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(54) **REFRIGERANT COMPRESSOR WITH RETURN OPENING**

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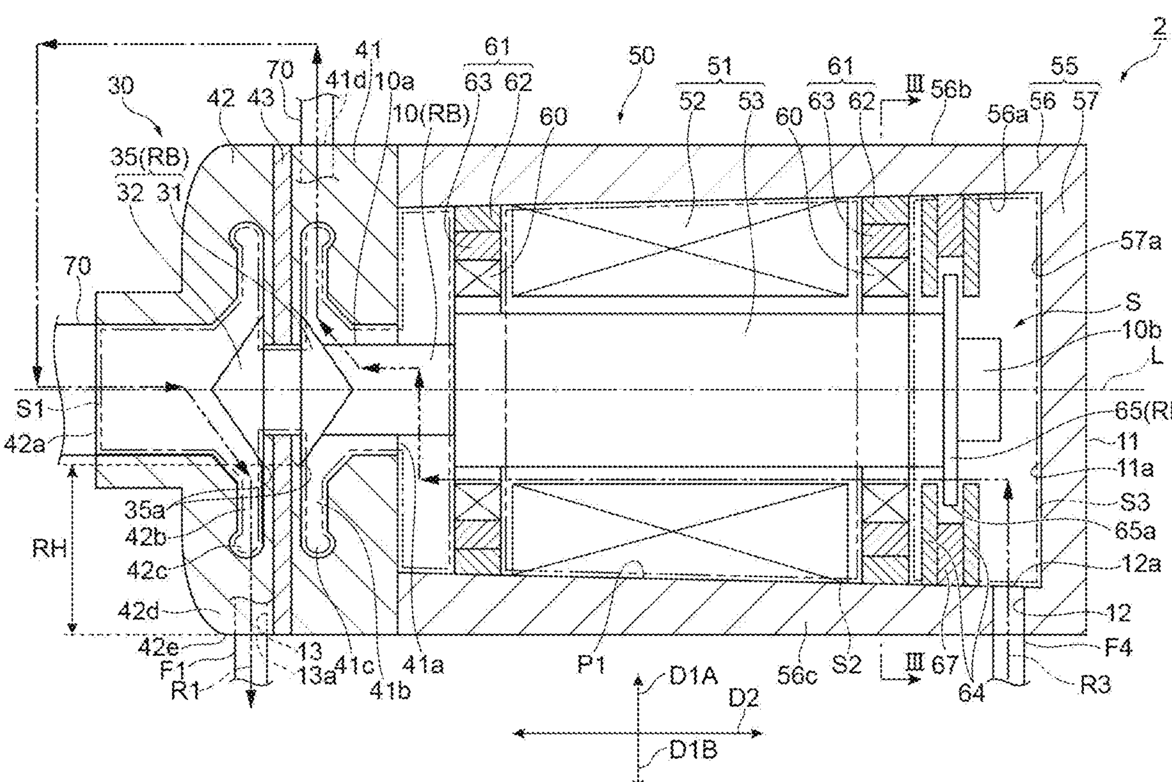
(57) **ABSTRACT**

A refrigerant compressor includes a rotating body, a non-contact bearing rotatably supporting the rotating body, and a housing having an inner space to accommodate the rotating body. The rotating body includes a shaft, and a protruding part that extends from the shaft in a radial direction and that is configured to rotate together with the shaft. The housing forms a suction inlet to supply a refrigerant to the inner space, a discharge outlet to discharge the refrigerant from the inner space, and a return opening that is positioned lower than the protruding part of the rotating body in a vertical direction.



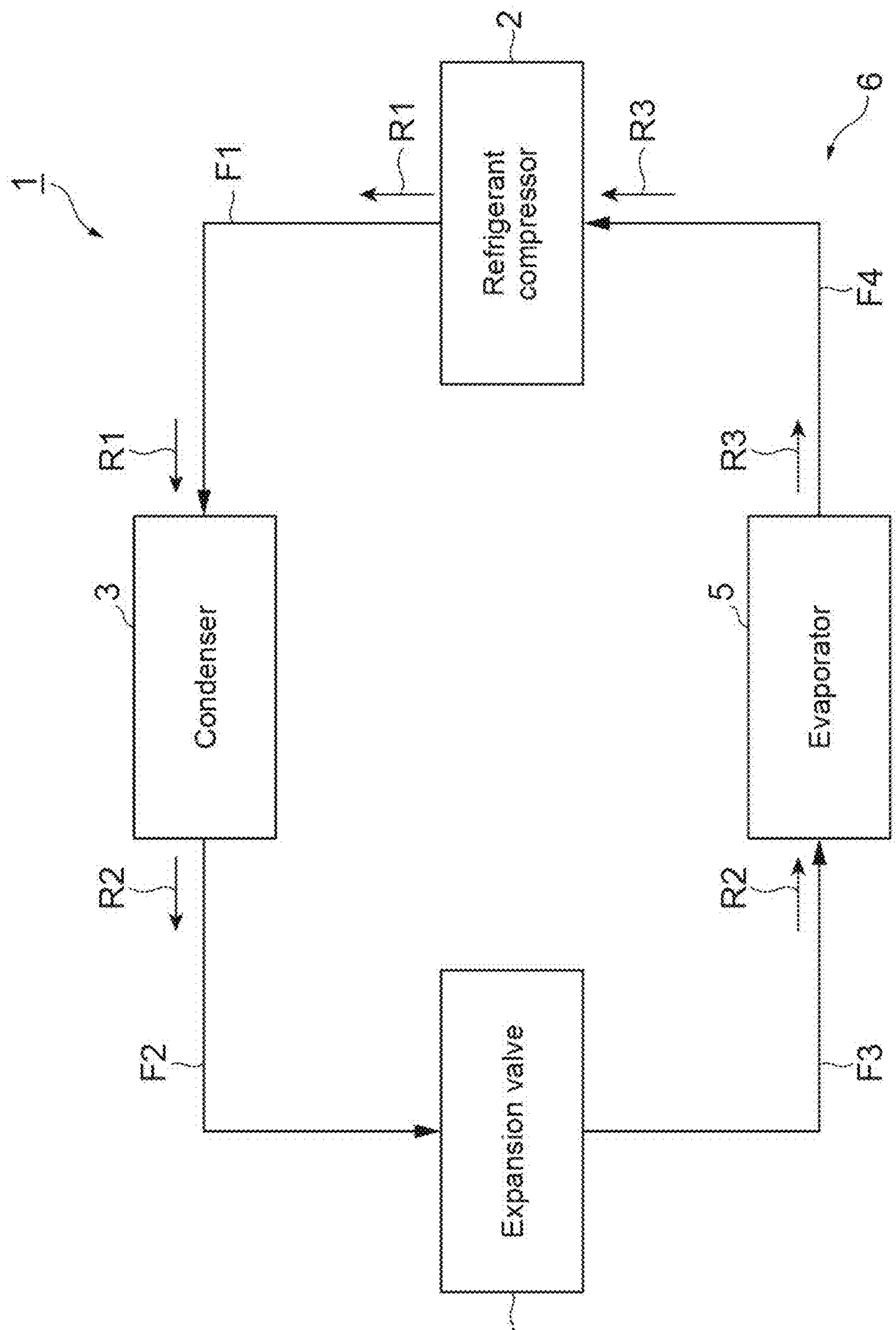

1
2
Refrigerant compressor
R1
R3
F1
6
F4
R1
R3
3
Condenser
5
Evaporator
R2
R2
F2
Expansion valve
F3
4

Fig. 1

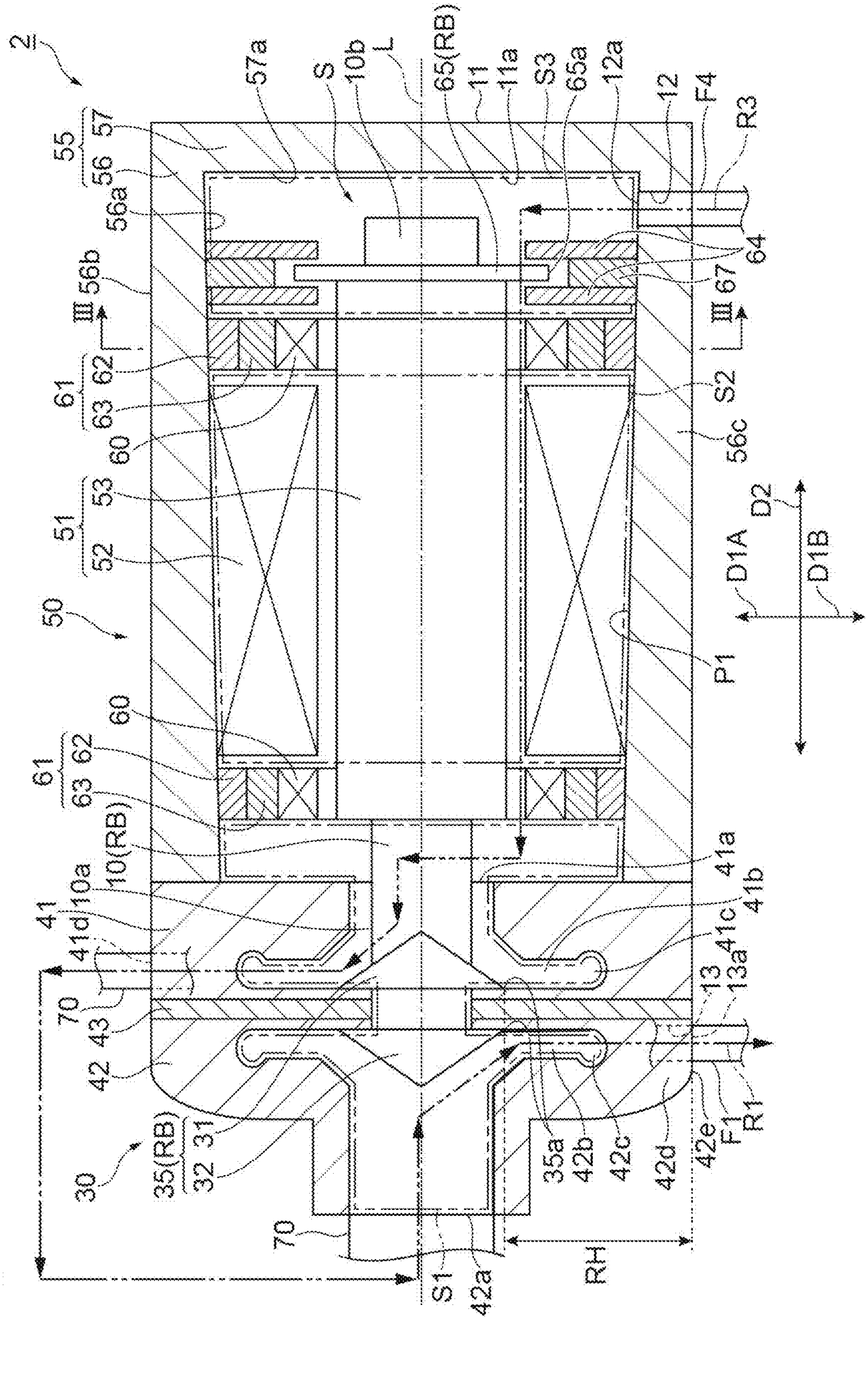

2
55
56
57
57a
S
10b
L
65(RB)
11
11a
S3
65a
12a
12
F4
R3
56a
64
56b
67
III
61
62
63
60
S2
56c
51
52
53
50
D2
D1A
D1B
P1
10(RB)
10a
41
41d
41a
41b
41c
13
13a
70
43
42
35a
42b
42c
42d
42e
F1
R1
30
35(RB)
31
32
S1
42a
RH

Fig.2

Fig.3

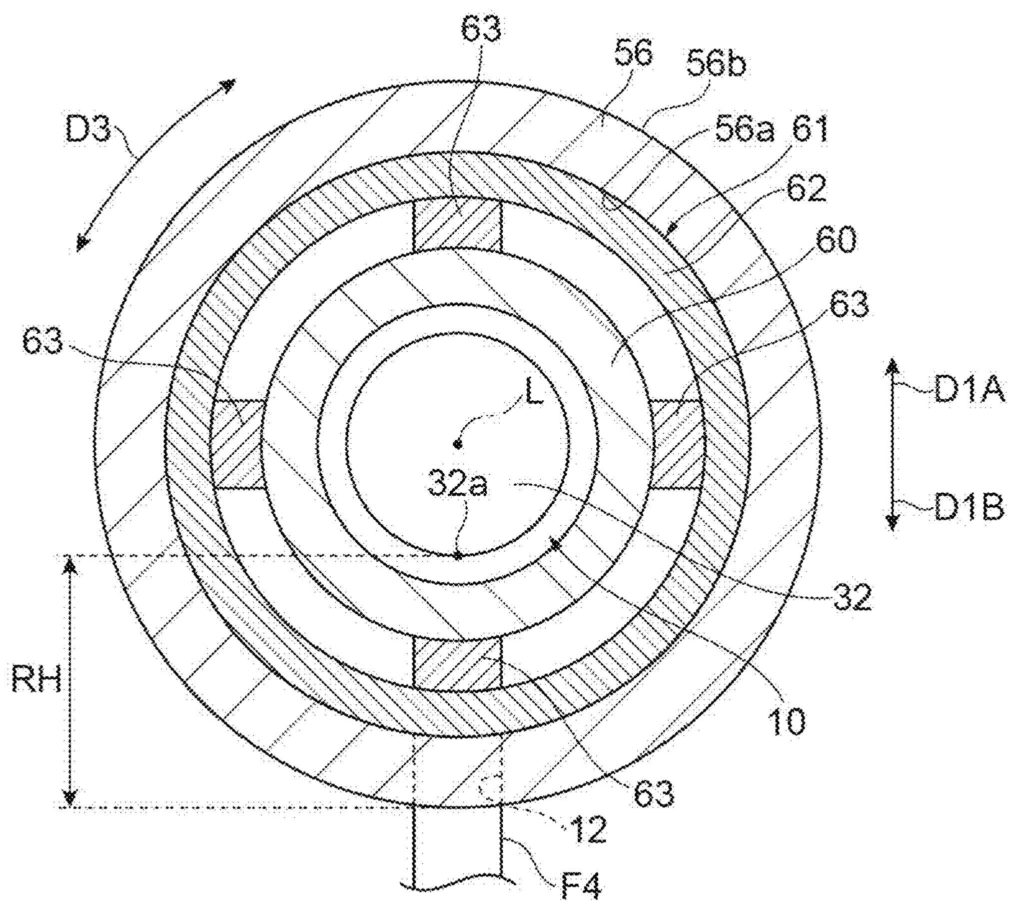
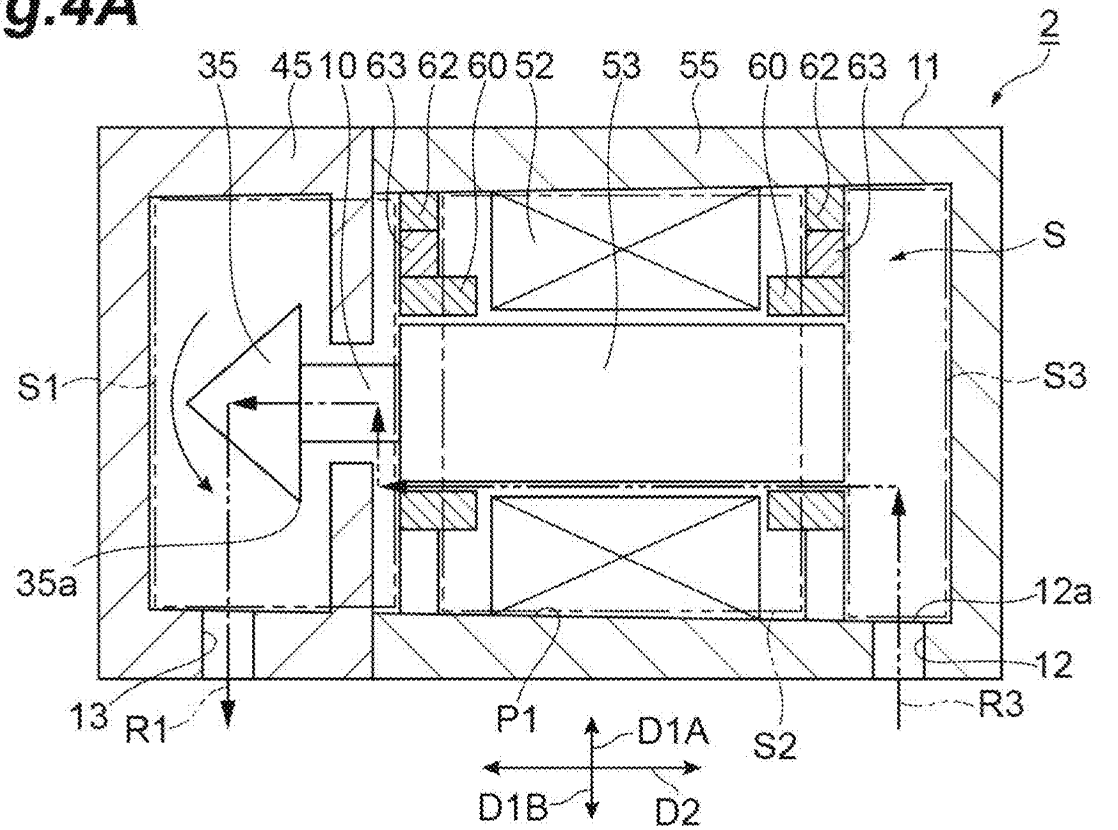
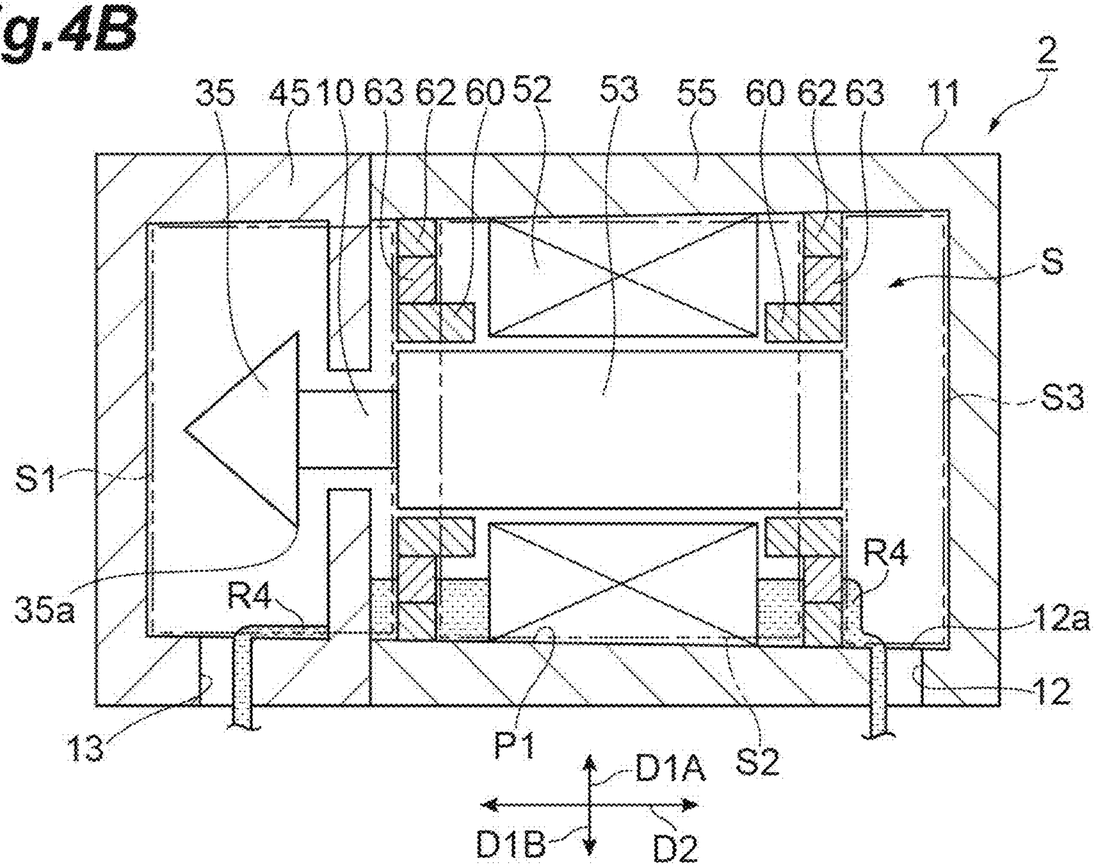


Fig.4A



2
35
45
10
63
62
60
52
53
55
60
62
63
11
S
S1
S3
35a
12a
12
13
R1
R3
P1
D1A
S2
D1B
D2

Fig.4B



2
35
45
10
63
62
60
52
53
55
60
62
63
11
S
S3
S1
R4
35a
R4
12a
12
13
P1
S2
D1A
D1B
D2

Fig.5

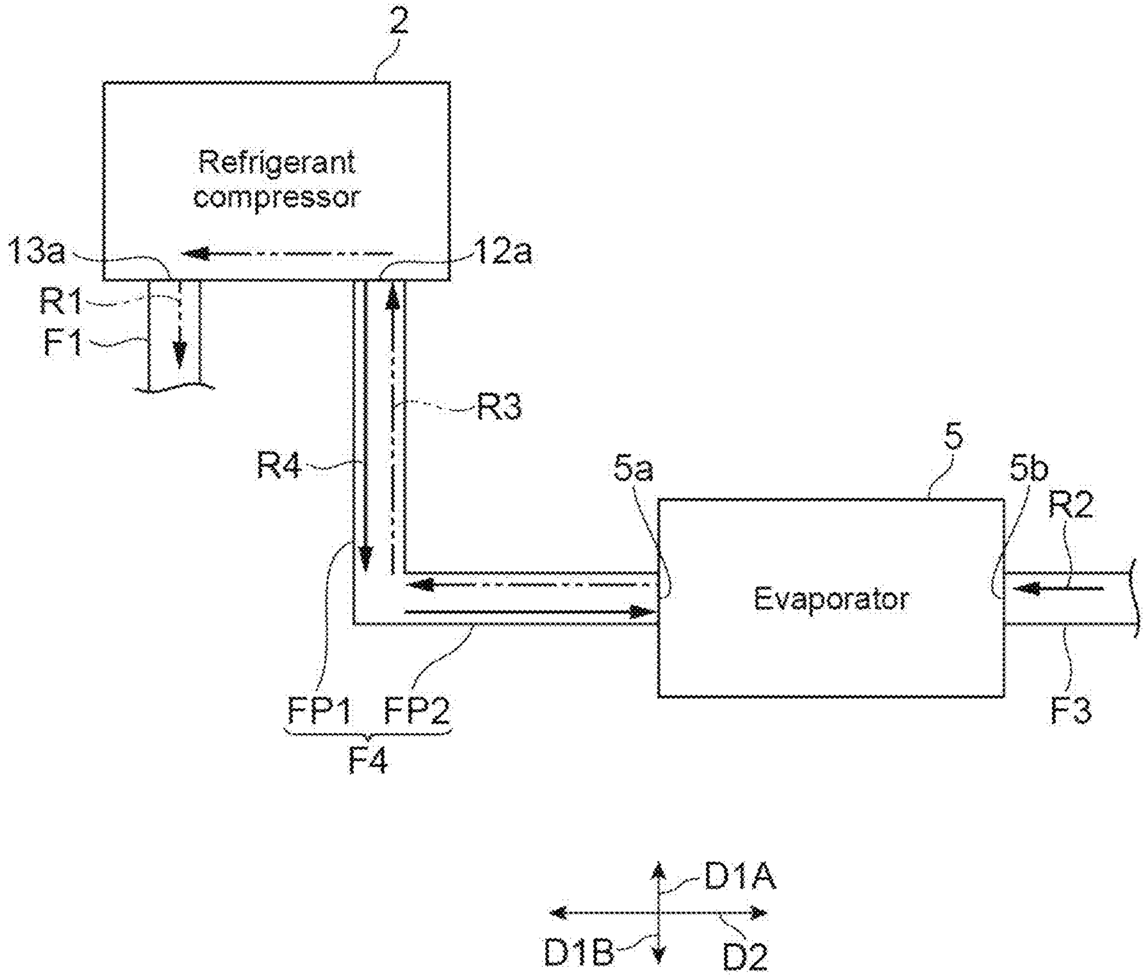

2
Refrigerant compressor
13a
12a
R1
F1
R3
R4
5
5a
5b
R2
Evaporator
FP1
FP2
F4
F3
D1A
D1B
D2

Fig.6A

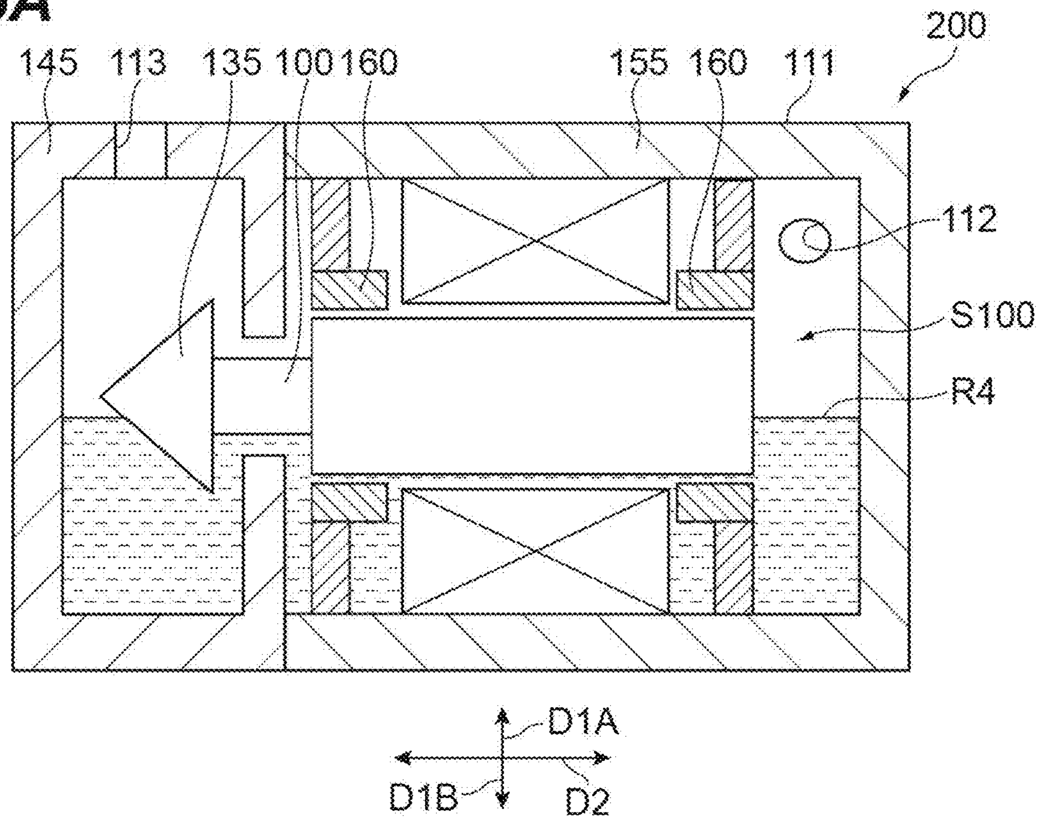
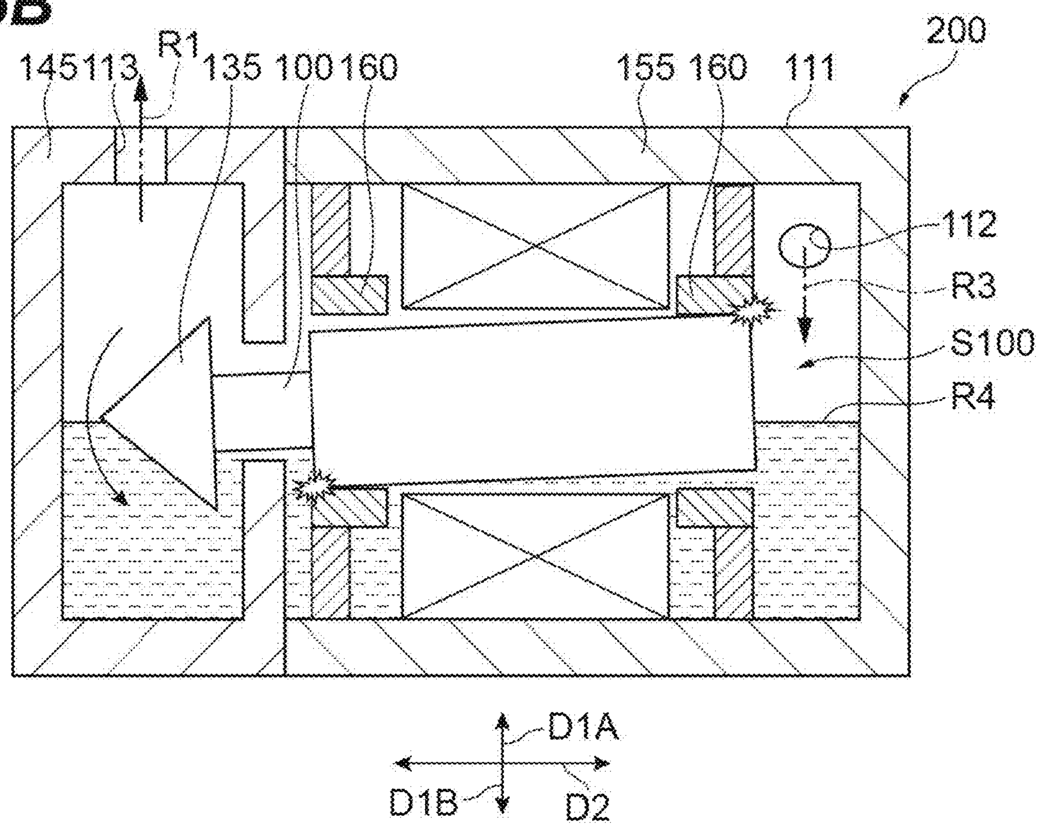

200
145
113
135
100
160
155
160
111
112
S100
R4
D1A
D1B
D2

Fig.6B


200
145
113
R1
135
100
160
155
160
111
112
R3
S100
R4
D1A
D1B
D2

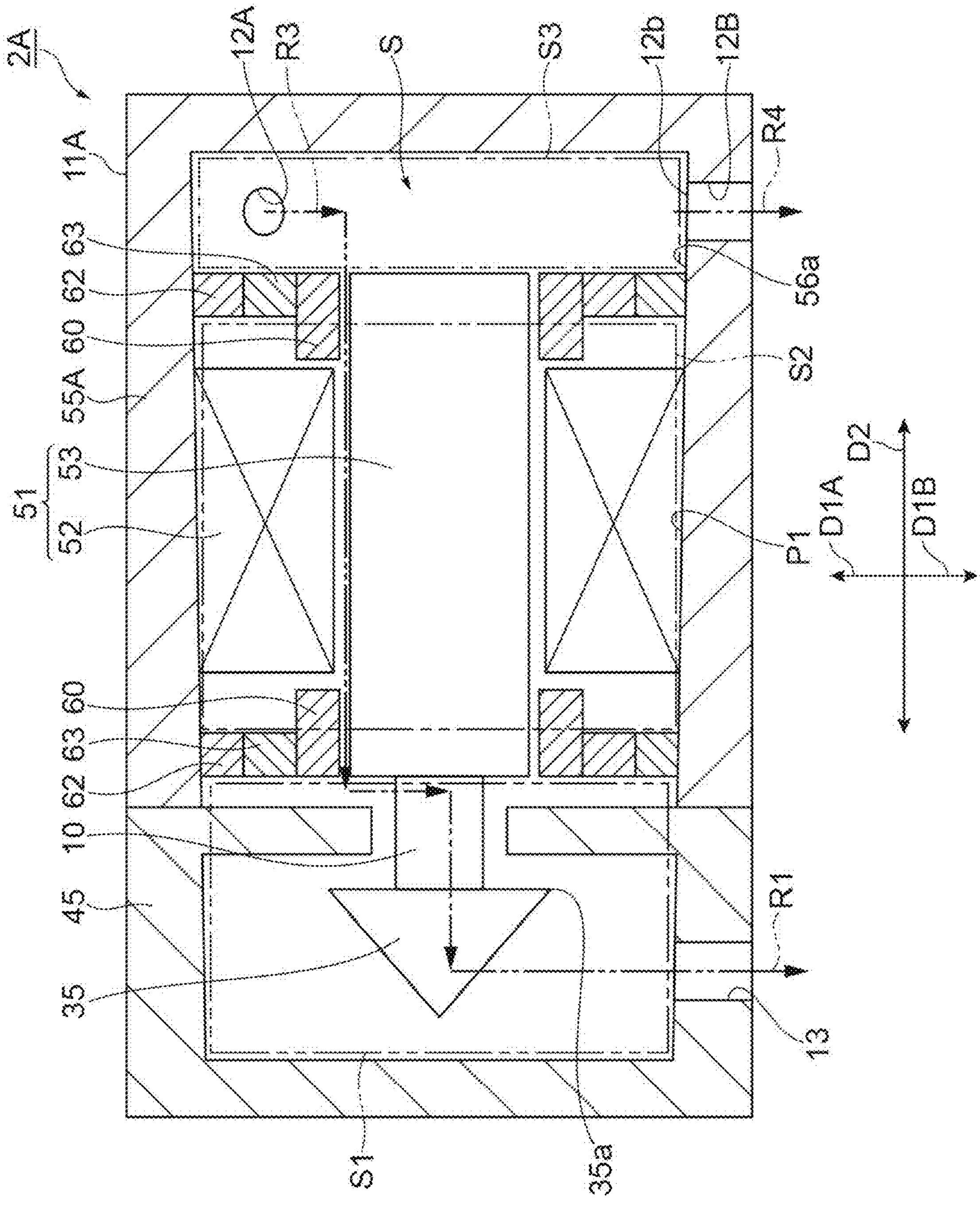

2A
11A
12A
R3
S
S3
12b
12B
R4
56a
S2
D2
D1A
D1B
P1
51
52
53
55A
60
62
63
10
45
35
S1
35a
R1
13

Fig.7

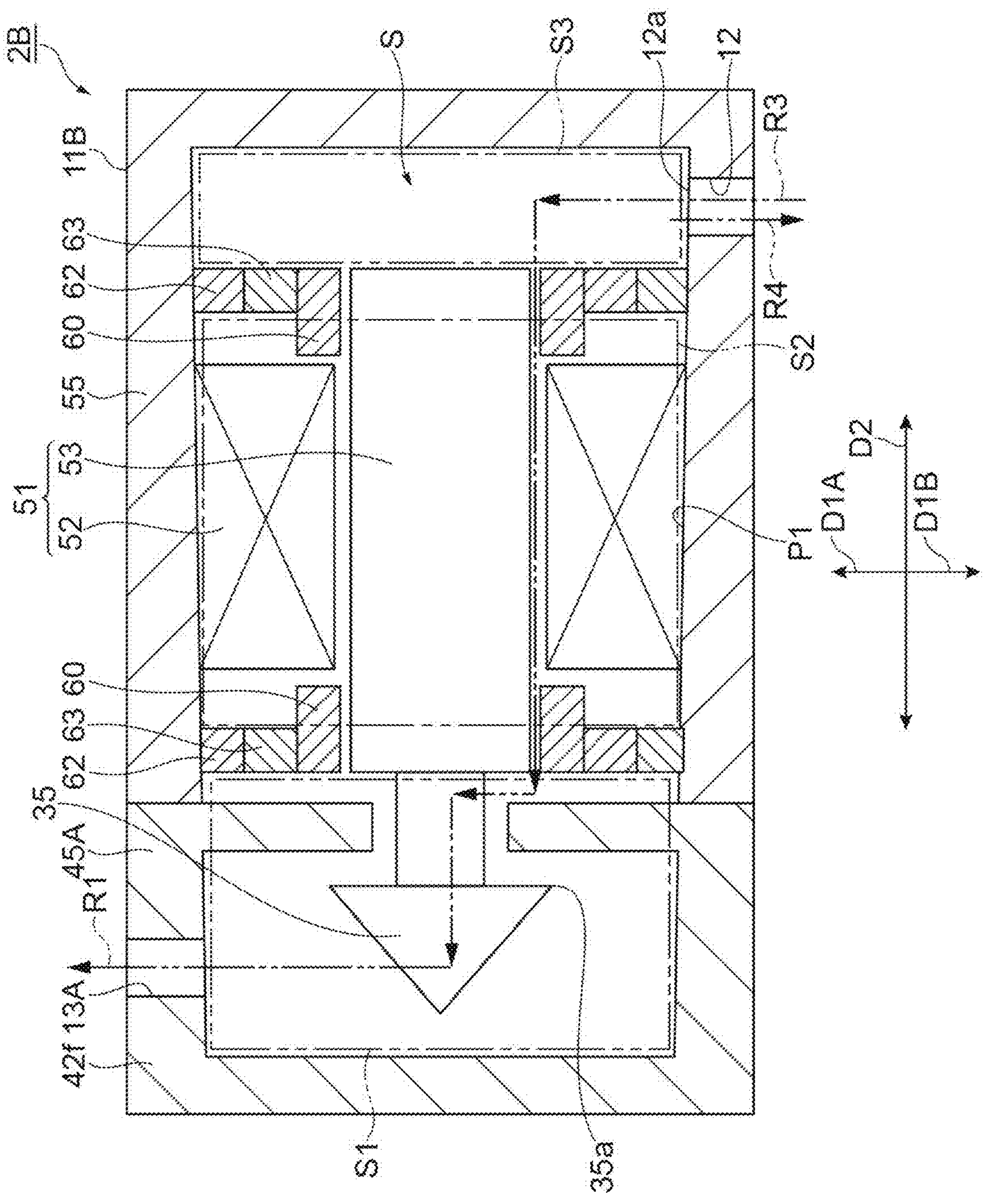

2B
S
S3
12a
12
11B
R3
62 63
62
60
55
R4
S2
51
53
52
D2
D1A
D1B
P1
62 63 60
35
45A
R1
13A
42f
S1
35a

Fig.8

REFRIGERANT COMPRESSOR WITH RETURN OPENING

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation application of PCT Application No. PCT/JP2023/008623, filed on Mar. 7, 2023, which claims the benefit of priority from Japanese Patent Application No. 2022-039282, filed on Mar. 14, 2022, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] Japanese Unexamined Patent Publications No. 2010-071082 and No. 2019-090602 disclose techniques relating to heat pumps. A heat pump has a refrigerant circulation system in which, for example, a refrigerant compressor, a condenser, an expansion valve, and an evaporator are sequentially connected in a ring. In the refrigerant circulation system, the refrigerant vaporized by the evaporator is compressed in the refrigerant compressor, and then heat is dissipated in the condenser to liquefy the refrigerant. The liquefied refrigerant is supplied to the evaporator through the expansion valve, and is vaporized in the evaporator. The vaporized refrigerant is supplied to the refrigerant compressor again. In the refrigerant compressor, a shaft is rotatably supported by a pair of bearings provided inside the housing. The refrigerant is compressed by an impeller rotating together with the shaft.

SUMMARY

[0003] An example refrigerant compressor is configured to compress a refrigerant circulating in a refrigerant circulation system. The refrigerant compressor includes: a rotating body including a shaft, and a protruding part protruding from the shaft in a radial direction and configured to rotate together with the shaft; a non-contact bearing unit rotatably supporting the rotating body; a housing including an inner space accommodating the protruding part; a suction inlet opening into the inner space and configured to supply the refrigerant to the inner space; a refrigerant passage communicating with the suction inlet and connected to an evaporator; a discharge port configured to discharge the refrigerant from the inner space; and a return passage communicating the inner space and the evaporator via a return opening provided in the inner space. The return opening is positioned lower than (more downward than) or below the protruding part in a vertical direction.

BRIEF DESCRIPTION OF DRAWINGS

[0004] FIG. **1** is a block diagram illustrating the configuration of an example freezer having an example refrigerant compressor.

[0005] FIG. **2** is a cross-sectional view illustrating the configuration of the example refrigerant compressor of FIG. **1**.

[0006] FIG. **3** is a cross-section of the example refrigerant compressor taken along line III-III of FIG. **2**

[0007] FIG. **4**A is a schematic cross-sectional view of the example refrigerant compressor during operation.

[0008] FIG. **4**B is a schematic cross-sectional view of the example refrigerant compressor when not in operation.

[0009] FIG. **5** is a diagram illustrating the connection configuration between the example refrigerant compressor and an evaporator.

[0010] FIG. **6**A is a cross-sectional view illustrating a refrigerant compressor of a comparative example when not in operation.

[0011] FIG. **6**B is a cross-sectional view illustrating the refrigerant compressor of the comparative example during operation.

[0012] FIG. **7** is a cross-sectional view illustrating another example refrigerant compressor.

[0013] FIG. **8** is a cross-sectional view illustrating another example refrigerant compressor.

DETAILED DESCRIPTION

[0014] An example refrigerant compressor is configured to compress a refrigerant circulating in a refrigerant circulation system. The refrigerant compressor includes: a rotating body having a shaft, and a protruding part protruding from the shaft in a radial direction and configured to rotate together with the shaft; a non-contact bearing unit rotatably supporting the rotating body; a housing having an inner space accommodating the protruding part; a suction inlet opening into the inner space and configured to supply the refrigerant to the inner space; a refrigerant passage communicating (fluidly coupled) with the suction inlet and connected to an evaporator; a discharge port configured to discharge the refrigerant from the inner space; and a return passage communicating (fluidly coupling) the inner space and the evaporator via a return opening provided in the inner space. The return opening is positioned below or lower than (more downward than) the protruding part in a vertical direction.

[0015] In the example refrigerant compressor above, the refrigerant vaporized in the evaporator passes through the refrigerant passage, is supplied to the inner space of the housing from the suction inlet, and is externally discharged from the discharge port. The refrigerant compressor above includes a return passage communicating (fluidly coupling) the inner space and the evaporator via a return opening provided in the inner space of the housing. The return opening is positioned below or lower than (more downward than) the protruding part of the rotating body in the vertical direction. The refrigerant liquefied in the inner space of the housing thus flows out from the inner space of the housing through the return passage before reaching the protruding part. The liquid that flows through the return passage is returned to the evaporator. The evaporator vaporizes the liquid, which is supplied to the refrigerant compressor again as the refrigerant. Such a configuration in which the liquid of the inner space is returned to the evaporator and vaporized enables the liquid to be efficiently removed from the inner space. As a result, situations in which the level of the liquid in the inner space reaches the protruding part can be suppressed, and situations in which the rotation of the shaft becomes unbalanced can be suppressed. This makes it possible to suppress deviation in the state of contact between the rotating body and the bearing unit at startup.

[0016] In some examples, the return passage may be formed of the refrigerant passage itself. In this case, the refrigerant passage has both the function of supplying the vaporized refrigerant from the evaporator, and the function of returning the refrigerant liquefied in the inner space of the housing to the evaporator. This configuration is capable of providing the function of returning the liquefied refrigerant to the evaporator, and the function of supplying the refrigerant from the evaporator through the same passage, thereby simplifying the configuration of the refrigerant compressor.

[0017] In some examples, the bearing unit may include a pair of bearings disposed along the axial direction in which the shaft extends, and supporting the shaft in a radial direction. The inner space may include a first inner region, a second inner region, and a third inner region communicating (fluidly coupled) with each other in the axial direction. The second inner region may be positioned between the pair of bearings in the axial direction. The first inner region may be positioned on one side of the pair of bearings in the axial direction. The third inner region may be positioned on another side of the pair of bearings in the axial direction. The suction inlet may communicate (be fluidly coupled) with the third inner region. The discharge port may communicate (be fluidly coupled) with the first inner region. In this case, the refrigerant supplied from the suction inlet passes through the pair of bearings and is discharged from the discharge port, so that the pair of bearings can be cooled using this flow of the refrigerant.

[0018] In some examples, the return passage may pass downward through the housing in the vertical direction from the inner space. In this case, the liquid generated in the inner space of the housing is capable of easily flowing into the return passage according to gravity. Accordingly, the liquid can be effectively removed from the inner space.

[0019] In some examples, the discharge port may pass downward through the housing in the vertical direction from the inner space at a position different from a position of the return passage. In this case, the discharge port can also be used as a passage for removing the liquid from the inner space of the housing in addition to the return passage. Accordingly, the liquid can be more effectively removed from the inner space.

[0020] In some examples, an inner wall surface of the housing may include an inclined part sloping downward toward the return opening between the discharge port and the return passage. In this case, the liquid generated in the inner space of the housing is capable of easily flowing into the return passage than into the discharge port according to gravity. Accordingly, the liquid can be actively flown to the evaporator. In such a case in which the liquid is actively flown to the evaporator that vaporizes the liquid, situations in which the flown liquid is pushed back to the refrigerant compressor does not tend to occur compared, for example, to a case in which the liquid is flown to another device such as a condenser in which the liquid tends to accumulate. Consequently, the liquid can be more effectively removed from the inner space by actively flowing the liquid to the evaporator.

[0021] In some examples, the discharge port may pass upward through the housing in the vertical direction from the inner space. In this case, the liquid generated in the inner space of the housing can be prevented from flowing into the discharge port, so that situations in which the flown liquid is pushed back to the refrigerant compressor does not tend to occur. Accordingly, the liquid can be more effectively removed from the inner space.

[0022] Hereinafter, with reference to the drawings, the same elements or similar elements having the same function are denoted by the same reference numerals, and redundant description will be omitted.

[0023] An example freezer **1** illustrated in FIG. **1** may be installed, for example, in a building or a factory to generate cooling water for ventilation. The freezer **1**, for example, includes a refrigerant compressor **2**, a condenser **3**, an expansion valve **4**, and an evaporator **5**. The refrigerant compressor **2**, the condenser **3**, the expansion valve **4**, and the evaporator **5** form a refrigerant circulation system **6** in which a refrigerant (e.g., fluorocarbon) circulates. In the refrigerant circulation system **6**, thermal energy is received and transmitted by the refrigerant undergoing phase changes while circulating the refrigerant compressor **2**, the condenser **3**, the expansion valve **4**, and the evaporator **5**.

[0024] The refrigerant compressor **2** is connected to the condenser **3** via a passage F**1**. The condenser **3** is connected to the expansion valve **4** via a passage F**2**. The expansion valve **4** is connected to the evaporator **5** via a passage F**3**. The evaporator **5** is connected to the refrigerant compressor **2** via a passage F**4**. These passages F**1**, F**2**, F**3**, and F**4** form a circulation passage for the refrigerant to flow through and circulate the refrigerant compressor **2**, the condenser **3**, the expansion valve **4**, and the evaporator **5**.

[0025] The refrigerant compressor **2** generates a compressed refrigerant gas R**1** by compressing a refrigerant gas R**3** supplied from the evaporator **5**. The refrigerant compressor **2** supplies the generated compressed refrigerant gas R**1** to the condenser **3** via the passage F**1**. The condenser **3** generates a liquid refrigerant R**2** by cooling and liquefying the compressed refrigerant gas R**1** which has high temperature and high pressure by being compressed by the refrigerant compressor **2**. The condenser **3** supplies the generated liquid refrigerant R**2** to the expansion valve **4** via the passage F**2**. The expansion valve **4** reduces the pressure of the liquid refrigerant R**2** which has been liquefied by the condenser **3**. The expansion valve **4** supplies the liquid refrigerant R**2** having reduced pressure to the evaporator **5** via the passage F**3**.

[0026] The evaporator **5** generates the refrigerant gas R**3** by evaporating the liquid refrigerant R**2** for which the pressure has been reduced by the expansion valve **4**. The evaporator **5** cools an object to be cooled (e.g., cooling water) by the heat of vaporization generated when the refrigerant gas R**3** is generated due to the evaporation of the liquid refrigerant R**2**. The evaporator **5** supplies the generated refrigerant gas R**3** to the refrigerant compressor **2** via the passage F**4**. The refrigerant gas R**3** supplied to the refrigerant compressor **2** is supplied to the condenser **3** again as the compressed refrigerant gas R**1** after being compressed by the refrigerant compressor **2**. The compressed refrigerant gas R**1**, the liquid refrigerant R**2**, and the refrigerant gas R**3** are examples of the potential states of the refrigerant in the refrigerant circulation system **6**.

[0027] The configuration of the refrigerant compressor **2** will next be described in detail with reference to FIG. **2**. The refrigerant compressor **2** is a so-called two-stage compressor. As illustrated in FIG. **2**, the refrigerant compressor **2** includes a shaft **10**, a compressor unit **30**, and a motor unit **50**. In the description below, "upward D1A" refers to upward in a vertical direction (gravity direction) of the refrigerant compressor **2**, when the refrigerant compressor **2** is installed in a location of use, and "downward D1B" refers to downward in the vertical direction. In some examples, the refrigerant compressor **2** is disposed such that an axis of rotation L of the shaft **10** extends in a horizontal direction of the refrigerant compressor **2**, when the refrigerant compressor **2** is installed in the location of use. Consequently, an axial direction D**2** in which the axis of rotation L extends is perpendicular to the vertical direction. In the description below, "upstream" refers to upstream in a direction of flow of the refrigerant that flows through the refrigerant compressor **2**, and "downstream" refers to downstream in the direction of flow.

[0028] The compressor unit **30** has a first impeller **31**, a second impeller **32**, a first impeller housing **41** that accommodates the first impeller **31**, and a second impeller housing **42** that accommodates the second impeller **32**. The first impeller **31** and the first impeller housing **41** form a low pressure-side compression stage. The second impeller **32** and the second impeller housing **42** form a high pressure-side compression stage. The first impeller **31** and the second impeller **32** are attached to one end portion **10***a* of the shaft **10**. Each of the first impeller **31** and the second impeller **32** is a protruding part (or a radial projection) that extends outward from the shaft **10** in a radial direction, and rotates about the axis of rotation L integrally with the shaft **10**. The first impeller **31** and the second impeller **32** are, for example, disposed such that rear surfaces thereof face each other in the axial direction D**2** with a gap therebetween. The second impeller **32** is, for example, disposed coaxial with the first impeller **31**, and has the same dimensions as the first impeller **31**. The first impeller **31** is, for example, disposed between the second impeller **32** and the motor unit **50** in the axial direction D**2**. Hereinafter, when the first impeller **31** and the second impeller **32** are described without any distinction, they are collectively referred to as an "impeller **35**."

[0029] The first impeller housing **41** and the second impeller housing **42** are connected to each other in the axial direction D**2**. An interstage plate **43** is provided between the first impeller housing **41** and the second impeller housing **42**. The interstage plate **43** is connected to the first impeller housing **41** and the second impeller housing **42** in the axial direction D**2**. Consequently, the second impeller housing **42** is connected to the first impeller housing **41** in the axial direction D**2** via the interstage plate **43**.

[0030] The motor unit **50** has an electric motor **51** and a motor housing **55** that accommodates the electric motor **51**. The electric motor **51** is a drive source for driving the compressor unit **30**. The electric motor **51** includes a stator **52** that is fixed to the motor housing **55**, and a rotor **53** that is fixed to the shaft **10**. The rotor **53** faces the stator **52** with a gap therebetween. The motor housing **55** is connected to the first impeller housing **41** in the axial direction D**2**. The motor housing **55**, the first impeller housing **41**, the interstage plate **43**, and the second impeller housing **42** form a housing **11** of the refrigerant compressor **2**.

[0031] The shaft **10** to which the first impeller **31** and the second impeller **32** are attached is accommodated in an inner space S of the housing **11**. The inner space S is a space defined by an inner wall surface **11***a* of the housing **11**. The shaft **10** extends across the motor housing **55**, the first impeller housing **41**, the interstage plate **43**, and the second impeller housing **42** in the axial direction D**2** in the inner space S. The shaft **10** is supported so as to be rotatable about the axis of rotation L by a pair of bearings **60**, **60** and a pair of bearings **64**, **64** provided inside the motor housing **55**. The pair of bearings **60**, **60** and the pair of bearings **64**, **64** form a "bearing unit". The pair of bearings **60**, **60** are provided so as to surround the shaft **10**, and are disposed in positions such that the electric motor **51** is disposed therebetween in the axial direction D**2**.

[0032] The inner space S of the housing **11** has a first inner region (or outlet region) S**1**, a second inner region (or intermediate region) S**2**, and a third inner region (or inlet region) S**3**. The first inner region S**1**, the second inner region S**2**, and the third inner region S**3** are arranged in order along the axial direction D**2** and communicate (be fluidly coupled) with each other. The second inner region S**2** is positioned between the pair of bearings **60**, **60** in the axial direction D**2**. The second inner region S**2** is surrounded by a center portion of the motor housing **55**. The electric motor **51** disposed between the pair of bearings **60**, **60** is disposed in the second inner region S**2**. The first inner region (or outlet region) S**1** is positioned on one side of the pair of bearings **60**, **60** in the axial direction D**2** on which the first impeller **31** and the second impeller **32** are positioned. The first inner region S**1** is surrounded mainly by the first impeller housing **41**, the second impeller housing **42**, and the interstage plate **43**. The third inner region (or inlet region) S**3** is positioned on the other side of the pair of bearings **60**, **60** in the axial direction D**2**. The third inner region S**3** is surrounded by an end portion of the motor housing **55** positioned on the opposite side from the first impeller housing **41** in the axial direction D**2**.

[0033] The housing **11** has a suction port **12** and a discharge port **13**. The suction port **12** is a port for sucking the refrigerant gas R**3** from the evaporator **5** (see FIG. **1**) into the inner space S. The suction port **12** communicates (is fluidly coupled) with the inner space S, and is connected to the evaporator **5** via the passage F**4**. The refrigerant gas R**3** sucked into the inner space S is compressed by the first impeller **31** and the second impeller **32** that rotate together with the shaft **10**. The discharge port **13** is a port for discharging the compressed refrigerant gas R**1** compressed in the inner space S from the inner space S to the condenser **3** (see FIG. **1**). The discharge port **13** communicates (is fluidly coupled) with the inner space S, and is connected to the condenser **3** via the passage F**1**. The suction port **12** is, for example, formed in the motor housing **55**, and communicates (is fluidly coupled) with the third inner region (or inlet region) S**3**. The discharge port **13** is, for example, formed in the second impeller housing **42**, and communicates (is fluidly coupled) with the first inner region (or outlet region) S**1**. Further configurations of the suction port **12** and the discharge port **13** will be described further below.

[0034] The motor housing **55**, for example, has a cylindrical side wall **56** centered about the axis of rotation L, and a disk-shaped end wall **57** that closes one end of the side wall **56** in the axial direction D**2**. The side wall **56** surrounds the rotor **53** that is fixed to the shaft **10**. The stator **52** is fixed to an inner surface **56***a* of the side wall **56**. A pair of support parts **61**, **61** that support the pair of bearings **60**, **60** are provided on the inner surface **56***a* of the side wall **56**.

[0035] As illustrated in FIG. **3**, each of the pair of support parts **61**, **61** includes a ring-like member **62** and four rod-like members **63**. The ring-like member **62**, for example, has an annular shape when viewed in the axial direction D**2**. The ring-like member **62** is disposed so as to surround the bearing **60** in a circumferential direction D**3**, and is fixed to the inner surface **56***a* of the side wall **56**. The four rod-like members **63** extend in a cross shape centered about the bearing **60**, and connects the bearing **60** to the ring-like member **62**. The shaft **10** is disposed so as to pass through the inside of the bearing **60**. The bearing **60** is a non-contact radial bearing. Examples of the bearing **60** include an air bearing, a gas bearing, and a magnetic bearing. During the rotation of the shaft **10**, the bearing **60** is disposed with a gap between the rotor **53** (see FIG. **2**), and supports the rotor **53** and the shaft **10** in the radial direction without contact.

[0036] Reference is made back to FIG. **2**. The second inner region S**2** communicates (is fluidly coupled) with the first inner region S**1** via the spaces between the rod-like members **63** in the circumferential direction D**3** (see FIG. **3**) and the gap between the rotor **53** and one of the bearings **60**. The second inner region S**2** communicates (is fluidly coupled) with the third inner region S**3** via the spaces between the rod-like members **63** in the circumferential direction D**3** and the gap between the rotor **53** and the other of the bearings **60**. Consequently, a fluid such as the refrigerant gas R**3** is capable of moving through the first inner region S**1**, the second inner region S**2**, and the third inner region S**3** in the inner space S of the housing **11**.

[0037] The pair of bearings **64**, **64** are, for example, provided so as to surround the shaft **10** in the third inner region S**3**, and disposed with gaps therebetween in the axial direction D**2**. The pair of bearings **64**, **64** are non-contact thrust bearings. Examples of the pair of bearings **64**, **64** include an air bearing, a gas bearing, and a magnetic bearing. A thrust collar **65** is provided between the pair of bearings **64**, **64**. The thrust collar **65** is a flange-shaped protruding part protruding from the shaft **10** at an end portion **10***b* of the shaft, and rotates about the axis of rotation L integrally with the shaft **10**. An annular spacer **67** that surrounds the circumference of the thrust collar **65** is provided between the pair of bearings **64**, **64**.

[0038] The pair of bearings **64**, **64** and the spacer **67** are fastened so as to be integrated by a plurality of fastening bolts. The pair of bearings **64**, **64** and the spacer **67** integrated with each other are fixed to the inner surface **56***a* of the side wall **56**. The pair of bearings **64**, **64** and the spacer **67** define an accommodation space in which the thrust collar **65** is accommodated. In this accommodation space, the thrust collar **65** rotates about the axis of rotation L together with the shaft **10** in a non-contact manner with the pair of bearings **64**, **64** and the spacer **67**. The pair of bearings **64**, **64**, the spacer **67**, and the thrust collar **65** support the rotor **53** and the shaft **10** in an axial direction D**1** without contact. The thrust collar **65**, the impeller **35**, and the shaft **10** rotate integrated with each other to form a rotating body RB.

[0039] The first impeller housing **41** is disposed so as to close the opening of the side wall **56** opposite from the end wall **57** in the axial direction D**2**. The first impeller housing **41** includes an inlet **41***a*, a diffuser passage **41***b*, a scroll passage **41***c*, and an outlet **41***d*. The inlet **41***a* is an opening that is coaxial with the shaft **10**, and communicates with the inside of the motor housing **55**. Consequently, the refrigerant gas R**3** sucked into the motor housing **55** flows into the inlet **41***a*. The first impeller **31** is disposed inward of the inlet **41***a*. Speed energy is applied to the refrigerant gas R**3** by the rotation of the first impeller **31**.

[0040] The scroll passage **41***c* is formed so as to surround the first impeller **31**. The diffuser passage **41***b* is formed between the first impeller **31** and the scroll passage **41***c*. The diffuser passage **41***b* compresses the refrigerant gas R**3** by converting the speed energy applied to the refrigerant gas R**3** into compression energy. The scroll passage **41***c* discharges the refrigerant gas R**3** compressed by the diffuser passage **41***b* outside the first impeller housing **41** from the outlet **41***d*. The outlet **41***d* is, for example, an opening that opens on a circumferential surface of the first impeller housing **41**.

[0041] The second impeller housing **42** includes an inlet **42***a*, a diffuser passage **42***b*, a scroll passage **42***c*, and the discharge port **13**. The inlet **42***a* is an opening that is coaxial with the inlet **41***a* of the first impeller housing **41**, and faces away from the inlet **41***a*. The inlet **42***a* is connected to the outlet **41***d* of the first impeller housing **41** via an external pipe **70**. Consequently, the refrigerant gas R**3** from the outlet **41***d* flows into the inlet **42***a* via the external pipe **70**. The second impeller **32** is disposed inward of the inlet **42***a*. Speed energy is applied to the refrigerant gas R**3** by the rotation of the second impeller **32**.

[0042] The scroll passage **42***c* is formed so as to surround the second impeller **32**. The diffuser passage **42***b* is formed between the second impeller **32** and the scroll passage **42***c*. The diffuser passage **42***b* further compresses the refrigerant gas R**3** by converting the speed energy applied to the refrigerant gas R**3** into compression energy. As a result, the compressed refrigerant gas R**1** is generated. The scroll passage **42***c* discharges the generated compressed refrigerant gas R**1** outside the second impeller housing **42** from the discharge port **13**.

[0043] The configurations of the suction port **12** and the discharge port **13** above will be further described. The suction port **12** includes a suction inlet **12***a* that opens on the inner wall surface **11***a*. The suction inlet **12***a* is disposed lower (more downward) D**1**B than the protruding part of the rotating body RB in the vertical direction. The suction inlet **12***a* being disposed more downward D**1**B than the protruding part of the rotating body RB refers to at least a portion of the suction inlet **12***a* being positioned lower or more downward D**1**B than a lower end of the protruding part when the refrigerant compressor **2** is installed in a location of installation. In some examples, the suction inlet **12***a* may be positioned entirely below the protruding part in the vertical direction. The "protruding part" herein may be one of the impeller **35** and the thrust collar **65** that is positioned more downward than the other. For example, in a case in which the "protruding part" refers to the impeller **35** (i.e., in a case in which the impeller **35** is positioned more downward D**1**B than the thrust collar **65**), the lower end of the "protruding part" refers to a lower end **35***a* of the impeller **35**. In this case, the suction inlet **12***a* is positioned more downward (or lower) D**1**B than at least the lower end **35***a* of the impeller **35**. In other words, the suction inlet **12***a* is positioned within a region RH between an outer surface **56***b* positioned at a lower end of the housing **11**, and the lower end **35***a* of the impeller **35**. The lower end **35***a* of the impeller **35** is a lowest (most downward) D**1**B portion of the impeller **35**. It can be said that the lower end **35***a* of the impeller **35** is a lowermost tip end or lowest position of the impeller **35**, that is, a tip end or position of the impeller **35** that is closest to the lower end of the housing **11**. Namely, the shaft **10** of the rotating body RB extending in the horizontal direction or axial direction D**2**, the impeller **35** corresponds to a radial projection having an outermost edge in the radial direction that forms the lowermost tip end or lowest position **35***a* of the rotating body RB in the vertical direction, such that the suction inlet **12***a* is positioned lower than the lowest position **35***a* of the rotating body RB in the vertical direction.

[0044] The suction inlet **12***a* being positioned more downward D**1**B than the impeller **35** refers to at least a part of the suction inlet **12***a* being positioned more downward D**1**B than the lower end **35***a* of the impeller **35**. That is, the suction inlet **12***a* has at least a portion that is positioned in the region RH. Consequently, the suction inlet **12***a* may have a portion that overlaps the impeller **35** in the horizontal direction. In some examples, the first impeller **31** and the second impeller **32** are disposed at the same height with each other, and have the same dimensions. Thus, the height of the lower end of the first impeller **31** and the height of the lower end of the second impeller **32** are the same. In a case in which the lower end of the first impeller **31** and the lower end of the second impeller **32** are different from each other, the lower end **35***a* of the impeller **35** may be the lower end of one of the first impeller **31** and the second impeller **32** that has a greater outer diameter.

[0045] In a case in which the "protruding part" refers to the thrust collar **65** (i.e., in a case in which the thrust collar **65** is positioned more downward D**1**B than the impeller **35**), the lower end of the "protruding part" refers to a lower end **65***a* of the thrust collar **65**. In this case, the suction inlet **12***a* is positioned more downward (or lower) D**1**B than at least the lower end **65***a* of the thrust collar **65**. The lower end **65***a* of the thrust collar **65** is a lowest (most downward) D**1**B portion of the thrust collar **65**. It can be said that the lower end **65***a* of the thrust collar **65** is a lowermost tip end or lowest position of the thrust collar **65**, that is, a tip end or position of the thrust collar **65** that is closest to the lower end of the housing **11**. Namely, the shaft **10** of the rotating body RB extending in the horizontal direction or axial direction D**2**, the thrust collar **65** corresponds to a radial projection having an outermost edge in the radial direction that forms the lowermost tip end or lowest position **65***a* of the rotating body RB in the vertical direction, such that the suction inlet **12***a* is positioned lower than the lowest position **65***a* of the rotating body RB in the vertical direction. The suction inlet **12***a* being positioned lower than (or more downward) D**1**B than the thrust collar **65** refers to at least a part of the suction inlet **12***a* being positioned more downward D**1**B than the lower end **65***a* of the thrust collar **65**. Either one of the impeller **35** or the thrust collar **65** may be positioned lower or more downward D**1**B than the other depending on the design. Namely, in a case in which the rotating body includes both the impeller **35** and the thrust collar **65**, the suction inlet **12***a* is located lower than both the impeller **35** and the thrust collar **65**. In some examples, the suction inlet **12***a* is located radially outwardly of both the impeller **35** and the thrust collar **65**.

[0046] The suction port **12** is, for example, formed so as to pass downward D**1**B through the side wall **56** from the third inner region S**3** of the motor housing **55**. For example, the suction port **12** passes through a lower end portion **56***c* of the side wall **56** surrounding the third inner region S**3**, in the vertical direction, from the inner surface **56***a* to the outer surface **56***b*. The lower end portion **56***c* is a downward D**1**B wall portion of the side wall **56** in the cross-section illustrated in FIG. **2**. Consequently, the suction inlet **12***a* opens on the inner surface **56***a* of the lower end portion **56***c*, and communicates (is fluidly coupled) with the third inner region S**3**. The discharge port **13** is, for example, formed so as to pass downward D**1**B through the second impeller housing **42** from the first inner region S**1** of the second impeller housing **42**. That is, the discharge port **13** passes through a lower end portion **42***d* of the second impeller housing **42** surrounding the first inner region S**1**, in the vertical direction. The lower end portion **42***d* is a downward D**1**B wall portion of the second impeller housing **42** in the cross-section illustrated in FIG. **2**. The discharge port **13** communicates (is fluidly coupled) with the first inner region S**1**. A discharge outlet **13***a* of the discharge port **13** opens on an outer surface **42***e* of the lower end portion **42***d*.

[0047] The inner surface **56***a* of the side wall **56** has an inclined part P**1** between the suction port **12** and the discharge port **13** in the axial direction D**2**. The inclined part P**1** may be a tapered surface that has a gradually decreasing diameter from the suction port **12** to the discharge port **13**. In the cross-section illustrated in FIG. **2**, the inclined part P**1** is inclined so as to slope downward toward the suction inlet **12***a*. That is, the inclined part P**1** is inclined so as to be positioned gradually downward D**1**B in the axial direction D**2**, from the discharge port **13** to the suction inlet **12***a*. The inclined part P**1** is, for example, formed continuously from an end portion of the side wall **56** closer to the first impeller housing **41** to the suction inlet **12***a*. In some examples, the suction inlet **12***a* is formed in the housing at a lowest position of the inner space S.

[0048] The flow of the refrigerant that flows through the refrigerant compressor **2** having the configuration above will be described. A schematic example of the refrigerant compressor **2** as illustrated in FIG. **4**A and FIG. **4**B will be used here for the sake of simplicity. In FIG. **4**A and FIG. **4**B, the first impeller **31** and the second impeller **32** are collectively shown as the impeller **35**, and the first impeller housing **41**, the interstage plate **43**, and the second impeller housing **42** (cf. FIG. **2**) are collectively shown as an impeller housing **45** in FIGS. **4**A and **4**B. Additionally, for the sake of simplicity, the pair of bearings **64**, **64**, the thrust collar **65**, and the spacer **67** are omitted, and the "impeller **35**" is considered the "protruding part" in the example of FIGS. **4**A and **4**B. It should be noted that in the case in which the "thrust collar **65**" is considered the "protruding part", the "impeller **35**" in the explanation can be replaced with the "thrust collar **65**."

[0049] As illustrated in FIG. **4**A, during operation of the refrigerant compressor **2**, the refrigerant gas R**3** supplied to the refrigerant compressor **2** from the upstream evaporator **5** (see FIG. **1**) is sucked (supplied) into the third inner region S**3** from the suction port **12** formed in downward D**1**B of the motor housing **55**. The refrigerant gas R**3** sucked into the third inner region S**3** passes the second inner region S**2** and the first inner region S**1** in order, during which the refrigerant gas R**3** cools the pair of bearings **60**, **60**, the rotor **53**, and the stator **52** along the flow path. The refrigerant gas R**3** that reaches the impeller **35** in the first inner region S**1** is compressed by the rotation of the impeller **35**. The compressed refrigerant gas R**1** is thus generated. The generated compressed refrigerant gas R**1** is discharged from the discharge port **13** formed in downward D**1**B of the impeller housing **45** to the downstream condenser **3**.

[0050] As illustrated in FIG. **4**B, when the refrigerant compressor **2** is not in operation, the refrigerant gas R**3** filling the inner space S of the housing **11** may liquefy due to the drop in temperature, and become a liquid R**4** in the inner space S. The liquid R**4** may be a liquid that includes the liquid refrigerant R**2** which is the liquefied refrigerant gas R**3**. In some examples, the suction port **12** is formed in downward D**1**B of the motor housing **55**, so that the liquid R**4** in the inner space S flows out of the housing **11** from the suction port **12** according to gravity. The suction port **12** is connected to the upstream evaporator **5** (see FIG. **1**). Consequently, the liquid R**4** that flows out from the suction port **12** returns to the evaporator **5**. The liquid R**4** that returns to the evaporator **5** is vaporized in the evaporator **5**, and supplied to the inner space S from the suction port **12** again as the refrigerant gas R**3**.

[0051] Consequently, in some examples, the suction port **12** has the function of a return port that returns the liquid R**4** that may accumulate in the inner space S to the upstream evaporator **5**, in addition to the function of a suction port that sucks the refrigerant gas R**3** from the upstream evaporator **5** into the inner space S of the housing **11**. The suction inlet **12***a* of the suction port **12** located at the inlet region S**3** thus also serves as a return opening through which the liquid R**4** that returns to the upstream evaporator **5** flows. That is, in some examples, the suction port **12** is an inlet path for the refrigerant gas R**3** that flows into the inner space S of the housing **11** from the upstream evaporator **5** as well as an outlet path for the liquid R**4** that flows out from the inner space S to the upstream evaporator **5**. It can be said that the return port that returns the liquid R**4** generated in the inner space S to the evaporator **5** is formed by the suction port **12** (i.e., formed integrally with the suction port **12**). That is, it can be said that the return opening is formed by the suction inlet **12***a* that is located at the inlet region S**3**. Namely, a single opening forms the suction inlet **12***a* and the return opening. The suction inlet **12***a* is connected to the evaporator **5** via the suction port **12** and the passage F4 (see FIG. **1**). The suction port **12** and the passage F4 form a refrigerant passage that supplies the refrigerant gas R**3** from the evaporator **5** to the inner space S. It can be said that the suction port **12** and the passage F4 form a return passage that returns the liquid R**4** generated in the inner space S to the evaporator **5**. Accordingly, the return passage and the refrigerant passage form a continuous passage that is fluidly coupled with the suction inlet **12***a* and the evaporator **5**. Namely, the continuous passage (return passage or refrigerant passage) extends from the evaporator **5** to the suction inlet **12***a* in a flow direction of the refrigerant gas R**3**. In some examples, the continuous passage (or return passage) extends downward D**1**B from the suction inlet **12***a* to the evaporator **5**.

[0052] Furthermore, in some examples, the discharge port **13** is formed in downward D**1**B of the impeller housing **45**. Thus, as illustrated in FIG. **4**B, the liquid R**4** generated in the first inner region **S1** flows out from the discharge port **13** according to gravity. The liquid R**4** discharged from the discharge port **13** flows to the downstream condenser **3** (see FIG. **1**), and circulates the refrigerant circulation system **6**. Consequently, some examples are configured so as to externally remove the liquid R**4** generated in the inner space S from the inner space S through the suction port **12** and the discharge port **13** which are formed in downward D**1**B of the housing **11**.

[0053] FIG. **5** illustrates the connection configuration of the suction inlet **12***a* of the refrigerant compressor **2** and the evaporator **5**. As illustrated in FIG. **5**, the evaporator **5** is positioned more downward D**1**B than the suction inlet **12***a* of the refrigerant compressor **2**. The evaporator **5** is connected to the suction inlet **12***a* via the passage F4 and the suction port **12**. It can be said that the passage F4 and the suction port **12** communicate (fluidly couple) the inner space S of the refrigerant compressor **2** (see FIG. **2**) and the evaporator **5** via the suction inlet **12***a*. The passage F4 has a linear passage FP**1** and a linear passage FP**2**. The linear passage FP**1** extends downward D**1**B from the suction inlet **12***a*. The linear passage FP**2** extends in the axial direction D2 from a lower end of the linear passage FP**1**, and is connected to a downstream flow port **5***a* of the evaporator **5**.

[0054] After flowing downward D**1**B through the linear passage FP**1** according to gravity, the liquid R**4** from the suction inlet **12***a* flows through the linear passage FP**2** in the axial direction D**1**, and then flows into the flow port **5***a* of the evaporator **5**. This configuration enables the liquid R**4** generated in the refrigerant compressor **2** to return easily to the evaporator **5** using gravity. The connection configuration between the refrigerant compressor **2** and the evaporator **5** is not limited to the example illustrated in FIG. **5**. For example, the passage F**4** may be connected to the downstream flow port **5***a* of the evaporator **5**, and another passage may be connected to an upstream flow port **5***b* of the evaporator **5**. The flow port **5***b* may be connected to the suction inlet **12***a* or to an opening other than the suction inlet **12***a* via this other passage. In this case, the liquid R**4** can be returned to the evaporator **5** by the other passage. A curved part that is curved downward D**1**B may be formed on the entirety or a part of the linear passage FP**2** of the passage F**4**. In this case, the refrigerant compressor **2** may have a mechanism to evaporate the accumulated liquid R**4** that may be generated in the curved part.

[0055] The operation and effects of the example refrigerant compressor **2** and the example freezer **1** described above will now be described together with the problem of a comparative example. FIG. **6**A and FIG. **6**B schematically illustrate a refrigerant compressor **200** according to a comparative example. In the refrigerant compressor **200**, a suction port **112** formed in a motor housing **155** of a housing **111** is positioned higher (more upward) D**1**A than an impeller **135** that is attached to a shaft **100**. A discharge port **113** formed in an impeller housing **145** is positioned higher (more upward) D**1**A than the impeller **135**. In the refrigerant compressor **200**, the refrigerant gas R**3** sucked into an inner space S**100** from the suction port **112** passes through a pair of bearings **160**, **160**, and the like, and reaches the impeller **135**. The refrigerant gas R**3** is compressed by the rotation of the impeller **135**, and is discharged from the discharge port **113** of the impeller housing **145** as the compressed refrigerant gas R**1**.

[0056] The inventors have discovered that, when the refrigerant compressor **200** is not in operation, the refrigerant gas R**3** filling the inner space S**100** may liquefy and accumulate in the inner space S**100** as the liquid R**4**, and as a result, the level of the liquid R**4** may reach the impeller **135** in the inner space S**100** as illustrated in FIG. **6**A. The inventors recognized that since the lower portion of the impeller **135** is soaked in the liquid R**4**, when the refrigerant compressor **200** is operated in this state, the impeller **135** rotates while being exposed to a large resistive force from the liquid R**4**, and that due to rotating while being exposed to a large resistive force from the liquid R**4**, the rotating body may be deviated so as to contact the non-contact bearings.

[0057] The upper portion of the impeller **135**, however, is not soaked in the liquid R**4**, and rotates without being exposed to the large resistive force that acts on the lower portion of the impeller **135**.

[0058] As a result, as illustrated in FIG. **6**B, the rotation of the shaft **100** may become unbalanced or unstable, to thereby cause the shaft **100** to tilt, and apply excessive load on the bearings **160**, **160** that support the shaft **100**. When such load is applied on the non-contact bearings **160**, **160**, the bearings **160**, **160** may not be able to withstand the load, and the performance of the bearings **160**, **160** may be inhibited due to damage or the like. As a result, defects such as reduction in the compression performance may occur. In a case in which high-strength bearings or large bearings are used to be able to withstand the excessive load, the cost and size of the refrigerant compressor **200** may increase.

[0059] However, in examples described herein, the suction inlet **12***a* is positioned more downward D**1**B than the impeller **35** in the vertical direction. Thus, as illustrated in FIG. **4**B for example, the liquid R**4** generated in the inner space S flows out from the inner space S through the suction port **12** before reaching the impeller **35**. The liquid R**4** that flows through the suction port **12** is returned to the upstream evaporator **5** via the passage F**4**. The evaporator **5** vaporizes the liquid R**4**, and supplies it to the refrigerant compressor **2** again via the passage F**4** and the suction port **12** as the refrigerant gas R**3**. Such a configuration in which the liquid R**4** of the inner space S is returned to the evaporator **5** and vaporized enables the liquid R**4** to be efficiently removed from the inner space S. As a result, situations in which the level of the liquid R**4** in the inner space S reaching the impeller **35** can be suppressed, and situations in which the rotation of the shaft **10** becomes unbalanced or unstable can be suppressed. Accordingly, a deviation of the rotating body RB that causes the rotating body RB to contact the bearing unit (pair of bearings **60**, **60** and pair of bearings **64**, **64**) at startup (start of rotation) can be suppressed. As a result, situations in which excessive load is applied on the bearing unit can be suppressed, and situations in which defects such as reduction in the compression performance occur due to reduction in the performance of the bearing unit can be suppressed.

[0060] In some examples, the suction port **12** and the passage F**4** also function as a return passage that returns the liquid R**4** of the inner space S to the evaporator **5**. That is, the suction port **12** and the passage F**4** have both the function of sucking in the refrigerant gas R**3** from the evaporator **5**, and the function of returning the liquid R**4** of the inner space S to the evaporator **5**. This configuration is capable of providing the function of returning the liquid R**4** to the evaporator **5** and the function of supplying the refrigerant gas R**3** from the evaporator **5** in the same passage. In some examples, the configuration of the refrigerant compressor **2** is further simplified, since a return passage that returns the liquid R**4** to the evaporator **5** is not separately provided.

[0061] In some examples, the suction inlet **12***a* communicates (is fluidly coupled) with the third inner region S**3**, and the discharge port **13** communicates (is fluidly coupled) with the first inner region S**1**. In this configuration, the refrigerant gas R**3** sucked in from the suction inlet **12***a* passes through the pair of bearings **60**, **60** and the electric motor **51** and is discharged from the discharge port **13**, so that the pair of bearings **60**, **60** and the electric motor **51** can be cooled using this flow of the refrigerant. This configuration is capable of employing a configuration in which a mechanism for cooling the pair of bearings **60**, **60** and the electric motor **51** is not separately provided. Alternatively, the configuration of the refrigerant compressor **2** can be simplified, since a simplified mechanism for cooling the bearings **60**, **60** and the electric motor **51** can be used. In practice, as illustrated in FIG. **2**, the refrigerant gas R**3** also passes through the pair of bearings **64**, **64**, so that the refrigerant gas R**3** is also capable of cooling the pair of bearings **64**, **64** in addition to cooling the pair of bearings **60**, **60** and the electric motor **51**.

[0062] In some examples, the suction port **12** passes downward D**1**B through the side wall **56** from the third inner region S**3**. This configuration enables the liquid R**4** generated in the inner space S to easily flow into the suction inlet **12***a* according to gravity. Accordingly, the liquid R**4** can be effectively removed from the inner space S.

[0063] In some examples, the discharge port **13** passes downward D**1**B through the second impeller housing **42** from the first inner region S**1**. This configuration also enables the liquid R**4** to be effectively removed from the inner space S, since the discharge port **13** can also be used as a passage for removing the liquid R**4** from the inner space S.

[0064] In some examples, the inner surface **56***a* of the side wall **56** includes the inclined part P**1** that slopes downward toward the suction inlet **12***a*. This configuration enables the liquid R**4** generated in the inner space S to more easily flow into the suction port **12** than into the discharge port **13** according to gravity. Accordingly, the liquid R**4** can be actively flown to the upstream evaporator **5** than to the downstream condenser **3**. In the case in which the liquid R**4** is actively flown to the evaporator **5** that vaporizes the liquid R**4**, situations in which the flown liquid R**4** is pushed back to the inner space S does not tend to occur compared to a case in which the liquid R**4** is actively flown to the condenser **3** in which the liquid R**4** tends to accumulate. In the configuration in which the liquid R**4** is actively flown to the condenser **3**, the liquid R**4** tends to accumulate in the condenser **3** since the condenser **3** is a device for generating the liquid refrigerant R**2**. When the compressed refrigerant gas R**1** flows into the condenser **3** from the discharge port **13** in this state, the liquid R**4** accumulated in the condenser **3** may be pushed back into the inner space S by the amount of the compressed refrigerant gas R**1** that has flown into the condenser **3**. Thus, in the configuration in which the liquid R**4** is actively flown to the evaporator **5** and not to the condenser **3**, situations in which the liquid R**4** is pushed back into the inner space S can be suppressed, so that the liquid R**4** can be more effectively removed from the inner space S.

[0065] It is to be understood that not all aspects, advantages and features described herein may necessarily be achieved by, or included in, any one particular example. Indeed, having described and illustrated various examples herein, it should be apparent that other examples may be modified in arrangement and detail.

[0066] FIG. **7** schematically illustrates an example refrigerant compressor **2**A. An example in which the suction port **12** also functions as a return port that returns the liquid R**4** in the inner space S to the evaporator **5** has been described above. In the example of FIG. **7**, a case in which a return port **12**B is formed separately from a suction port **12**A is described. That is, in this example, the return port **12**B is not configured by the suction port **12**A, but is configured separately from the suction port **12**A.

[0067] The suction port **12**A is, for example, formed so as to communicate (be fluidly coupled) with the third inner region S**3** in a motor housing **55**A, and is positioned higher (or more upward) D**1**A than the impeller **35**. The suction port **12**A is connected to the upstream evaporator **5** (see FIG. **1**) via the passage F**4**. The refrigerant gas R**3** sucked into the third inner region S**3** from the suction port **12**A passes through the second inner region S**2** and the first inner region S**1** in order, during which the refrigerant gas R**3** cools the pair of bearings **60**, **60**, and the electric motor **51** in the flow path. The refrigerant gas R**3** that reaches the impeller **35** in the first inner region S**1** is compressed by the rotation of the impeller **35**. The compressed refrigerant gas R**1** is thus generated. The generated compressed refrigerant gas R**1** is discharged from the discharge port **13** formed in downward D**1**B of the impeller housing **45** to the downstream condenser **3** (see FIG. **1**). The passage F**4** and the suction port **12**A form a refrigerant passage that supplies the refrigerant gas R**3** from the evaporator **5** to the inner space S.

[0068] The return port **12**B is formed in the same position as the suction port **12** of the examples described above. That is, the return port **12**B is formed so as to pass downward D**1**B through the motor housing **55**A from the third inner region S**3** of a housing **11**A. Consequently, a return opening **12***b* of the return port **12**B that opens on the inner surface **56***a* of the motor housing **55**A is positioned more downward D**1**B than the lower end **35***a* of the impeller **35**, similarly to the suction inlet **12***a* according to the examples described above. The return port **12**B is connected to the upstream evaporator **5** (see FIG. **1**) via a passage different from the passage F**4**. This passage and the return port **12**B form a return passage for returning the liquid R**4** to the evaporator **5**.

[0069] The liquid R**4** generated in the inner space S such as when not in operation flows into the return port **12**B from the downward D**1**B return opening **12***b*, and is returned to the evaporator **5** via the return port **12**B. The liquid R**4** that is returned to the evaporator **5** is vaporized in the evaporator **5**, and supplied to the inner space S from the suction port **12**A again as the refrigerant gas R**3**. Even in this example, the liquid R**4** generated in the inner space S can be removed from the inner space S through the return port **12**B, so that operation and effects similar to those of the examples described above can be produced.

[0070] FIG. **8** schematically illustrates another example refrigerant compressor **2**B. An example in which the discharge port **13** is formed in downward D**1**B of the impeller housing **45** has been described above. In this example, an example in which a discharge port **13**A is formed in upward D**1**A of an impeller housing **45**A is described. The discharge port **13**A is, for example, formed so as to pass upward D**1**A through the impeller housing **45**A from the first inner region S**1** of a housing **11**B. That is, the discharge port **13**A passes through an upper end portion **42***f* of the impeller housing **45**A that surrounds the first inner region S**1**, in the vertical direction. The upper end portion **42***f* may be an upward D**1**A wall portion of the impeller housing **45**A.

[0071] Even in this example, the liquid R**4** generated in the inner space S can be removed from the inner space S through the suction port **12**, so that operation and effects similar to those of the examples described above can be produced. Furthermore, this example is capable of preventing the liquid R**4** generated in the inner space S from flowing into the discharge port **13**A, which makes it more difficult for situations in which the flown liquid R**4** is pushed back to the refrigerant compressor **2** to occur. Accordingly, the liquid R**4** can be more effectively removed from the inner space S.

[0072] The present disclosure is not limited to the examples described above, and various other examples are possible. For example, features of different examples may be suitably combined together. In the examples described above, the refrigerant compressor **2** has two impellers (first impeller and second impeller). However, the refrigerant compressor may have one impeller. The orientation of the rear surface of the impeller is not particularly limited, and may be suitably changed.

[0073] In the examples described above, the suction port **12** is formed so as to communicate with the third inner region S**3**, and the discharge port **13** is formed so as to communicate with the first inner region S**1**. However, the suction port **12** and the discharge port **13** may both be formed so as to communicate with the first inner region S**1**. That is, the suction port **12** and the discharge port **13** may both be formed in the impeller housing **45**. In this case, a port through which a cooling medium flows for cooling the pair of bearings **60**, **60** and the electric motor **51** may be separately formed. The suction port **12** may be formed in the end wall **57** as long as it is positioned more downward D**1**B than the impeller **35**.

[0074] The present disclosure includes the following configurations.

[0075] A refrigerant compressor of a configuration [1] may be described as "a refrigerant compressor configured to compress a refrigerant circulating in a refrigerant circulation system, the refrigerant compressor including: a rotating body including a shaft, and a protruding part protruding from the shaft in a radial direction and configured to rotate together with the shaft; a non-contact bearing unit rotatably supporting the rotating body; a housing including an inner space accommodating the protruding part; a suction inlet opening into the inner space and configured to supply the refrigerant to the inner space; a refrigerant passage communicating with the suction inlet and connected to an evaporator; a discharge port configured to discharge the refrigerant from the inner space; and a return passage communicating the inner space and the evaporator via a return opening provided in the inner space, wherein the return opening is positioned more downward than the protruding part in a vertical direction."

[0076] The refrigerant compressor of a configuration [2] may be described as "the refrigerant compressor according to the configuration [1], wherein the return passage is formed of the refrigerant passage itself."

[0077] The refrigerant compressor of a configuration [3] may be described as "the refrigerant compressor according to the configuration [1] or [2], wherein the bearing unit includes a pair of bearings disposed along an axial direction in which the shaft extends, and supporting the shaft in a radial direction, wherein the inner space includes a first inner region, a second inner region, and a third inner region communicating with each other in the axial direction, wherein the second inner region is positioned between the pair of bearings in the axial direction, wherein the first inner region is positioned on one side of the pair of bearings in the axial direction, wherein the third inner region is positioned on another side of the pair of bearings in the axial direction, wherein the suction inlet communicates with the third inner region, and wherein the discharge port communicates with the first inner region."

[0078] The refrigerant compressor of a configuration [**4**] may be described as "the refrigerant compressor according to any one of the configurations [**1**] to [**3**], wherein the return passage passes downward through the housing in the vertical direction from the inner space."

[0079] The refrigerant compressor of a configuration [**5**] may be described as "the refrigerant compressor according to the configuration [**4**], wherein the discharge port passes downward through the housing in the vertical direction from the inner space at a position different from a position of the return passage."

[0080] The refrigerant compressor of a configuration [6] may be described as "the refrigerant compressor according to the configuration [5], wherein an inner wall surface of the housing includes an inclined part sloping downward toward the return opening between the discharge port and the return passage."

[0081] The refrigerant compressor of a configuration [7] may be described as "the refrigerant compressor according to any one of the configurations [1] to [4], wherein the discharge port passes upward through the housing in the vertical direction from the inner space."

1. A refrigerant compressor for a refrigerant circulation system, the refrigerant compressor comprising:
- a rotating body including a shaft, and a protruding part protruding from the shaft in a radial direction and configured to rotate together with the shaft;
- at least one non-contact bearing rotatably supporting the rotating body;
- a housing having an inner space accommodating the protruding part;
- a suction inlet opening into the inner space and configured to supply a refrigerant to the inner space;
- a refrigerant passage fluidly coupled with the suction inlet and an evaporator;
- a discharge outlet configured to discharge the refrigerant from the inner space; and
- a return passage fluidly coupling the inner space and the evaporator via a return opening provided in the inner space,
- wherein the return opening is positioned lower than the protruding part in a vertical direction of the refrigerant compressor.

2. The refrigerant compressor according to claim **1**, wherein the return passage and the refrigerant passage form a continuous passage that extends from the evaporator to the suction inlet in a flow direction of the refrigerant in gas form.

3. The refrigerant compressor according to claim **1**,
- wherein the at least one non-contact bearing includes a pair of bearings including a first bearing and a second bearing disposed along an axial direction of the shaft, and supporting the shaft in the radial direction,
- wherein the inner space includes a first inner region, a second inner region, and a third inner region fluidly coupled with each other in the axial direction,
- wherein the second inner region is positioned between the pair of bearings in the axial direction,
- wherein the first bearing is positioned between the first inner region and the second inner region, in the axial direction,
- wherein the second bearing is positioned between the second inner region and the third inner region, in the axial direction,
- wherein the suction inlet is fluidly coupled with the third inner region, and
- wherein the discharge outlet is fluidly coupled with the first inner region.

4. The refrigerant compressor according to claim **1**, wherein the return passage extends downward through the housing in the vertical direction from the inner space.

5. The refrigerant compressor according to claim **3**, wherein the discharge outlet is fluidly coupled with the first inner region via a discharge port that extends downward through the housing in the vertical direction, from the inner space at a position different from a position of the return opening.

6. The refrigerant compressor according to claim **5**, wherein an inner wall surface of the housing includes an inclined part sloping downward toward the return opening between the discharge port and the return opening.

7. The refrigerant compressor according to claim **3**, wherein the discharge outlet is fluidly coupled with the first inner region via a discharge port that extends upward through the housing in the vertical direction from the inner space.

8. The refrigerant compressor according to claim **1**, wherein the suction inlet is formed in the housing at a position that is higher than the return opening.

9. The refrigerant compressor according to claim **1**,
- wherein the return opening is formed in the housing at a lowest position of the inner space, and
- wherein the return passage extends downward from the return opening toward the evaporator.

10. A refrigerant compressor comprising:
- a rotating body including a shaft and a protruding part configured to rotate together with the shaft, wherein the protruding part extends from the shaft in a radial direction;
- at least one non-contact bearing configured to rotatably support the rotating body; and
- a housing having an inner space configured to accommodate the rotating body,
- wherein the housing forms a suction inlet configured to supply refrigerant to the inner space from an evaporator, a discharge outlet configured to discharge a refrigerant from the inner space and a return opening configured to direct liquefied refrigerant from the inner space to the evaporator, and
- wherein the return opening is positioned lower than the protruding part of the rotating body in a vertical direction of the refrigerant compressor.

11. The refrigerant compressor according to claim **10**,
- wherein the shaft of the rotating body extends substantially in a horizontal direction of the refrigerant compressor,
- wherein the protruding part corresponds to a radial projection having an outermost edge in the radial direction that forms a lowest position of the rotating body in the vertical direction, and
- wherein the return opening is positioned lower than the lowest position of the rotating body in the vertical direction.

12. The refrigerant compressor according to claim **10**, wherein the protruding part forms an impeller.

13. The refrigerant compressor according to claim **12**,
- wherein the rotating body further includes a thrust collar, and
- wherein the return opening is located lower than both the thrust collar and the impeller.

14. The refrigerant compressor according to claim **13**,
wherein the thrust collar is located at a first end portion of the shaft of the rotating body,
wherein the impeller is located at a second end portion of the shaft opposite the first end portion, and
wherein the return opening is located in a region of the inner space of the housing, that is formed adjacent to the first end portion of the shaft.

15. The refrigerant compressor according to claim **10**,
wherein the inner space has an inlet region that includes the suction inlet that is fluidly coupled with the evaporator, and an outlet region located opposite the inlet region in an axial direction of the shaft of the rotating body, and
wherein the return opening is formed in the inlet region of the inner space.

16. The refrigerant compressor according to claim **10**, further comprising a refrigerant passage extending from the evaporator to the suction inlet in a flow direction of the refrigerant in gas form,
wherein the suction inlet forms the return opening, to return the liquified refrigerant to the evaporator via the refrigerant passage.

17. The refrigerant compressor according to claim **15**, wherein the discharge outlet is fluidly coupled with the outlet region via a discharge port that is positioned lower than the protruding part of the rotating body in the vertical direction, to further direct the liquified refrigerant out from the inner space.

18. The refrigerant compressor according to claim **10**, wherein at least one of the suction inlet or discharge outlet is located at a higher position than the return opening in the vertical direction.

19. The refrigerant compressor according to claim **10**,
wherein the housing includes an inner wall surface that forms the inner space, and
wherein a lower portion of the inner wall surface slopes downwardly toward the return opening, in an axial direction of the shaft of the rotating body.

20. The refrigerant compressor according to claim **10**, further comprising a return passage that extends downward from the return opening toward the evaporator.

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