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

(11) EP 4 461 962 A1

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

(43) Date of publication:
13.11.2024 Bulletin 2024/46

(21) Application number: **24732156.5**

(22) Date of filing: **05.03.2024**

(51) International Patent Classification (IPC):
F04C 29/12 *(2006.01)* ***F04C 2/344*** *(2006.01)*

(86) International application number:
PCT/JP2024/008357

(87) International publication number:
WO 2024/203041 (03.10.2024 Gazette 2024/40)

(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:
GE KH MA MD TN

(30) Priority: **29.03.2023 JP 2023053770**

(71) Applicant: **DAIKIN INDUSTRIES, LTD.**
Osaka-shi, Osaka 530-0001 (JP)

(72) Inventors:
- **SOTOJIMA, Takazo**
  Osaka-shi
  Osaka
  5300001 (JP)
- **UENO, Hiromichi**
  Osaka-shi
  Osaka
  5300001 (JP)
- **KAWAE, Arisa**
  Osaka-shi
  Osaka
  5300001 (JP)
- **KUMAZAKI, Tomoya**
  Osaka-shi
  Osaka
  5300001 (JP)
- **KATAYAMA, Tatsuya**
  Osaka-shi
  Osaka
  5300001 (JP)
- **WADA, Hikaru**
  Osaka-shi
  Osaka
  5300001 (JP)

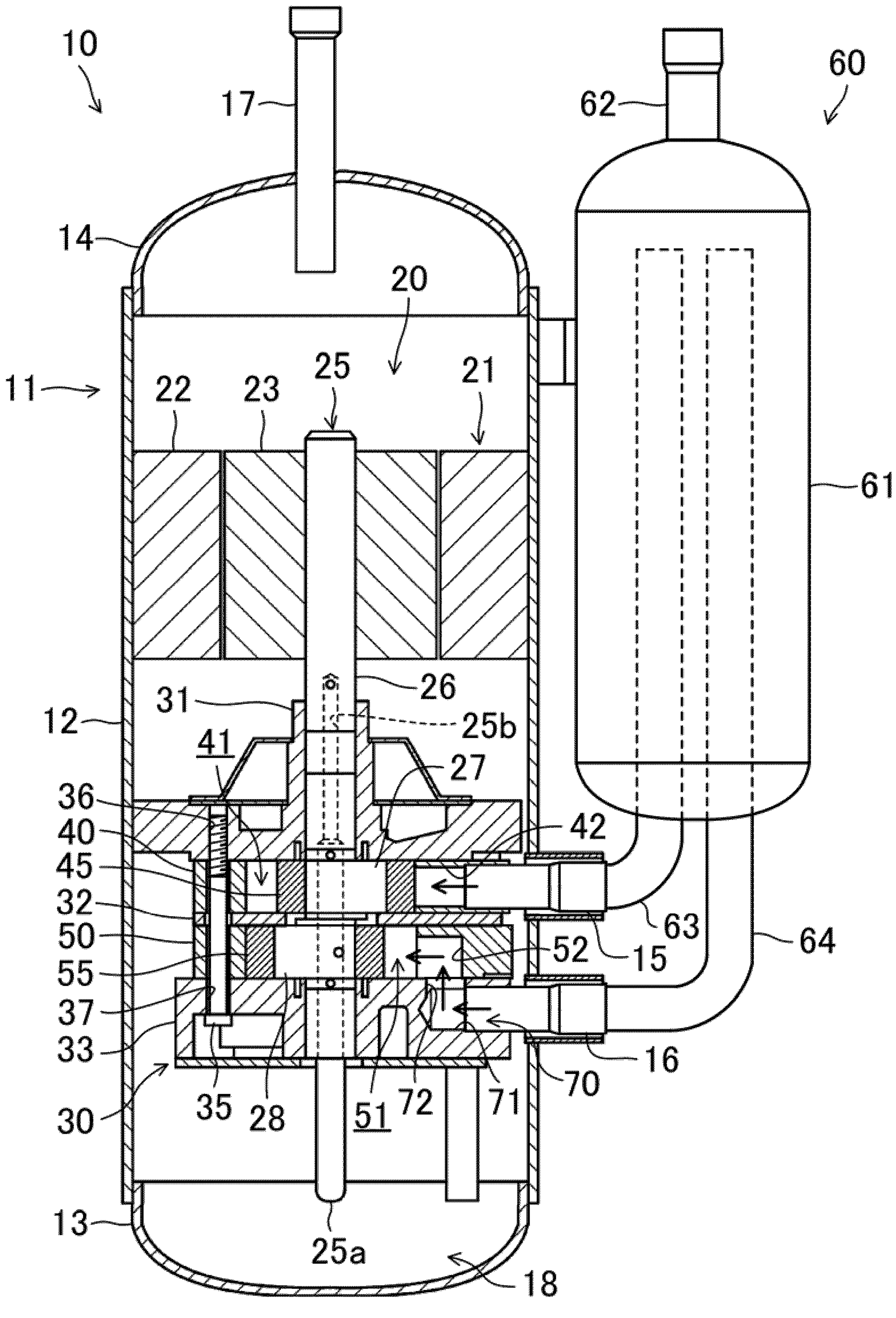
(74) Representative: **Goddar, Heinz J.**
Boehmert & Boehmert
Anwaltspartnerschaft mbB
Pettenkoferstrasse 22
80336 München (DE)

(54) **ROTARY COMPRESSOR AND REFRIGERATION DEVICE**

(57) A first suction pipe (15) is connected to a first cylinder (40). The first suction pipe (15) sucks a fluid into a first cylinder chamber (41). A rear head (33) is provided with an in-head suction passage (70) communicating with a second cylinder chamber (51). A second suction pipe (16) is connected to the rear head (33). The second suction pipe (16) sucks the fluid into the second cylinder chamber (51) through the in-head suction passage (70).

EP 4 461 962 A1

FIG.2


10
17
62
60
14
20
11
22
23
25
21
61
26
31
25b
12
41
27
36
40
42
45
32
63
50
52
15
64
55
37
33
16
70
30
35
28
51
72
71
13
25a
18

Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] Patent Document 1 discloses a compressor including a front head, a first cylinder having a first cylinder chamber, a partition plate, a second cylinder having a second cylinder chamber, and a rear head. A first suction pipe is connected to the first cylinder, and a second suction pipe is connected to the second cylinder. Refrigerant gas is sucked into the first cylinder chamber and the second cylinder chamber from an accumulator via the first suction pipe and the second suction pipe.

CITATION LIST

PATENT DOCUMENT

[0003] Patent Document 1: Japanese Unexamined Patent Publication No. 2022-072807

SUMMARY OF THE INVENTION

TECHNICAL PROBLEMS

[0004] For the higher efficiency of the compressor, reducing a leakage loss by thinning the first and second cylinders has been demanded.

[0005] However, thinning the first and second cylinders reduces the distance between the first and second suction pipes, which may decrease the strength of the casing around connections with the first and second suction pipes.

[0006] An object of the present disclosure is to increase the efficiency of the compressor and increase the distance between the first suction pipe and the second suction pipe.

SOLUTION TO THE PROBLEMS

[0007] A first aspect of the present disclosure is directed to a rotary compressor including: a rotary compressor including: a stack of a first head (31), a first cylinder (40) having a first cylinder chamber (41), a middle plate (32), a second cylinder (50) having a second cylinder chamber (51), and a second head (33); a first piston (45) that eccentrically rotates in the first cylinder chamber (41); and a second piston (55) that eccentrically rotates in the second cylinder chamber (51), the rotary compressor including: a first suction pipe (15) that is connected to the first cylinder (40) and sucks a fluid into the first cylinder chamber (41); an in-head suction passage (70) that is provided in the second head (33) and communicates with the second cylinder chamber (51); and a second suction pipe (16) that is connected to the second head (33) and sucks a fluid into the second cylinder chamber (51) through the in-head suction passage (70).

[0008] According to the first aspect, the distance between the first suction pipe (15) and the second suction pipe (16) can be increased as compared with the case in which the second suction pipe (16) is connected to the second cylinder (50). This can reduce the thicknesses of the first cylinder (40) and the second cylinder (50) to reduce the leakage loss, making it possible to increase the efficiency of the rotary compressor.

[0009] A second aspect of the present disclosure is an embodiment of the first aspect. In the rotary compressor of the second aspect, the first head (31) has a threaded hole (36), the first cylinder (40), the middle plate (32), the second cylinder (50), and the second head (33) each have a through hole (37) located to correspond to the threaded hole (36), and a bolt (35) is inserted from the second head (33) side to fasten the first head (31), the first cylinder (40), the middle plate (32), the second cylinder (50), and the second head (33).

[0010] According to the second aspect, when tightened, the bolt (35) causes the second cylinder (50) near the seat surface of the bolt (35) to have a tightening strain greater than a tightening strain of the first cylinder (40). On the other hand, when the fluid is sucked into the second cylinder (50) from the second head (33) side, the low-temperature fluid is heated while passing through the in-head suction passage (70), which reduces the difference in temperature distribution between the second cylinder (50) and the fluid. This causes a thermal strain of the second cylinder (50) due to thermal expansion to be lower than a thermal strain of the first cylinder (40).

[0011] Thus, the leakage loss in the second cylinder (50), which is near the seat surface of the bolt (35), can be reduced by setting the clearance between the second cylinder (50) and the second piston (55) small in consideration of the influence of the tightening strain and the thermal strain.

[0012] A third aspect of the present disclosure is an embodiment of the first aspect. In the rotary compressor of the third aspect, the first cylinder (40) has a threaded hole (36), the middle plate (32), the second cylinder (50), and the second head (33) each have a through hole (37) located to correspond to the threaded hole (36), and a bolt (35) is inserted from the second head (33) side to fasten the first cylinder (40), the middle plate (32), the second cylinder (50), and the second head (33).

[0013] According to the third aspect, the leakage loss in the second cylinder (50), which is near the seat surface of the bolt (35), can be reduced by setting the clearance between the second cylinder (50) and the second piston (55) small in consideration of the influence of the tightening strain and the thermal strain.

[0014] A fourth aspect of the present disclosure is an embodiment of any one of the first to third aspects. In the rotary compressor of the fourth aspect, the in-head suction passage (70) includes: a first passage (71) extending in a radial direction; and a second passage (72) extending in an axial direction to allow the first passage (71) and the second cylinder chamber (51) to communicate with each other.

[0015] According to the fourth aspect, the low-temperature fluid that has flowed into the in-head suction passage (70) from the second suction pipe (16) is heated when passing through the first passage (71) and the second passage (72), and then flows into the second cylinder chamber (51) in the radial direction. This can reduce direct spraying of the low-temperature fluid on the second piston (55).

[0016] A fifth aspect of the present disclosure is directed to a refrigeration apparatus including: the rotary compressor (10) of any one of the first to fourth aspects; and a fluid circuit (1a) through which a fluid compressed by the rotary compressor (10) flows.

[0017] According to the fifth aspect, a refrigeration apparatus including the rotary compressor (10) can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a refrigerant circuit diagram illustrating a configuration of a refrigeration apparatus according to a first embodiment.
FIG. 2 is a longitudinal sectional view illustrating a configuration of a rotary compressor.
FIG. 3 is a transverse sectional view illustrating a configuration of a first cylinder and a first piston.
FIG. 4 is a transverse sectional view illustrating a configuration of a second cylinder and a second piston.
FIG. 5 is a longitudinal sectional view illustrating a configuration of a rotary compressor according to a second embodiment.

DESCRIPTION OF EMBODIMENT

«First Embodiment»

[0019] As illustrated in FIG. 1, a rotary compressor (10) is provided in a refrigeration apparatus (1). The refrigeration apparatus (1) includes a refrigerant circuit (1a) which is a fluid circuit filled with a refrigerant. The refrigerant circuit (1a) includes a rotary compressor (10), a radiator (3), a decompression mechanism (4), and an evaporator (5). The decompression mechanism (4) is, for example, an expansion valve. The refrigerant circuit (1a) performs a vapor compression refrigeration cycle.

[0020] The refrigeration apparatus (1) is an air conditioner. The air conditioner may be any of a cooling-only apparatus, a heating-only apparatus, or an air conditioner switchable between cooling and heating. In this case, the air conditioner has a switching mechanism (e.g., a four-way switching valve) configured to switch the direction of circulation of the refrigerant. The refrigeration apparatus (1) may be a water heater, a chiller unit, or a cooling apparatus configured to cool air in an internal space. The cooling apparatus cools the air in a refrigerator, a freezer, or a container, for example.

[0021] As illustrated in FIG. 2, the rotary compressor (10) includes a casing (11), a drive mechanism (20), and a compression mechanism (30). The drive mechanism (20) and the compression mechanism (30) are housed in the casing (11).

[0022] The casing (11) is configured as a vertically long cylindrical closed container. The casing (11) includes a barrel (12), a bottom end plate (13), and a top end plate (14). The barrel (12) is in the shape of a cylinder extending in the vertical direction, with both axial ends open. The bottom end plate (13) is fixed to the lower end of the barrel (12). The top end plate (14) is fixed to the upper end of the barrel (12).

[0023] A first suction pipe (15) and a second suction pipe (16) pass through, and are fixed to, the barrel (12). A discharge pipe (17) passes through, and is fixed to, the top end plate (14).

[0024] The casing (11) has an oil reservoir (18) at its bottom. The oil reservoir (18) is formed by the bottom end plate (13) and an inner wall of a lower portion of the barrel (12). The oil reservoir (18) stores oil for lubricating the sliding portions of the compression mechanism (30) and a drive shaft (25).

<Drive Mechanism>

[0025] The drive mechanism (20) includes a motor (21) and a drive shaft (25). The motor (21) is disposed above the compression mechanism (30). The motor (21) includes a stator (22) and a rotor (23).

[0026] The stator (22) is fixed to the inner peripheral surface of the barrel (12) of the casing (11). The rotor (23) extends to penetrate the stator (22) in the vertical direction. The drive shaft (25) passes through the axis of the rotor (23) and is fixed to the rotor (23). The drive shaft (25) is driven to rotate together with the rotor (23) when the motor (21) is energized.

[0027] The drive shaft (25) is arranged on the axis of the barrel (12) of the casing (11). An oil supply pump (25a) is provided at the lower end of the drive shaft (25). The oil supply pump (25a) conveys the oil collected in the oil reservoir (18). The conveyed oil is supplied to the sliding portions of the compression mechanism (30) and the drive shaft (25) through an oil passage (25b) in the drive shaft (25).

[0028] The drive shaft (25) includes a main shaft portion (26), a first eccentric portion (27), and a second eccentric portion (28). An upper part of the main shaft portion (26) is fixed to the rotor (23) of the motor (21). The first eccentric portion (27) is disposed above the second eccentric portion (28). The axes of the first eccentric portion (27) and the second eccentric portion (28) are eccentric from the axis of the main shaft portion (26) by a predetermined amount.

[0029] Part of the main shaft portion (26) above the first eccentric portion (27) is rotatably supported by a front head (31) described later. Part of the main shaft portion (26) below the second eccentric portion (28) is rotatably supported by a rear head (33) described later.

<Compression Mechanism>

[0030] In the example shown in FIG. 2, the compression mechanism (30) is a two-cylinder rotary fluid machine. The compression mechanism (30) is disposed below the motor (21). The compression mechanism (30) includes a front head (31) as a first head, a first cylinder (40), a middle plate (32), a second cylinder (50), and a rear head (33) as a second head.

[0031] The front head (31), the first cylinder (40), the middle plate (32), the second cylinder (50), and the rear head (33) are stacked in this order from top to bottom and fixed with a bolt (35).

[0032] Specifically, the front head (31) is provided with a threaded hole (36). The first cylinder (40), the middle plate (32), the second cylinder (50), and the rear head (33) are each provided with a through hole (37) located to correspond to the threaded hole (36).

[0033] The bolt (35) is inserted into the holes from the rear head (33) side and fastens the front head (31), the first cylinder (40), the middle plate (32), the second cylinder (50), and the rear head (33).

[0034] The front head (31) is fixed to the barrel (12) of the casing (11). The front head (31) is stacked on top of the first cylinder (40). The front head (31) is arranged to cover a first cylinder chamber (41) of the first cylinder (40) from above. The main shaft portion (26) of the drive shaft (25) is inserted in the front head (31) to pass through the center of the front head (31). The front head (31) rotatably supports the drive shaft (25). The front head (31) has a first discharge passage (49) penetrating the front head (31) in the axial direction (see FIG. 3).

[0035] The first cylinder (40) is configured as a flat, substantially annular member. As illustrated in FIG. 3, the first cylinder (40) includes a first cylinder chamber (41), a first suction passage (42), and a first blade chamber (43).

[0036] The first cylinder chamber (41) is provided in a center portion of the first cylinder (40). The first suction passage (42) extends from the inner wall surface of the first cylinder chamber (41) toward the outside in the radial direction of the first cylinder (40). The first suction passage (42) opens on the outer surface of the first cylinder (40). The first suction pipe (15) is connected to an inlet end of the first suction passage (42). An outlet end of the first suction passage (42) communicates with the first cylinder chamber (41).

[0037] The first cylinder chamber (41) houses a first piston (45). The first piston (45) includes a first piston body (46) and a first blade (47). The first piston body (46) is formed in an annular shape. The first eccentric portion (27) of the drive shaft (25) fits into the first piston body (46). The first blade (47) extends radially outward from the first piston body (46). The first blade (47) is supported by a pair of first bushes (48). The first blade (47) divides the inside of the first cylinder chamber (41) into a low-pressure chamber and a high-pressure chamber.

[0038] The first piston (45) rotates eccentrically in the first cylinder chamber (41) when the drive shaft (25) is driven to rotate. When the volume of the low-pressure chamber gradually increases with the eccentric rotation of the first piston (45), the refrigerant flowing through the first suction pipe (15) is sucked through the first suction passage (42) into the low-pressure chamber in the radial direction.

[0039] When the low-pressure chamber is isolated from the first suction passage (42), the isolated space constitutes a high-pressure chamber. The internal pressure of the high-pressure chamber increases as the volume of the high-pressure chamber gradually decreases. When the internal pressure of the high-pressure chamber exceeds a predetermined pressure, the refrigerant in the high-pressure chamber flows out of the compression mechanism (30) through the first discharge passage (49). The high-pressure refrigerant flows upward through the internal space of the casing (11) and passes through a core cut (not shown) of the motor (21) or any other passage. The high-pressure refrigerant that has flowed upward of the motor (21) is transferred to the refrigerant circuit through the discharge pipe (17).

[0040] The first blade chamber (43) is located radially outward of the first cylinder chamber (41) and away from the first cylinder chamber (41). The first blade chamber (43) penetrates into the first cylinder (40) in the thickness direction of the first cylinder (40). A tip portion of the first blade (47) is housed in the first blade chamber (43). The first blade (47) swings in the first blade chamber (43) with the eccentric rotation of the first piston body (46).

[0041] As illustrated in FIG. 2, the middle plate (32) is sandwiched between the first cylinder (40) and the second cylinder (50). The middle plate (32) is disposed to cover the first cylinder chamber (41) of the first cylinder (40) from below. The middle plate (32) is disposed to cover a second cylinder chamber (51) of the second cylinder (50) from above.

[0042] As also illustrated in FIG. 4, the second cylinder (50) is configured as a flat, substantially annular member. The second cylinder (50) includes the second cylinder chamber (51), a second suction passage (52), and a second blade chamber (53).

[0043] The second cylinder chamber (51) is provided in the center of the second cylinder (50). The second suction passage (52) extends from the inner wall surface of the second cylinder chamber (51) toward the outside in the radial direction of the second cylinder (50). The second suction passage (52) opens on a surface of the second cylinder (50) (a lower surface in FIG. 2) facing the rear head (33).

[0044] An inlet end of the second suction passage (52) communicates with an in-head suction passage (70) of the rear head (33), which will be described later. An outlet end of the second suction passage (52) communicates with the second cylinder chamber (51).

[0045] The second cylinder chamber (51) houses a second piston (55). The second piston (55) includes a second piston body (56) and a second blade (57). The second piston body (56) is formed in an annular shape. The second eccentric portion (28) of the drive shaft (25) fits into the second piston body (56). The second blade (57) extends radially outward from the second piston body (56). The second blade (57) is supported by a pair of second bushes (58). The second blade (57) divides the inside of the second cylinder chamber (51) into a low-pressure chamber and a high-pressure chamber.

[0046] The action of the second piston (55) is substantially the same as the action of the first piston (45), and will not be described below.

[0047] The second blade chamber (53) is located radially outward of the second cylinder chamber (51) and away from the second cylinder chamber (51). The second blade chamber (53) penetrates into the second cylinder (50) in the thickness direction of the second cylinder (50). A tip portion of the second blade (57) is housed in the second blade chamber (53). The second blade (57) swings in the second blade chamber (53) with the eccentric rotation of the second piston body (56).

[0048] As illustrated in FIG. 2, the rear head (33) is stacked on the bottom of the second cylinder (50). The rear head (33) is disposed to cover the second cylinder chamber (51) of the second cylinder (50) from below. The main shaft portion (26) of the drive shaft (25) is inserted in the rear head (33) to pass through the center of the rear head (33). The rear head (33) rotatably supports the drive shaft (25).

[0049] The rear head (33) is provided with the in-head suction passage (70). The in-head suction passage (70) includes a first passage (71) and a second passage (72). The first passage (71) extends outward in the radial direction of the rear head (33). The first passage (71) opens on the outer surface of the rear head (33). An inlet end of the first passage (71) is connected to the second suction pipe (16). The second passage (72) is provided at an outlet end of the first passage (71).

[0050] The second passage (72) extends upward in the axial direction and opens on the top surface of the rear head (33). An outlet end of the second passage (72) communicates with the second cylinder chamber (51) via the second suction passage (52) of the second cylinder (50).

[0051] This configuration can increase the distance between the first suction pipe (15) and the second suction pipe (16) as compared with the case in which the second suction pipe (16) is connected to the second cylinder (50). This can reduce the thicknesses of the first cylinder (40) and the second cylinder (50) to reduce a leakage loss, making it possible to increase the efficiency of the rotary compressor (10).

[0052] The low-temperature refrigerant that has flowed into the in-head suction passage (70) from the second suction pipe (16) is heated when passing through the first passage (71) and the second passage (72), and then flows into the second cylinder chamber (51). This can reduce direct spraying of the low-temperature refrigerant on the second piston (55).

[0053] As indicated by the arrows in FIG. 2, the refrigerant is sucked into the second cylinder chamber (51) via the second suction pipe (16), the in-head suction passage (70) of the rear head (33), and the second suction passage (52) of the second cylinder (50).

[0054] The rear head (33) has a second discharge passage (59) penetrating the rear head (33) in the axial direction (see FIG. 4). When the internal pressure of the high-pressure chamber in the second cylinder chamber (51) exceeds a predetermined pressure with the rotation of the second piston (55), the refrigerant in the high-pressure chamber flows out of the compression mechanism (30) through the second discharge passage (59).

[0055] The bolt (35) is inserted into the through holes (37) from the rear head (33) side and tightened in the threaded hole (36) of the front head (31). When tightened, the bolt (35) causes the second cylinder (50) near the seat surface of the bolt (35) to have a tightening strain $\delta 3$ which is greater than a tightening strain 61 of the first cylinder (40) ($\delta 1 < \delta 3$).

[0056] On the other hand, when the fluid is sucked into the second cylinder (50) from the second head (33) side, the low-temperature fluid is heated while passing through the in-head suction passage (70), which reduces the difference in temperature distribution between the second cylinder (50) and the fluid. This causes a thermal strain $\delta 4$ of the second cylinder (50) due to thermal expansion to be lower than a thermal strain $\delta 2$ of the first cylinder (40) ($\delta 2 > \delta 4$).

[0057] Thus, the leakage loss in the second cylinder (50), which is near the seat surface of the bolt (35), can be reduced by setting the clearance between the second cylinder (50) and the second piston (55) small in consideration of the influence of the tightening strain and the thermal strain.

<Configuration of Accumulator>

[0058] An accumulator (60) is connected to the upstream side of the rotary compressor (10). The accumulator (60) temporarily stores the refrigerant that is to be sucked into the rotary compressor (10) and performs gas-liquid separation for a liquid refrigerant and oil contained in a gas refrigerant.

[0059] The accumulator (60) includes a closed container (61), an inlet pipe (62), a first outlet pipe (63), and a second outlet pipe (64). The inlet pipe (62) allows the refrigerant to flow into the closed container (61). The outlet pipe (63) allows the refrigerant to flow out of the closed container (61).

[0060] The closed container (61) is configured as a vertically long cylindrical member. The inlet pipe (62) is connected to the top of the closed container (61). A lower end of the inlet pipe (62) opens in the internal space of the closed container (61) near the top of the closed container (61).

[0061] The first outlet pipe (63) and the second outlet pipe (64) are connected to the bottom of the closed container (61). Each of the first outlet pipe (63) and the second outlet pipe (64) has an upper end portion extending upward in the internal space of the closed container (61) and opens near the top of the closed container (61).

[0062] The first outlet pipe (63) has a lower end portion that extends downward from the lower end of the closed container (61), bends toward the first suction pipe (15) of the rotary compressor (10), and is connected to the first suction pipe (15). The second outlet pipe (64) has a lower end portion that extends downward from the lower end of the closed container (61), bends toward the second suction pipe (16) of the rotary compressor (10), and is connected to the second suction pipe (16).

-Advantages of First Embodiment-

[0063] According to the features of this embodiment, the distance between the first suction pipe (15) and the second suction pipe (16) can be increased as compared with the case in which the second suction pipe (16) is connected to the second cylinder (50). This can reduce the thicknesses of the first cylinder (40) and the second cylinder (50) to reduce the leakage loss, making it possible to increase the efficiency of the rotary compressor.

[0064] Further, connecting the first suction pipe (15) to the first cylinder (40) can reduce suction and heating of the refrigerant in the first cylinder chamber (41). This can improve the efficiency of the rotary compressor (10) as compared with the case in which the first suction pipe (15) is connected to the first head (31) and the second suction pipe (16) is connected to the second head (33).

[0065] According to the features of this embodiment, when tightened, the bolt (35) causes the second cylinder (50) near the seat surface of the bolt (35) to have a tightening strain greater than a tightening strain of the first cylinder (40). On the other hand, when the fluid is sucked into the second cylinder (50) from the second head (33) side, the low-temperature fluid is heated while passing through the in-head suction passage (70), which reduces the difference in temperature distribution between the second cylinder (50) and the fluid. This causes a thermal strain of the second cylinder (50) due to thermal expansion to be lower than a thermal strain of the first cylinder (40).

[0066] Thus, the leakage loss in the second cylinder (50), which is near the seat surface of the bolt (35), can be reduced by setting the clearance between the second cylinder (50) and the second piston (55) small in consideration of the influence of the tightening strain and the thermal strain.

[0067] Further, connecting the first suction pipe (15) to the first cylinder (40) located near the first head (31) provided with the threaded hole (36) can reduce a suction pressure loss of the refrigerant. This can reduce the loss of the compression mechanism (30) as a whole, making it possible to improve the efficiency of the rotary compressor (10).

[0068] According to the features of this embodiment, the low-temperature fluid that has flowed into the in-head suction passage (70) from the second suction pipe (16) is heated when passing through the first passage (71) and the second passage (72), and then flows into the second cylinder chamber (51) in the radial direction. This can reduce direct spraying of the low-temperature fluid on the second piston (55).

[0069] According to the features of this embodiment, the refrigeration apparatus includes the rotary compressor (10) and the fluid circuit (1a) through which the fluid compressed by the rotary compressor (10) flows. This can provide a refrigeration apparatus including the rotary compressor (10).

«Second Embodiment»

[0070] In the following description, the same reference characters designate the same components as those of the first embodiment, and the description is focused only on the difference.

[0071] As illustrated in FIG. 5, a compression mechanism (30) is disposed below the motor (21). The compression mechanism (30) includes a front head (31), a first cylinder (40), a middle plate (32), a second cylinder (50), and a rear head (33).

[0072] The front head (31), the first cylinder (40), the middle plate (32), the second cylinder (50), and the rear head (33) are stacked in this order from top to bottom and fixed with bolts (35).

[0073] Specifically, the first cylinder (40) has a threaded hole (36). The front head (31), the middle plate (32), the second cylinder (50), and the rear head (33) are each provided with a through hole (37) located to correspond to the threaded hole (36). The front head (31) has a counterbore located to correspond to the through hole (37).

[0074] The lower one of the bolts (35) is inserted into the holes from the rear head (33) side and fastens the first cylinder (40), the middle plate (32), the second cylinder (50), and the rear head (33). The upper one of the bolts (35) is inserted into the holes from the front head (31) side and fastens the front head (31) and the first cylinder (40).

-Advantages of Second Embodiment-

[0075] According to the features of this embodiment, the leakage loss in the second cylinder (50), which is near the seat surface of the bolt (35), can be reduced by setting the clearance between the second cylinder (50) and the second piston (55) small in consideration of the influence of the tightening strain and the thermal strain.

<<Other Embodiments>>

[0076] While the embodiments and variations have been described above, it will be understood that various changes in form and details can be made without departing from the spirit and scope of the claims. The elements according to embodiments, the variations thereof, and the other embodiments may be combined and replaced with each other. In addition, the expressions of "first," "second," "third," ... , in the specification and claims 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

[0077] As can be seen from the foregoing description, the present disclosure is useful for a rotary compressor and a refrigeration apparatus.

DESCRIPTION OF REFERENCE CHARACTERS

[0078]

1	Refrigeration Apparatus
1a	Fluid Circuit
10	Rotary Compressor
15	First Suction Pipe
16	Second Suction Pipe
31	Front Head (First Head)
32	Middle Plate
33	Rear Head (Second Head)
35	Bolt
36	Threaded Hole
37	Through Hole
40	First Cylinder
41	First Cylinder Chamber
45	First Piston
50	Second Cylinder
51	Second Cylinder Chamber
55	Second Piston
70	In-Head Suction Passage
71	First Passage
72	Second Passage

Claims

1. A rotary compressor including: a stack of a first head (31), a first cylinder (40) having a first cylinder chamber (41), a middle plate (32), a second cylinder (50) having a second cylinder chamber (51), and a second head (33); a first piston (45) that eccentrically rotates in the first cylinder chamber (41); and a second piston (55) that eccentrically rotates in the second cylinder chamber (51), the rotary compressor comprising:

   a first suction pipe (15) that is connected to the first cylinder (40) and sucks a fluid into the first cylinder chamber (41);
   an in-head suction passage (70) that is provided in the second head (33) and communicates with the second cylinder chamber (51); and
   a second suction pipe (16) that is connected to the second head (33) and sucks a fluid into the second cylinder chamber (51) through the in-head suction passage (70).

2. The rotary compressor of claim 1, wherein

   the first head (31) has a threaded hole (36),
   the first cylinder (40), the middle plate (32), the second cylinder (50), and the second head (33) each have a through hole (37) located to correspond to the threaded hole (36), and
   a bolt (35) is inserted from the second head (33) side to fasten the first head (31), the first cylinder (40), the middle plate (32), the second cylinder (50), and the second head (33).

3. The rotary compressor of claim 1, wherein

   the first cylinder (40) has a threaded hole (36), the middle plate (32), the second cylinder (50), and the second head (33) each have a through hole (37) located to correspond to the threaded hole (36), and
   a bolt (35) is inserted from the second head (33) side to fasten the first cylinder (40), the middle plate (32), the second cylinder (50), and the second head (33).

4. The rotary compressor of any one of claims 1 to 3, wherein
   the in-head suction passage (70) includes: a first passage (71) extending in a radial direction; and a second passage (72) extending in an axial direction to allow the first passage (71) and the second cylinder chamber (51) to communicate with each other.

5. A refrigeration apparatus, comprising: the rotary compressor (10) of any one of claims 1 to 4; and
   a fluid circuit (1a) through which a fluid compressed by the rotary compressor (10) flows.

FIG.1

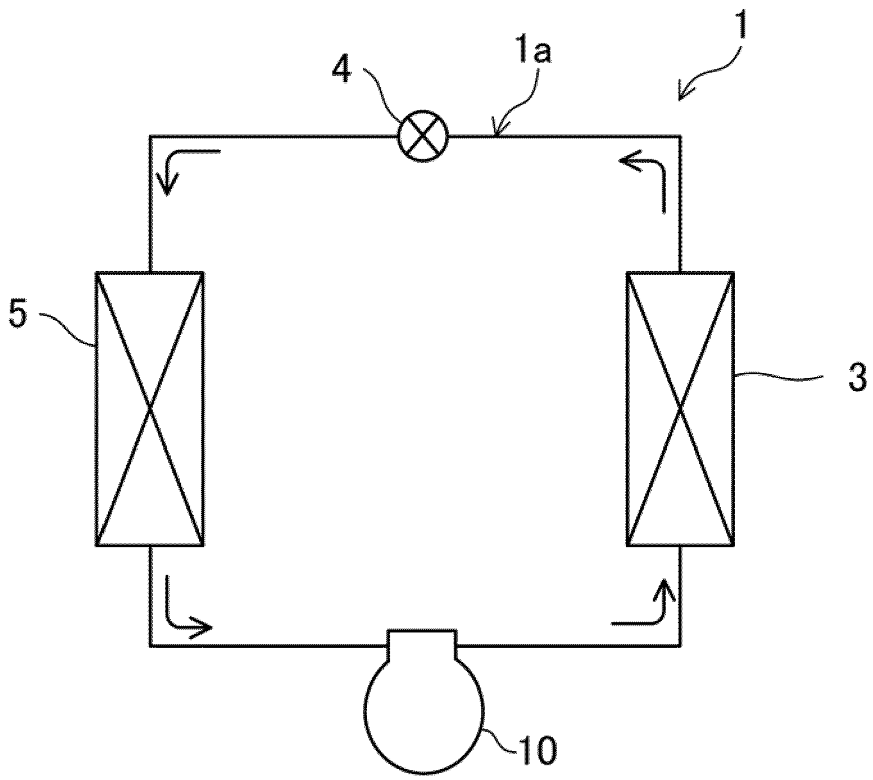


FIG.2

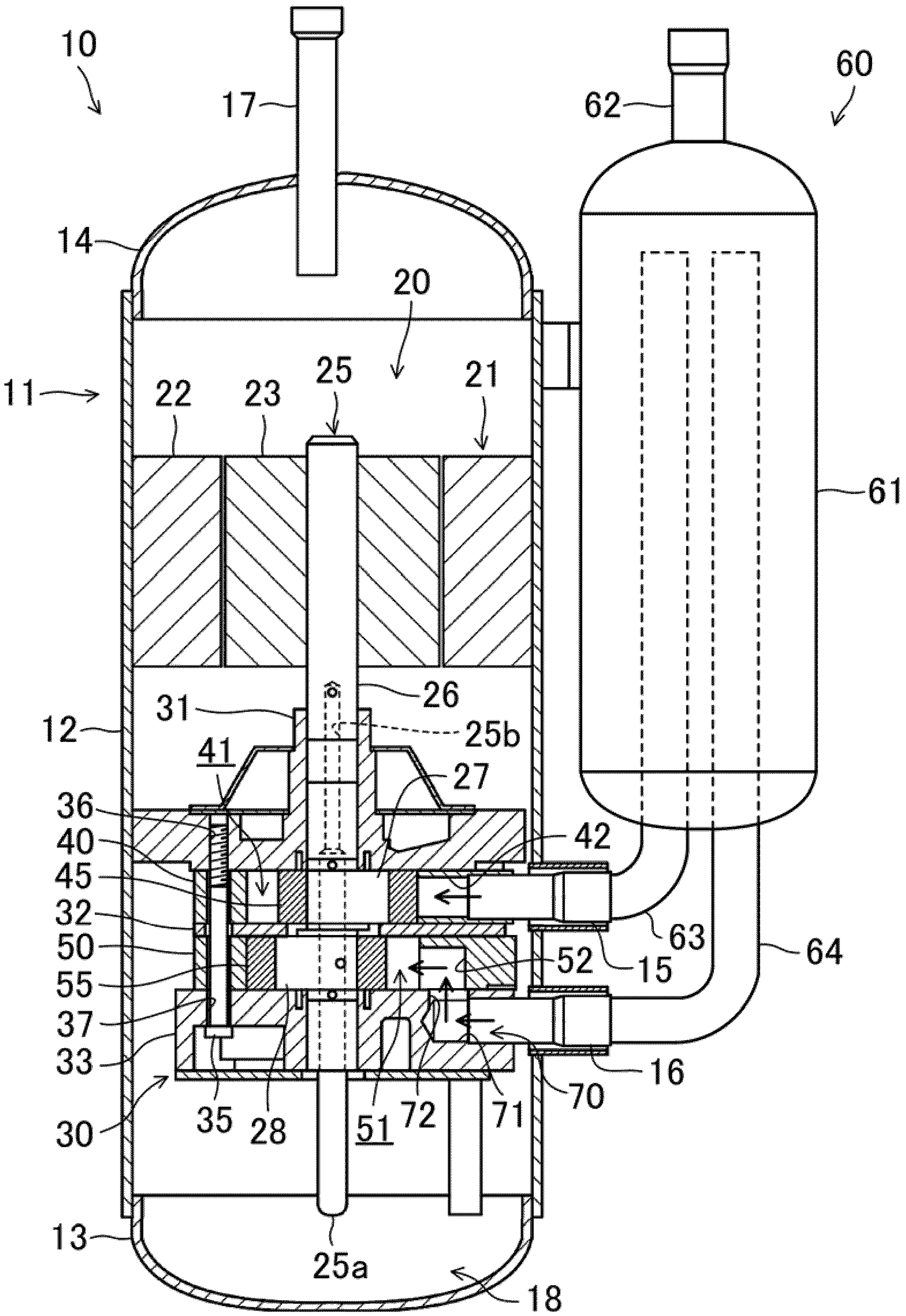

10
17
62
60
14
20
25
21
11
22
23
61
26
31
25b
12
41
27
36
40
42
45
32
63
50
52
15
64
55
37
16
33
70
35
28
51
72
71
30
13
25a
18

FIG.3

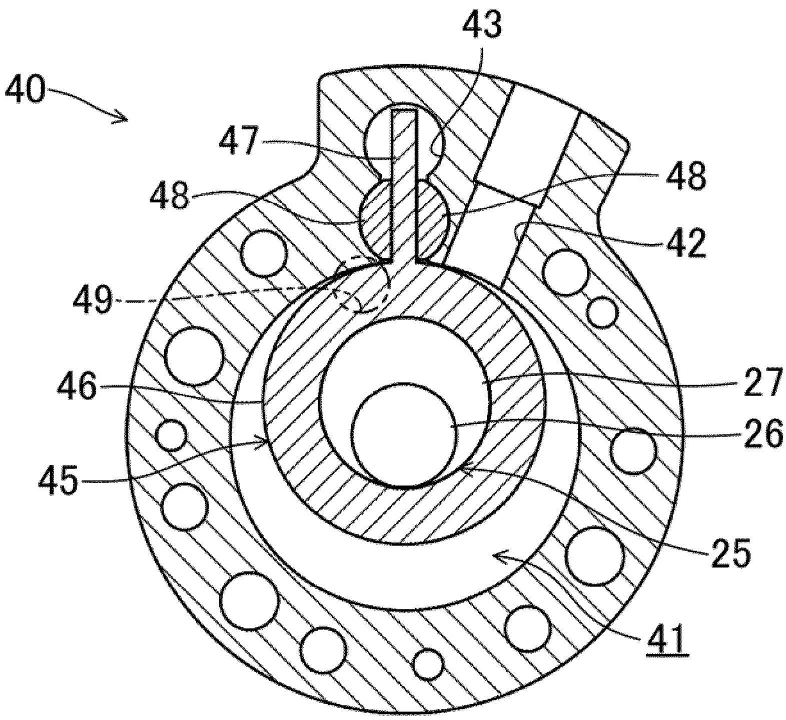

43
40
47
48
48
42
49
27
46
26
45
25
41

FIG.4

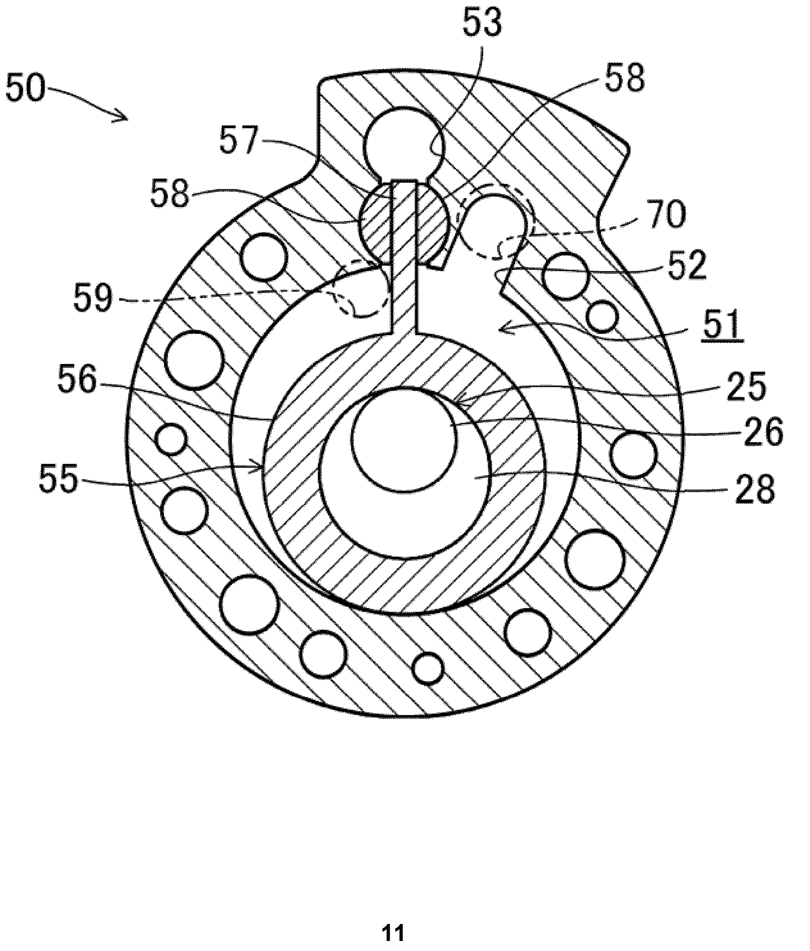
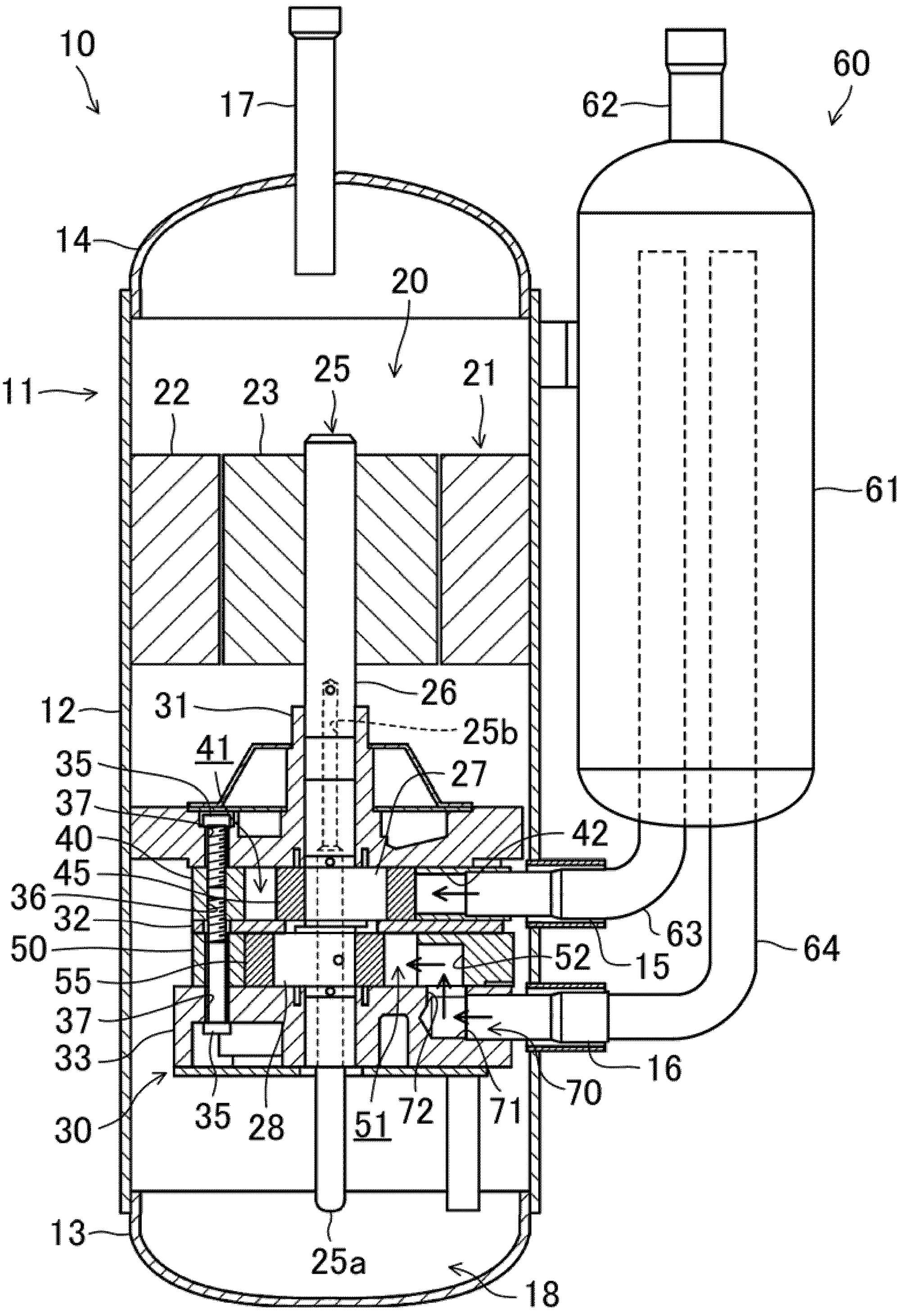

53
58
50
57
58
70
52
59
51
56
25
26
55
28

FIG.5


10
17
62
60
14
20
25
21
11
22
23
61
26
12
31
25b
41
35
27
37
40
42
45
36
32
63
50
52
15
64
55
37
33
16
70
30
35
28
51
72
71
13
25a
18

INTERNATIONAL SEARCH REPORT

International application No. **PCT/JP2024/008357**

A. CLASSIFICATION OF SUBJECT MATTER

F04C 29/12(2006.01)i; ***F04C 2/344***(2006.01)i
FI: F04C29/12 J; F04C2/344 331D

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)

F04C29/12; F04C2/344

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 1971-2024
Registered utility model specifications of Japan 1996-2024
Published registered utility model applications of Japan 1994-2024

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 2010-84594 A (DAIKIN INDUSTRIES, LTD.) 15 April 2010 (2010-04-15) paragraphs [0031]-[0060], fig. 1	1-5

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 May 2024	**21 May 2024**

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.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/008357

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2010-84594 A	15 April 2010	(Family: none)	

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2022072807 A **[0003]**