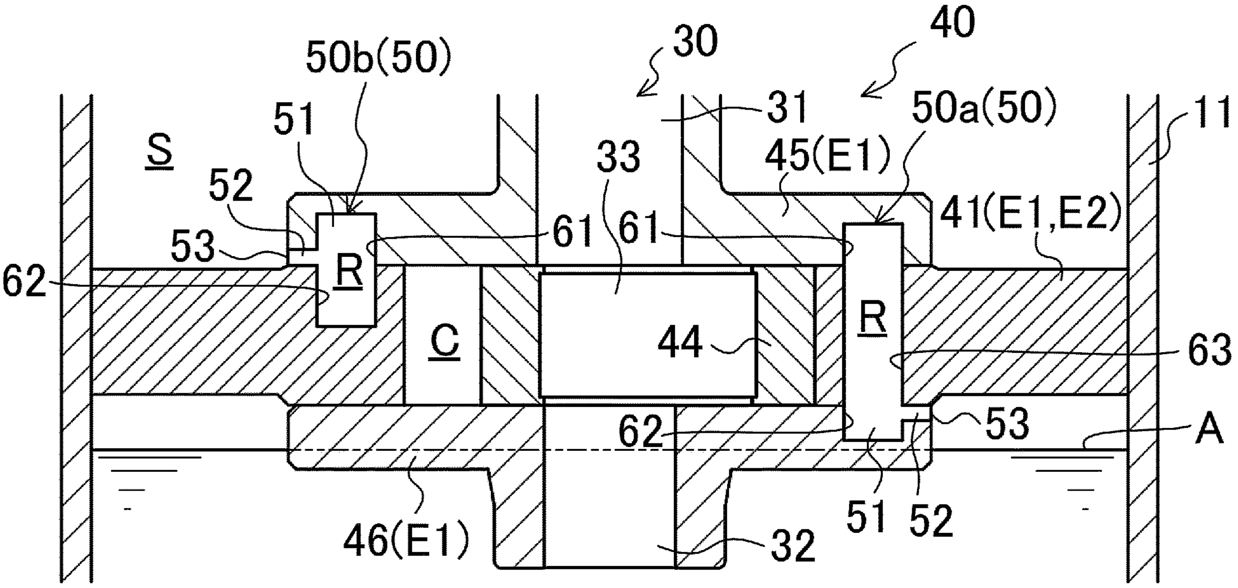
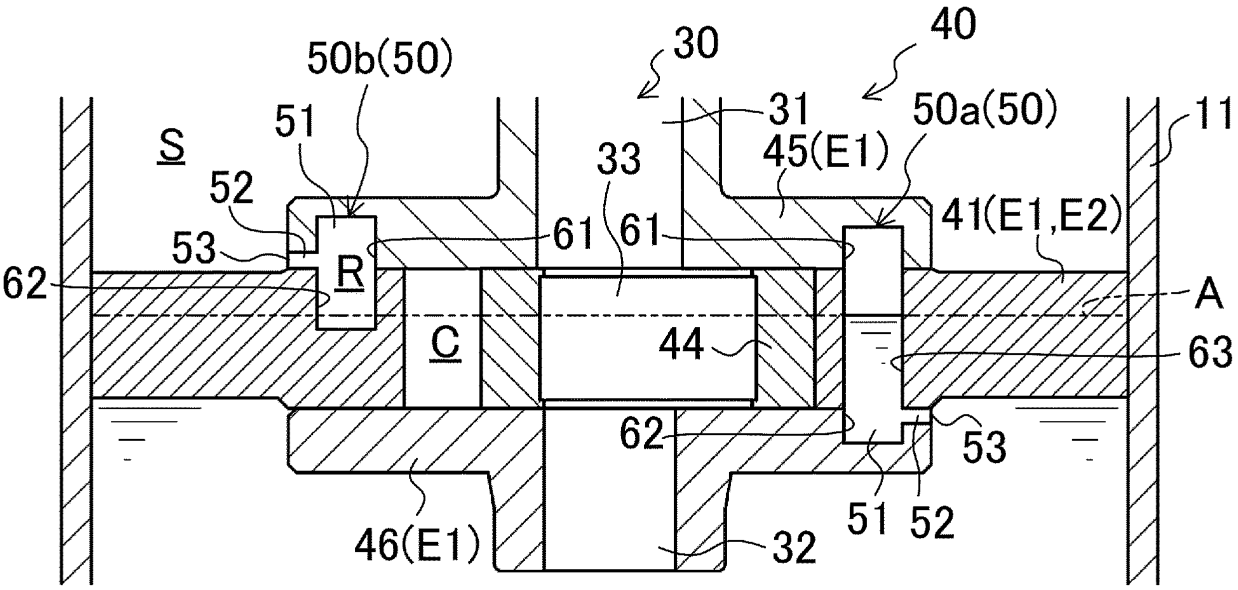

50b(50)
30
40
31
50a(50)
11
S
51
33
45(E1)
52
41(E1,E2)
61
61
53
R
62
R
C
44
63
62
53
A
46(E1)
51
52
32

FIG.10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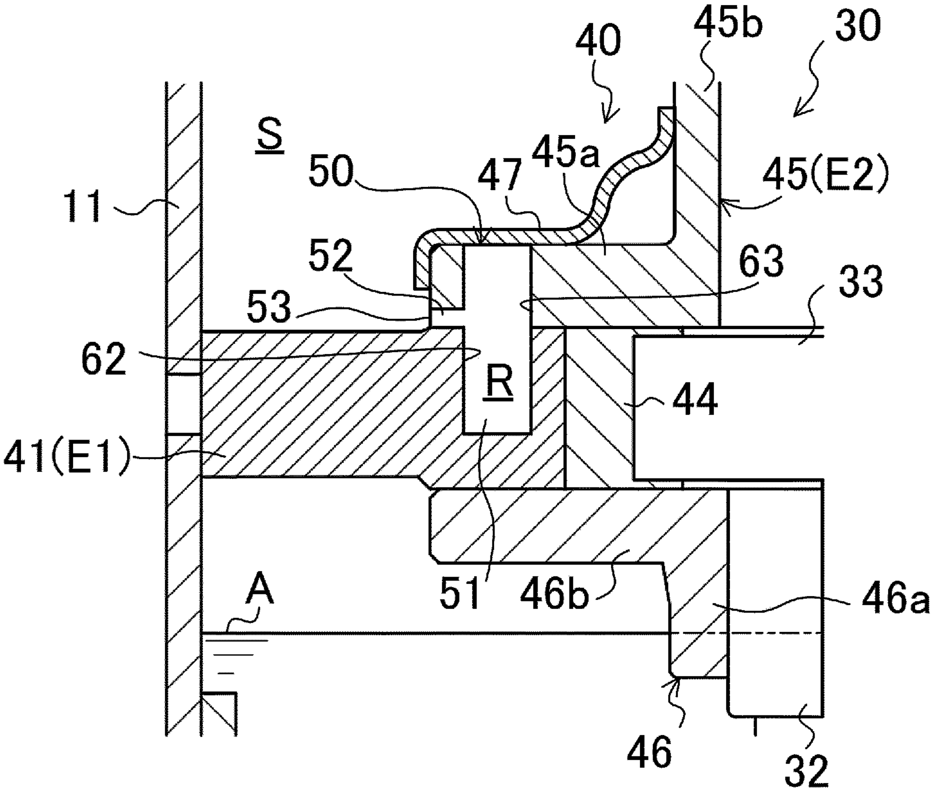
40
31
50a(50)
11
S
51
33
45(E1)
52
41(E1,E2)
61
61
53
R
62
A
C
44
63
62
53
46(E1)
51
52
32

FIG.11


40
45b
30
S
50
47
45a
45(E2)
11
52
63
33
53
62
R
44
41(E1)
A
51
46b
46a
46
32

INTERNATIONAL SEARCH REPORT

International application No. **PCT/JP2023/010007**

A. CLASSIFICATION OF SUBJECT MATTER

F04C 29/06(2006.01)i; ***F04B 39/00***(2006.01)i
FI: F04B39/00 101J; F04C29/06 D

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)

F04C29/06; F04B39/00

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 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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	JP 09-203386 A (HITACHI, LTD.) 05 August 1997 (1997-08-05) paragraphs [0001], [0039]-[0050], fig. 4, 5	1-2, 4-5, 11
Y		3
A		6-10
X	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 076554/1986 (Laid-open No. 188587/1987) (TOSHIBA CORP.) 01 December 1987 (1987-12-01) specification, page 5, line 12 to page 7, line 19, fig. 1, 2	1-2, 4-5
Y		3
A		6-11
Y	JP 2021-127687 A (DAIKIN IND., LTD.) 02 September 2021 (2021-09-02) paragraph [0052], fig. 2	3
A	JP 2010-144526 A (DAIKIN IND., LTD.) 01 July 2010 (2010-07-01) paragraphs [0061]-[0064], fig. 7, 8	1

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

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Date of the actual completion of the international search	Date of mailing of the international search report
07 April 2023	**18 April 2023**

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

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/010007

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 09-203386 A	05 August 1997	(Family: none)	
JP 62-188587 U1	01 December 1987	(Family: none)	
JP 2021-127687 A	02 September 2021	US 2022/0372983 A1 paragraph [0045], fig. 2 WO 2021/162039 A1 EP 4074970 A1 CN 115038874 A	
JP 2010-144526 A	01 July 2010	(Family: none)	

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2014118862 A **[0004]**