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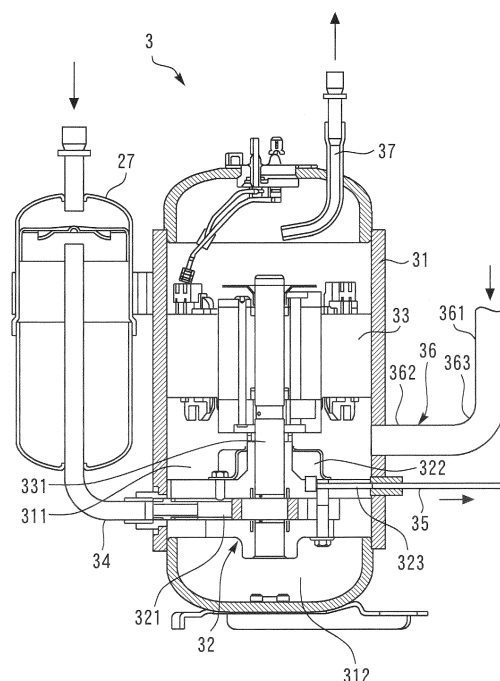
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(54) **COMPRESSOR, REFRIGERATION CYCLE DEVICE, AND HEAT PUMP HOT-WATER SUPPLY DEVICE**

(57) The compressor includes: a first intake passage for guiding refrigerant to a compressing element without releasing the refrigerant into the sealed container; a first discharge passage for discharging a compressed high pressure refrigerant and refrigerator oil from the compressing element directly to an outside of the sealed container without releasing the high pressure refrigerant into the sealed container and without separating the high pressure refrigerant and the refrigerator oil; a second intake passage for guiding the high pressure refrigerant and the refrigerator oil having passed through an external heat exchanger into the sealed container; non-rotational oil separation means included with the second intake passage, for separating the high pressure refrigerant and the refrigerator oil without rotating; and a second discharge passage for discharging the high pressure refrigerant in the sealed container to the outside of the sealed container without compressing the high pressure refrigerant.

FIG. 3



Description

Technical Field

5 **[0001]** The present invention relates to a compressor, a refrigeration cycle device, and a heat pump hot-water supply device.

Background Art

10 **[0002]** Patent Literature 1 discloses a hot-water supplying compressor having a compressing element and an electric actuating element in a sealed container. The compressor includes: an intake pipe (first intake passage) for guiding a refrigerant on a low pressure side directly to the compressing element; a discharge pipe (first discharge passage) for discharging a high pressure refrigerant compressed by the compressing element directly to an outside of the sealed container without releasing the high pressure refrigerant into the sealed container; a refrigerant reintroduction pipe
 15 (second intake passage) for reintroducing the refrigerant discharged from the discharge pipe and subjected to heat exchange into the sealed container; and a refrigerant redischarge pipe (second discharge passage) for discharging the refrigerant reintroduced into the sealed container and having passed through the electric actuating element to the outside of the sealed container.

20 Citation List

Patent Literature

25 **[0003]** Patent Literature 1: Japanese Patent Laid-Open No. 2006-132427

Summary of Invention

Technical Problem

30 **[0004]** Generally, refrigerator oil is supplied into a compression chamber of a compressing element of a compressor in order to lubricate and seal a slide portion and reduce friction and gap leakage. The refrigerator oil refers to a lubricant for a compressor of a refrigeration cycle device. For the compressor disclosed in Patent Literature 1, a large amount of refrigerator oil together with a compressed high pressure refrigerant gas flows out of the compressing element to the first discharge passage, and is discharged to the outside of the compressor. The high pressure refrigerant gas and the
 35 refrigerator oil form a gas-liquid two-phase flow, which flows through an external heat exchanger and flows through the second intake passage to an internal space of the sealed container of the compressor. A part of the refrigerator oil in the gas-liquid two-phase flow is atomized and mixed in the refrigerant gas. A part of the refrigerator oil as a liquid film in the gas-liquid two-phase flow is also raised and spattered by a flow of the refrigerant gas when released from an outlet of the second intake passage to the internal space of the sealed container of the compressor. This causes the refrigerator
 40 oil to be atomized and mixed in the refrigerant gas.

[0005] Refrigerator oil generally has a density of about 800 to 1000 kg/m³, which varies little depending on temperatures. In contrast, a refrigerant gas on a high pressure side has significantly varying densities of about 100 to 1000 kg/m³ depending on temperatures. Specifically, a hot high pressure refrigerant gas has a density sufficiently lower than that of the refrigerator oil, and with decreasing temperature of the high pressure refrigerant gas, the density increases and comes closer to that of the refrigerator oil. The high pressure refrigerant gas in the second intake passage has been
 45 already cooled by the external heat exchanger, and is thus low in temperature and high in density. Thus, a difference between the density of the high pressure refrigerant gas and the density of the refrigerator oil is small in the second intake passage. As such, due to the small difference between the densities of the high pressure refrigerant gas and the refrigerator oil flowing from the second intake passage to an internal space of a sealed container of a compressor, the
 50 high pressure refrigerant gas and the refrigerator oil cannot be efficiently separated by a separation method using a centrifugal force of rotation.

[0006] In the invention in Patent Literature 1, when the mixture of the high pressure refrigerant gas and the refrigerator oil having flowed from the second intake passage to the internal space of the sealed container of the compressor passes through the electric actuating element, the refrigerator oil is separated by a centrifugal force (see paragraph 0019 in
 55 Patent Literature 1). Specifically, in the invention in Patent Literature 1, there exists the high pressure refrigerant gas containing a large amount of refrigerator oil below the electric actuating element, and the high pressure refrigerant gas below the electric actuating element moves up above the electric actuating element through a gap between a rotor and a stator that constitute the electric actuating element, and a vertical through hole formed in the rotor. In this case, the

refrigerator oil is spattered toward the stator located outside by a centrifugal force caused by rotation of the rotor. However, as described above, due to the small difference between the densities of the high pressure refrigerant gas and the refrigerator oil flowing from the second intake passage to the internal space of the sealed container, the high pressure refrigerant gas and the refrigerator oil cannot be efficiently separated by the method using the centrifugal force of rotation.

On the contrary, the high pressure refrigerant gas containing a large amount of refrigerator oil rotates while passing through the electric actuating element, and thus the high pressure refrigerant gas and the refrigerator oil are stirred, which may promote mixture of the high pressure refrigerant gas and the refrigerator oil. For this reason, the invention in Patent Literature 1 cannot efficiently separate the high pressure refrigerant gas and the refrigerator oil having flowed from the second intake passage into the sealed container. Thus, the amount of refrigerator oil discharged together with the high pressure refrigerant gas from the second discharge passage cannot be reduced, but the refrigerator oil together with the high pressure refrigerant gas is circulated to a refrigerant circuit downstream of the second discharge passage. Thus, the refrigerator oil prevents heat transfer in the heat exchanger that performs heat exchange of the high pressure refrigerant discharged from the second discharge passage, or the refrigerator oil increases pressure loss, thereby reducing performance of a refrigeration cycle. Further, in the invention in Patent Literature 1, the large amount of refrigerator oil adheres to the electric actuating element to increase rotational resistance of the electric actuating element.

[0007] Conventionally, there is also a refrigeration cycle device including an oil separator on a discharge side of a standard compressor including one intake passage and one discharge passage, and configured so that the oil separator separates and returns refrigerator oil into the compressor. The refrigerator oil discharged together with a high pressure and high temperature refrigerant from a compressing element of the compressor is hot and has thermal energy. In the refrigeration cycle device including the oil separator on the discharge side of the compressor as described above, the hot refrigerator oil discharged from the compressing element is not circulated to a heat exchanger, and heat of the hot refrigerator oil cannot be effectively used.

[0008] The present invention is achieved to solve the above described problems, and has an object to provide a compressor capable of effectively using thermal energy of hot refrigerator oil discharged from a first discharge passage of the compressor, reducing rotational resistance of an electric actuating element of the compressor, and reliably reducing an amount of refrigerator oil flowing out of a second discharge passage, and further has an object to provide a refrigeration cycle device and a heat pump hot-water supply device including the compressor.

Solution to Problem

[0009] A compressor of the invention includes: a sealed container; a compressing element provided in the sealed container; an electric actuating element provided in the sealed container, the electric actuating element driving the compressing element; a first intake passage for guiding sucked low pressure refrigerant to the compressing element without releasing the low pressure refrigerant to an internal space of the sealed container; a first discharge passage for discharging high pressure refrigerant compressed by the compressing element and refrigerator oil from the compressing element directly to an outside of the sealed container without releasing the high pressure refrigerant to the internal space of the sealed container and without separating the high pressure refrigerant and the refrigerator oil; a second intake passage for guiding the high pressure refrigerant and the refrigerator oil having passed through the first discharge passage and an external heat exchanger provided downstream of the first discharge passage to the internal space of the sealed container; non-rotational oil separation means included with the second intake passage, for separating the high pressure refrigerant and the refrigerator oil without rotating the high pressure refrigerant and the refrigerator oil; and a second discharge passage for discharging the high pressure refrigerant in the internal space of the sealed container, the high pressure refrigerant having been separated from the refrigerator oil by the non-rotational oil separation means, to the outside of the sealed container without compressing the high pressure refrigerant.

Advantageous Effects of Invention

[0010] According to the present invention, thermal energy of hot refrigerator oil discharged from a first discharge passage of a compressor can be effectively used, rotational resistance of an electric actuating element of the compressor can be reduced, and an amount of refrigerator oil flowing out of a second discharge passage can be reliably reduced. This can increase energy efficiency, prevent inhibition of heat transfer in a heat exchanger that performs heat exchange of a refrigerant discharged from the second discharge passage and an increase in pressure loss, and also prevent a reduction in refrigerator oil in the compressor.

Brief Description of Drawings

[0011]

[Figure 1] Figure 1 is a configuration diagram of a heat pump hot-water supply device including a compressor according to Embodiment 1 of the present invention.

[Figure 2] Figure 2 is a configuration diagram of a storage type hot-water supply system including the heat pump hot-water supply device in Figure 1.

[Figure 3] Figure 3 is a sectional view of the compressor according to Embodiment 1 of the present invention.

[Figure 4] Figure 4 is a schematic sectional view of a flow state of a refrigerant gas and refrigerator oil.

[Figure 5] Figure 5 is a longitudinal sectional view of around a downstream end of a second intake passage included in a compressor according to Embodiment 1 of the present invention.

[Figure 6] Figure 6 is a cross sectional view of around a downstream end of a second intake passage included in a compressor according to Embodiment 2 of the present invention.

[Figure 7] Figure 7 is a cross sectional view of around a downstream end of a second intake passage included in a compressor according to Embodiment 3 of the present invention.

[Figure 8] Figure 8 is a longitudinal sectional view of around the downstream end of the second intake passage included in the compressor according to Embodiment 3 of the present invention.

[Figure 9] Figure 9 is a view of around a downstream end of a second intake passage included in a compressor according to Embodiment 4 of the present invention.

Description of Embodiments

[0012] Now, with reference to the drawings, embodiments of the present invention will be described. In the drawings, like components are denoted by like reference numerals and overlapping descriptions will be omitted.

Embodiment 1

[0013] Figure 1 is a configuration diagram of a heat pump hot-water supply device including a compressor according to Embodiment 1 of the present invention. Figure 2 is a configuration diagram of a storage type hot-water supply system including the heat pump hot-water supply device in Figure 1. As shown in Figure 1, the heat pump hot-water supply device 1 of this embodiment includes a refrigerant circuit including a compressor 3, a first water-refrigerant heat exchanger 4 (first heat exchanger), a second water-refrigerant heat exchanger 5 (second heat exchanger), an expansion valve 6 (expansion means), and an evaporator 7, and water channels that cause water to flow through the first water-refrigerant heat exchanger 4 and the second water-refrigerant heat exchanger 5. The evaporator 7 in this embodiment is constituted by an air-refrigerant heat exchanger that performs heat exchange between air and refrigerant. The heat pump hot-water supply device 1 according to this embodiment further includes a fan 8 that blows air to the evaporator 7, and a high and low pressures heat exchanger 9 that performs heat exchange between a high pressure side refrigerant and a low pressure side refrigerant. The compressor 3, the first water-refrigerant heat exchanger 4, the second water-refrigerant heat exchanger 5, the expansion valve 6, the evaporator 7, and the high and low pressures heat exchanger 9 are connected by a pipe through which the refrigerant passes to form a refrigerant circuit. During heating operation, the heat pump hot-water supply device 1 actuates the compressor 3 to operate a refrigeration cycle.

[0014] As shown in Figure 2, the heat pump hot-water supply device 1 according to this embodiment may be combined with a tank unit 2 and used as a storage type hot-water supply system. In the tank unit 2, a hot water storage tank 2a that stores water, and a water pump 2b are provided. The heat pump hot-water supply device 1 and the tank unit 2 are connected via pipes 11 and 12 through which water flows, and electric wires (not shown). One end of the pipe 11 is connected to a water inlet 1a of the heat pump hot-water supply device 1. The other end of the pipe 11 is connected to a lower portion of the hot water storage tank 2a in the tank unit 2. The water pump 2b is provided in a middle of the pipe 11 in the tank unit 2. One end of the pipe 12 is connected to a hot water outlet 1b of the heat pump hot-water supply device 1. The other end of the pipe 12 is connected to an upper portion of the hot water storage tank 2a in the tank unit 2. Instead of the shown configuration, the water pump 2b may be placed in the heat pump hot-water supply device 1.

[0015] As shown in Figure 1, the compressor 3 in the heat pump hot-water supply device 1 includes a sealed container 31, a compressing element 32 and an electric actuating element 33 provided in the sealed container 31, a first intake passage 34, a first discharge passage 35, a second intake passage 36, and a second discharge passage 37. A low pressure refrigerant sucked through the first intake passage 34 flows directly into the compressing element 32 without being released to an internal space 311 of the sealed container 31. The compressing element 32 is driven by the electric actuating element 33, and compresses the low pressure refrigerant into a high pressure refrigerant. The high pressure refrigerant compressed by the compressing element 32 is discharged together with refrigerator oil through the first discharge passage 35 directly to the outside of the sealed container 31 without being released to the internal space 311 of the sealed container 31 and without being separated from the refrigerator oil. The high pressure refrigerant and the refrigerator oil discharged from the first discharge passage 35 flow through a pipe 10 and reach the first water-refrigerant heat exchanger 4. The high pressure refrigerant and the refrigerator oil having passed through the first water-refrigerant

heat exchanger 4 flow through a pipe 17 and reach the second intake passage 36. The second intake passage 36 guides the high pressure refrigerant and the refrigerator oil to the internal space 311 of the sealed container 31 of the compressor 3. The high pressure refrigerant having flowed to the internal space 311 of the sealed container 31 passes between a rotor and a stator of the electric actuating element 33 to cool the electric actuating element 33, and is then discharged through the second discharge passage 37 to the outside of the sealed container 31. The high pressure refrigerant having been discharged from the second discharge passage 37 passes through a pipe 18 and reaches the second water-refrigerant heat exchanger 5. The high pressure refrigerant having passed through the second water-refrigerant heat exchanger 5 passes through a pipe 19 and reaches the expansion valve 6. The high pressure refrigerant passes through the expansion valve 6 to turn into a low pressure refrigerant. The low pressure refrigerant passes through a pipe 20 and flows into the evaporator 7. The low pressure refrigerant having passed through the evaporator 7 passes through a pipe 21 and reaches the first intake passage 34, and is sucked into the compressor 3. The high and low pressures heat exchanger 9 performs heat exchange between the high pressure refrigerant passing through the pipe 19 and the low pressure refrigerant passing through the pipe 21.

[0016] The heat pump hot-water supply device 1 further includes a water channel 23 that connects the water inlet 1a and an inlet of the second water-refrigerant heat exchanger 5, a water channel 24 that connects an outlet of the second water-refrigerant heat exchanger 5 and an inlet of the first water-refrigerant heat exchanger 4, and a water channel 26 that connects an outlet of the first water-refrigerant heat exchanger 4 and the hot water outlet 1b. During heating operation, water having flowed in from the water inlet 1a flows through the water channel 23 into the second water-refrigerant heat exchanger 5, and is heated by heat from the refrigerant in the second water-refrigerant heat exchanger 5. Hot water generated by heating in the second water-refrigerant heat exchanger 5 flows through the water channel 24 into the first water-refrigerant heat exchanger 4, and is further heated by heat from the refrigerant in the first water-refrigerant heat exchanger 4. The hot water further increased in temperature by being further heated in the first water-refrigerant heat exchanger 4 passes through the water channel 26 and reaches the hot water outlet 1b, and is fed through the pipe 12 to the tank unit 2.

[0017] An appropriate refrigerant includes refrigerants that can generate a high temperature hot water, for example, refrigerants such as carbon dioxide, R410A, propane, or propylene, but not limited to them.

[0018] The high temperature and high pressure refrigerant gas and the refrigerator oil discharged from the first discharge passage 35 of the compressor 3 release heat and are reduced in temperature while passing through the first water-refrigerant heat exchanger 4. Due to pressure loss that occurs in the first water-refrigerant heat exchanger 4, the pipes 10, 17, of the like, pressure of the high pressure refrigerant in the second intake passage 36 is slightly lower than pressure of the high pressure refrigerant in the first discharge passage 35. In this embodiment, the high pressure refrigerant reduced in temperature while passing through the first water-refrigerant heat exchanger 4 is sucked from the second intake passage 36 to the internal space 311 of the sealed container 31 to cool the electric actuating element 33, thereby reducing a temperature of the electric actuating element 33 and a surface temperature of the sealed container 31. This can increase motor efficiency of the electric actuating element 33, and reduce heat dissipation loss from a surface of the sealed container 31. The high pressure refrigerant gas guided from the second intake passage 36 to the internal space 311 of the sealed container 31 draws heat from the electric actuating element 33 and is increased in temperature, and then discharged from the second discharge passage 37 in a high pressure state. The high pressure refrigerant discharged from the second discharge passage 37 flows into the second water-refrigerant heat exchanger 5, and releases heat and is reduced in temperature while passing through the second water-refrigerant heat exchanger 5. The high pressure refrigerant reduced in temperature heats the low pressure refrigerant while passing through the high and low pressures heat exchanger 9, and then passes through the expansion valve 6. The high pressure refrigerant passes through the expansion valve 6, and is thus reduced in pressure into a low pressure gas-liquid two-phase state. The low pressure refrigerant having passed through the expansion valve 6 absorbs heat from outside air while passing through the evaporator 7, and is evaporated and gasified. The low pressure refrigerant coming out of the evaporator 7 is heated by the high and low pressures heat exchanger 9, and then sucked from the first intake passage 34 into the compressor 3.

[0019] If the high pressure side refrigerant pressure is critical pressure or more, the high pressure refrigerant in the first water-refrigerant heat exchanger 4 and the second water-refrigerant heat exchanger 5 is reduced in temperature and releases heat still in a supercritical state without gas-liquid phase transition. If the high pressure side refrigerant pressure is the critical pressure or less, the high pressure refrigerant is liquefied and releases heat. In this embodiment, carbon dioxide is preferably used as a refrigerant to bring the high pressure side refrigerant pressure to the critical pressure or more. When the high pressure side refrigerant pressure is the critical pressure or more, the liquefied refrigerant can be reliably prevented from flowing through the second intake passage 36 to the internal space 311 of the sealed container 31. This can reliably prevent the liquefied refrigerant from adhering to the electric actuating element 33, and reduce rotational resistance of the electric actuating element 33. Also, the liquefied refrigerant does not flow through the second intake passage 36 to the internal space 311 of the sealed container 31, thereby preventing the refrigerator oil from being diluted by the refrigerant.

[0020] As shown in Figure 2, a water supply pipe 13 is further connected to a lower portion of the hot water storage

tank 2a of the tank unit 2. Water supplied from an external water source such as a water supply flows through the water supply pipe 13 into the hot water storage tank 2a and is stored. The hot water storage tank 2a is always filled with water flowing in from the water supply pipe 13. A hot-water supplying mixing valve 2c is further provided in the tank unit 2. The hot-water supplying mixing valve 2c is connected via a hot water delivery pipe 14 to the upper portion of the hot water storage tank 2a. A water supply branch pipe 15 branching off from the water supply pipe 13 is connected to the hot-water supplying mixing valve 2c. One end of the hot-water supply pipe 16 is further connected to the hot-water supplying mixing valve 2c. The other end of the hot-water supply pipe 16 is connected to a hot-water supply terminal such as a tap, a shower, or a bathtub (not shown).

[0021] During heating operation in which water stored in the hot water storage tank 2a is heated, the water stored in the hot water storage tank 2a is fed by the water pump 2b through the pipe 11 to the heat pump hot-water supply device 1, and heated in the heat pump hot-water supply device 1 to be high temperature hot water. The high temperature hot water generated in the heat pump hot-water supply device 1 returns through the pipe 12 to the tank unit 2, and flows into the hot water storage tank 2a from above. By such heating operation, in the hot water storage tank 2a, the high temperature hot water is stored in an upper side and low temperature water is stored in a lower side.

[0022] When hot water is supplied from the hot-water supply pipe 16 to the hot-water supply terminal, the high temperature hot water in the hot water storage tank 2a is supplied through the hot water delivery pipe 14 to the hot-water supplying mixing valve 2c, and low temperature water is supplied through the water supply branch pipe 15 to the hot-water supplying mixing valve 2c. The high temperature hot water and the low temperature water are mixed by the hot-water supplying mixing valve 2c, and then supplied through the hot-water supply pipe 16 to the hot-water supply terminal. The hot-water supplying mixing valve 2c has a function of adjusting a mixture ratio between the high temperature hot water and the low temperature water so as to reach a hot-water supply temperature set by a user.

[0023] The storage type hot-water supply system includes a control unit 50. The control unit 50 is electrically connected to actuators and sensors (not shown) included in the heat pump hot-water supply device 1 and the tank unit 2, and user interface devices (not shown), and functions as control means for controlling operation of the storage type hot-water supply system. In Figure 2, the control unit 50 is provided in the heat pump hot-water supply device 1, but the control unit 50 may be provided other than in the heat pump hot-water supply device 1. The control unit 50 may be provided in the tank unit 2. The control unit 50 may be provided in the heat pump hot-water supply device 1 and the tank unit 2 in a divided manner so as to be able to mutually communicate.

[0024] During heating operation, the control unit 50 performs control so that a temperature of the hot water supplied from the heat pump hot-water supply device 1 to the tank unit 2 (hereinafter referred to as "hot water delivery temperature") reaches a target hot water delivery temperature. The target hot water delivery temperature is set to, for example, 65°C to 90°C. In this embodiment, the control unit 50 adjusts a rotation speed of the water pump 2b to control the hot water delivery temperature. The control unit 50 detects the hot water delivery temperature using a temperature sensor (not shown) provided in the water channel 26. When the detected hot water delivery temperature is higher than the target hot water delivery temperature, the rotation speed of the water pump 2b is corrected to be higher, and when the hot water delivery temperature is lower than the target hot water delivery temperature, the rotation speed of the water pump 2b is corrected to be lower. As such, the control unit 50 can perform control so that the hot water delivery temperature matches the target hot water delivery temperature. The hot water delivery temperature may be controlled by controlling a temperature of the refrigerant discharged from the first discharge passage 35 of the compressor 3, a rotation speed of the compressor 3, or the like.

[0025] Figure 3 is a sectional view of the compressor according to Embodiment 1 of the present invention. Now, with reference to Figure 3, the compressor 3 according to this embodiment will be further described. As shown in Figure 3, the sealed container 31 of the compressor 3 according to this embodiment has a substantially cylindrical shape. An accumulator 27 is provided adjacent to the sealed container 31 of the compressor 3. The low pressure refrigerant passes through the accumulator 27, and is then sucked from the first intake passage 34 into the compressor 3. The accumulator 27 is not shown in Figure 1 mentioned above.

[0026] The compressing element 32 is placed under the electric actuating element 33 in the sealed container 31. The electric actuating element 33 drives the compressing element 32 via a rotating shaft 331. The compressing element 32 includes a compression chamber 321, a muffler 322, and a frame 323. A low pressure refrigerant gas sucked from the first intake passage 34 flows into the compression chamber 321, and is compressed in the compression chamber 321 into a high pressure refrigerant gas. The high pressure refrigerant gas compressed in the compression chamber 321 is discharged into the muffler 322. The high pressure refrigerant gas discharged into the muffler 322 passes in the frame 323, and is discharged through the first discharge passage 35 to the outside of the sealed container 31. As described above, the high pressure refrigerant gas discharged from the first discharge passage 35 passes through the first water-refrigerant heat exchanger 4, and is sucked from the second intake passage 36 to the internal space 311 of the sealed container 31. The internal space 311 of the sealed container 31 is brought into high pressure atmosphere filled with the high pressure refrigerant gas having flowed in from the second intake passage 36. However, as described above, the pressure in the internal space 311 of the sealed container 31, that is, the pressure in the second intake passage 36 is

slightly lower than the pressure in the muffler 322, that is, the pressure in the first discharge passage 35 due to pressure loss that occurs in the first water-refrigerant heat exchanger 4, the pipes 10, 17, or the like.

[0027] The first intake passage 34, the first discharge passage 35, and the second intake passage 36 protrude from side surfaces of the sealed container 31. The second intake passage 36 is placed above the first discharge passage 35. An outlet of the second intake passage 36 opens into a space below the electric actuating element 33 in the internal space 311 of the sealed container 31. Specifically, the outlet of the second intake passage 36 is lower than the electric actuating element 33. An oil reservoir 312 that stores refrigerator oil (not shown) is located in a lower portion of the internal space 311 of the sealed container 31. An oil surface of the refrigerator oil in the oil reservoir 312 in the sealed container 31 is lower than an opening of the outlet of the second intake passage 36. An inlet of the second discharge passage 37 opens into a space above the electric actuating element 33 in the internal space 311 of the sealed container 31. As such, the outlet of the second intake passage 36 and the inlet of the second discharge passage 37 are located on opposite sides with the electric actuating element 33 therebetween.

[0028] The high pressure refrigerant gas having flowed from the second intake passage 36 into the space below the electric actuating element 33 in the internal space 311 of the sealed container 31 passes through a gap between the rotor and the stator of the electric actuating element 33, or the like, and moves to the space above the electric actuating element 33 in the internal space 311. Then, the high pressure refrigerant gas is discharged through the second discharge passage 37 to the outside of the sealed container 31. As described above, the refrigerant discharged from the second discharge passage 37 passes through the second water-refrigerant heat exchanger 5, the expansion valve 6, the evaporator 7, or the like, and then returns to the first intake passage 34 of the compressor 3.

[0029] In order to lubricate and seal a slide portion of the compressing element 32 to reduce friction and gap leakage, the refrigerator oil is supplied from the oil reservoir 312 into the compression chamber 321. The refrigerator oil supplied into the compression chamber 321 and the compressed high pressure refrigerant gas pass together through the muffler 322 and the frame 323, and are discharged through the first discharge passage 35 to the outside of the sealed container 31. The high pressure refrigerant gas and the refrigerator oil discharged from the first discharge passage 35 form a gas-liquid two-phase flow, which is guided through the pipe 10 to the first water-refrigerant heat exchanger 4. The high pressure refrigerant gas and the refrigerator oil discharged from the first discharge passage 35 have high temperature. The compressor 3 discharges the high pressure refrigerant gas compressed by the compressing element 32 and the refrigerator oil supplied to the compressing element 32 through the first discharge passage 35 to the outside of the sealed container 31 without separating the high pressure refrigerant gas and the refrigerator oil. There is no oil separation means (oil separator) for separating the refrigerator oil in a path of the refrigerant from the compressing element 32 to the first water-refrigerant heat exchanger 4. Thus, a large amount of refrigerator oil is guided together with the high pressure refrigerant gas from the compressing element 32 to the first water-refrigerant heat exchanger 4. With such a configuration, the first water-refrigerant heat exchanger 4 can heat water to be heated effectively using thermal energy of the high pressure refrigerant gas and also thermal energy of the refrigerator oil. This provides high energy efficiency.

[0030] The high pressure refrigerant gas and the refrigerator oil having passed through the first water-refrigerant heat exchanger 4 flow through the pipe 10 and the second intake passage 36 to the internal space 311 of the sealed container 31. As described above, in the compressor 3, a large amount of refrigerator oil is guided together with the high pressure refrigerant gas from the compressing element 32 to the first water-refrigerant heat exchanger 4. Thus, the large amount of refrigerator oil flows together with the high pressure refrigerant gas from the second intake passage 36 to the internal space 311 of the sealed container 31. The large amount of refrigerator oil being circulated to the first water-refrigerant heat exchanger 4 increases pressure loss of the first water-refrigerant heat exchanger 4, but such a disadvantage is outweighed by the advantage that the thermal energy of the hot refrigerator oil can be effectively used in the first water-refrigerant heat exchanger 4.

[0031] Figure 4 is a schematic sectional view of a flow state of the refrigerant gas and the refrigerator oil. As shown in Figure 4, the flow state of the refrigerant gas and the refrigerator oil is referred to as an annular flow or an annular dispersed flow. Specifically, the refrigerator oil as a liquid phase flows as an annular liquid film along a pipe wall, and the refrigerant gas as a gas phase flows through a center of the pipe. A part of the refrigerator oil is spattered in the refrigerant gas in the center of the pipe to form mist. The high pressure refrigerant gas and the refrigerator oil flow from the second intake passage 36 to the internal space 311 of the sealed container 31 while forming such an annular flow or an annular dispersed flow (hereinafter, generally referred to as "annular flow"). A part of the refrigerator oil in the annular flow is atomized and mixed in the high pressure refrigerant gas. Also, a part of the liquid film of the refrigerator oil may be raised and spattered by the flow of the high pressure refrigerant gas when released from the outlet of the second intake passage 36 to the internal space 311 of the sealed container 31. Thus, the refrigerator oil may be atomized and mixed in the high pressure refrigerant gas.

[0032] The refrigerator oil generally has a density of about 800 to 1000 kg/m³, which varies little depending on temperatures. In contrast, the refrigerant gas on the high pressure side has significantly varying densities of about 100 to 1000 kg/m³ depending on temperatures. Specifically, a hot high pressure refrigerant gas has a density sufficiently lower than that of the refrigerator oil, and with decreasing temperature of the high pressure refrigerant gas, the density increases

and comes closer to that of the refrigerator oil. The high pressure refrigerant gas in the second intake passage 36 has been already cooled by the first external heat exchanger 4, and is thus low in temperature and high in density. Thus, a difference between the density of the high pressure refrigerant gas and the density of the refrigerator oil is small in the second intake passage 36. Thus, the high pressure refrigerant gas and the refrigerator oil flowing from the second intake passage 36 to the internal space 311 of the sealed container 31 cannot be efficiently separated by a separation method using a centrifugal force of rotation. On the contrary, if the high pressure refrigerant gas and the refrigerator oil having a small difference in density are rotated, the high pressure refrigerant gas and the refrigerator oil are stirred, which may promote mixture of the high pressure refrigerant gas and the refrigerator oil.

[0033] In view of the above, in the compressor 3 according to Embodiment 1, non-rotational oil separation means (non-rotational oil separator) for separating the high pressure refrigerant gas and the refrigerator oil without rotating the high pressure refrigerant gas and the refrigerator oil is included with the second intake passage 36. In the compressor 3 according to Embodiment 1, as shown in Figure 3, a configuration in which a cross-sectional area (channel cross-sectional area) of the second intake passage 36 is larger than a cross-sectional area (channel cross-sectional area) of the first discharge passage 35 corresponds to the non-rotational oil separation means included with the second intake passage 36.

[0034] Here, a flow speed u [m/s] of the high pressure refrigerant gas in the second intake passage 36 is expressed by the following expression:

$$u = G/(\rho A) \dots (1)$$

when G [kg/s] is a mass flow rate of the refrigerant circulated in the refrigerant circuit of the heat pump hot-water supply device 1, A [m²] is a cross-sectional area (channel cross-sectional area) of the second intake passage 36, and ρ [kg/m³] is the density of the high pressure refrigerant gas in the second intake passage 36.

[0035] Thus, the flow speed u of the high pressure refrigerant gas in the second intake passage 36 is low with increasing cross-sectional area A of the second intake passage 36. The amount of mist spattered in the gas phase in the annular flow increases with increasing flow speed in the gas phase. Thus, reducing the flow speed u of the high pressure refrigerant gas in the second intake passage 36 reduces the amount of mist of the refrigerator oil spattered in the high pressure refrigerant gas flow in the annular flow of the second intake passage 36. Thus, as in Embodiment 1, the cross-sectional area A of the second intake passage 36 is larger than the cross-sectional area of the first discharge passage 35, and thus the high pressure refrigerant gas and the refrigerator oil flowing from the second intake passage 36 to the internal space 311 of the sealed container 31 can be reliably prevented from being mixed and can be efficiently separated. Also, according to Embodiment 1, the flow speed u of the high pressure refrigerant gas in the second intake passage 36 is reduced, and thus a liquid film of the refrigerator oil is reliably prevented from being raised and spattered by the flow of the high pressure refrigerant gas when the high pressure refrigerant gas and the refrigerator oil are released from the outlet of the second intake passage 36 to the internal space 311 of the sealed container 31. This can efficiently separate the high pressure refrigerant gas and the refrigerator oil.

[0036] According to Embodiment 1, as described above, the high pressure refrigerant gas and the refrigerator oil are efficiently separated in the second intake passage 36. Figure 5 is a longitudinal sectional view of around a downstream end (outlet) of the second intake passage 36 included in the compressor 3 according to Embodiment 1. As shown in Figure 5, the high pressure refrigerant gas spouts laterally (substantially horizontally) from the outlet of the second intake passage 36, and is released to the internal space 311 of the sealed container 31. In contrast, the refrigerator oil having flowed out of the outlet of the second intake passage 36 falls in the internal space 311 of the sealed container 31 by gravity, and returns to the oil reservoir 312. Such a configuration can prevent a collision between the flow of the high pressure refrigerant gas spouting from the outlet of the second intake passage 36 and the refrigerator oil flowing out of the outlet of the second intake passage 36. Thus, the liquid film of the refrigerator oil can be reliably prevented from being raised and spattered by the flow of the high pressure refrigerant gas in the internal space 311 of the sealed container 31. This can more reliably separate the high pressure refrigerant gas and the refrigerator oil.

[0037] In particular, in Embodiment 1, the second intake passage 36 having the cross-sectional area A larger than the cross-sectional area of the first discharge passage 35 is provided as the non-rotational oil separation means, thereby sufficiently reducing the flow speed u of the high pressure refrigerant gas in the second intake passage 36. Thus, the high pressure refrigerant gas softly spouts from the outlet of the second intake passage 36 to the internal space 311 of the sealed container 31, thereby more reliably preventing mixture with the refrigerator oil to more reliably separate the high pressure refrigerant gas and the refrigerator oil.

[0038] As described above, in the separation method using a centrifugal force of rotation, when the high pressure refrigerant gas and the refrigerator oil having a small difference in density are rotated, the high pressure refrigerant gas and the refrigerator oil are stirred, which may promote mixture of the high pressure refrigerant gas and the refrigerator

oil. In contrast, the non-rotational oil separation means included with the second intake passage 36 of the compressor 3 separates the high pressure refrigerant gas and the refrigerator oil without rotating the high pressure refrigerant gas and the refrigerator oil. This can efficiently separate the high pressure refrigerant gas and the refrigerator oil having a small difference in density.

[0039] Also, according to Embodiment 1, the high pressure refrigerant gas separated from the refrigerator oil by the non-rotational oil separation means included with the second intake passage 36 passes through the gap between the rotor and the stator of the electric actuating element 33, or the like, to the second discharge passage 37. When the high pressure refrigerant gas passes through the gap in the electric actuating element 33, the high pressure refrigerant gas is rotated by rotation of the rotor. However, the refrigerator oil has been already separated, thereby reliably preventing mixture of the high pressure refrigerant gas and the refrigerator oil from being promoted.

[0040] As described above, according to Embodiment 1, the non-rotational oil separation means is included with the second intake passage 36, thereby allowing the high pressure refrigerant gas and the refrigerator oil flowing from the second intake passage 36 to the internal space 311 of the sealed container 31 to be efficiently separated. Thus, the amount of refrigerator oil mixed in the high pressure refrigerant gas discharged from the internal space 311 of the sealed container 31 through the second discharge passage 37 to the outside of the sealed container 31 can be reliably reduced. This can reduce a circulation rate of the refrigerator oil to the second water-refrigerant heat exchanger 5, the expansion valve 6, the evaporator 7, or the like, and reliably prevent an increase in pressure loss caused by the refrigerator oil and inhibition of heat transfer in the second water-refrigerant heat exchanger 5. This can improve performance of the heat pump hot-water supply device 1.

[0041] The high pressure refrigerant gas guided through the second intake passage 36 to the internal space 311 of the sealed container 31 is discharged through the second discharge passage 37 to the outside of the sealed container 31 without being compressed. Specifically, the high pressure refrigerant gas in the internal space 311 of the sealed container 31 is discharged through the second discharge passage 37 to the outside of the sealed container 31 without passing through a compressing element. Thus, the high pressure refrigerant gas separated from the refrigerator oil by the non-rotational oil separation means in the second intake passage 36 is not again mixed with the refrigerator oil in the compressing element, and is thus discharged from the second discharge passage 37 outside of the sealed container 31 while containing little refrigerator oil.

[0042] In Embodiment 1, a position where the refrigerator oil separated by the non-rotational oil separation means included with the second intake passage 36 flows to the internal space 311 of the sealed container 31 (that is, the outlet of the second intake passage 36) is lower than the electric actuating element 33. Thus, as shown in Figure 5, the refrigerator oil separated by the non-rotational oil separation means falls in the internal space 311 of the sealed container 31 without contact with the electric actuating element 33, and returns to the oil reservoir 312. Such a configuration can reliably prevent adhesion of the refrigerator oil to the electric actuating element 33, and thus can reliably reduce rotational resistance of the electric actuating element 33. This increases energy efficiency.

[0043] In Embodiment 1, the cross-sectional area A of the second intake passage 36 is preferably set so that the flow speed u of the high pressure refrigerant gas in the second intake passage 36 is 1 m/s or less. The flow speed u of the high pressure refrigerant gas in the second intake passage 36 is set to be 1 m/s or less, and thus mixture of the high pressure refrigerant gas and the refrigerator oil flowing from the second intake passage 36 into the sealed container 31 can be reliably prevented to more reliably separate the high pressure refrigerant gas and the refrigerator oil. Thus, the amount of the refrigerator oil mixed in the high pressure refrigerant gas and flowing through the second discharge passage 37 can be more reliably reduced. This can further reduce the circulation rate of the refrigerator oil to the second water-refrigerant heat exchanger 5, the expansion valve 6, the evaporator 7, or the like, and more reliably prevent an increase in pressure loss caused by the refrigerator oil and inhibition of heat transfer in the second water-refrigerant heat exchanger 5. This can further improve performance of the heat pump hot-water supply device 1.

[0044] According to the expression (1) above, in order to set the flow speed u of the high pressure refrigerant gas in the second intake passage 36 to 1 m/s or less, the cross-sectional area A of the second intake passage 36 may be set so as to satisfy the following expression:

$$A \geq G / (1 \cdot \rho) \dots (2)$$

[0045] In the expression (2) above, the density ρ of the high pressure refrigerant gas in the second intake passage 36 is a material property determined based on the pressure and the temperature of the high pressure refrigerant gas in the second intake passage 36. The mass flow rate G of the refrigerant can be calculated based on the following expression:

$$Q = G \Delta h \dots (3)$$

where Q [kW] is a heating power of the heat pump hot-water supply device 1, and Δh [kJ/kg] is an enthalpy difference between the first water-refrigerant heat exchanger 4 and the second water-refrigerant heat exchanger 5.

[0046] In Embodiment 1, as shown in Figure 3, the second intake passage 36 includes a first portion 361 through which a fluid flows downward, and a second portion 362 that is bent from the first portion 361. The fluid flows laterally through the second portion 362. A downstream end (outlet) of the second portion 362 opens to the internal space 311 of the sealed container 31. A curved portion 363 is formed between the first portion 361 and the second portion 362. With such a configuration, an annular liquid film of the refrigerator oil is formed along the pipe wall in the first portion 361. When the annular liquid film of the refrigerator oil flows down the first portion 361 and passes through the curved portion 363, an inertial force acts. By the inertial force, the liquid film of the refrigerator oil is deflected toward a lower inner wall of the second portion 362. The liquid film of the refrigerator oil is deflected toward the lower inner wall of the second portion 362 of the second intake passage 36, and thus the liquid film of the refrigerator oil flowing out of the downstream end (outlet) of the second intake passage 36 into the sealed container 31 can more reliably fall without colliding with the flow of the high pressure refrigerant gas spouting from the downstream end (outlet) of the second intake passage 36 into the sealed container 31. Thus, the liquid film of the refrigerator oil can be more reliably prevented from being raised and spattered by the flow of the high pressure refrigerant gas in the sealed container 31. This can more reliably separate the high pressure refrigerant gas and the refrigerator oil.

[0047] The embodiment in which the compressor according to the present invention is used to configure the heat pump hot-water supply device has been described above, however, not limited to the heat pump hot-water supply device, the present invention may be similarly applied to various vapor compression refrigeration cycle devices such as an air conditioning device or a cooling device.

Embodiment 2

[0048] Next, with reference to Figure 6, Embodiment 2 of the present invention will be described. Differences from Embodiment 1 described above will be mainly described, and like or corresponding parts are denoted by like reference numerals and descriptions thereof will be omitted. Embodiment 2 is similar to Embodiment 1 other than a different configuration of non-rotational oil separation means included with a second intake passage 36.

[0049] Figure 6 is a cross sectional view of a second intake passage 36 included in a compressor 3 according to Embodiment 2 of the present invention. As shown in Figure 6, in this embodiment, longitudinal grooves 364 are formed in an inner wall of the second intake passage 36. In this embodiment, many grooves 364 are formed in parallel over the entire inner periphery of the second intake passage 36.

[0050] In Embodiment 2, the grooves 364 are formed in the inner wall of the second intake passage 36, and thus refrigerator oil is reliably captured by the inner wall of the second intake passage 36 by action of surface tension. Thus, the refrigerator oil is reliably prevented from being spattered and atomized in the high pressure refrigerant gas in a center of the second intake passage 36. This can reliably prevent atomized refrigerator oil from flowing from a downstream end (outlet) of the second intake passage 36 to an internal space 311 of a sealed container 31. The refrigerator oil captured by the grooves 364 smoothly flows along the grooves 364, and falls from the downstream end of the second intake passage 36 into an oil reservoir 312 in a lower portion of the internal space 311 of the sealed container 31. Thus, the refrigerator oil and the high pressure refrigerant gas can be more reliably separated. In this embodiment, mixture of the high pressure refrigerant gas and the refrigerator oil flowing from the second intake passage 36 to the internal space 311 of the sealed container 31 can be prevented to reliably separate the high pressure refrigerant gas and the refrigerator oil in this manner. This can provide similar advantage as of Embodiment 1.

[0051] In Embodiment 2, a configuration in which the grooves 364 are formed in the inner wall of the second intake passage 36 corresponds to non-rotational oil separation means (non-rotational oil separator) included with the second intake passage 36. Thus, in Embodiment 2, a cross-sectional area of the second intake passage 36 may not satisfy the conditions described in Embodiment 1.

[0052] In the example in Figure 6, the groove 364 has a substantially V-shaped section. The groove 364 may have a rectangular or semicircular section. The groove 364 may not be completely parallel to an axial direction of the second intake passage 36, but the groove 364 may be twisted with respect to the axial direction of the second intake passage 36. Also in this embodiment, for the same reason as in Embodiment 1, the second intake passage 36 preferably includes a first portion 361 directed downward, and a second portion 362 bent from the first portion 361 and laterally directed.

Embodiment 3

[0053] Next, with reference to Figures 7 and 8, Embodiment 3 of the present invention will be described. Differences from the embodiments described above will be mainly described, and like or corresponding parts are denoted by like reference numerals and descriptions thereof will be omitted. Figure 7 is a cross sectional view of around a downstream end of a second intake passage 36 included in a compressor 3 according to Embodiment 3 of the present invention.

Figure 8 is a longitudinal sectional view of around the downstream end of the second intake passage 36 included in the compressor 3 according to Embodiment 3 of the present invention. Embodiment 3 is the same as Embodiment 1 other than a different configuration of non-rotational oil separation means included with the second intake passage 36.

[0054] As shown in Figure 7, in Embodiment 3, an inner pipe 38 is provided inside the second intake passage 36. A high pressure refrigerant gas can pass through an inside of the inner pipe 38. Specifically, the inner pipe 38 has a channel cross-sectional area through which the high pressure refrigerant gas can smoothly pass. The refrigerator oil can pass between an inner wall of the second intake passage 36 and an outer wall of the inner pipe 38. Specifically, a gap to form a channel cross-sectional area through which the refrigerator oil can smoothly pass is formed between the inner wall of the second intake passage 36 and the outer wall of the inner pipe 38. In Embodiment 3, grooves 364 as in Embodiment 2 are formed in the inner wall of the second intake passage 36 so that the refrigerator oil can pass through the grooves 364.

[0055] As shown in Figure 8, a downstream end of the inner pipe 38 protrudes from a downstream end of the second intake passage 36. Specifically, the downstream end of the inner pipe 38 is located in a position protruding inward of a sealed container 31 as compared to the position of the downstream end of the second intake passage 36. The refrigerator oil flows out of the downstream end of the second intake passage 36, and falls into an oil reservoir 312 in a lower portion of an internal space 311 of the sealed container 31. The high pressure refrigerant gas spouts from the downstream end of the inner pipe 38 to the internal space 311 of the sealed container 31. Thus, the refrigerator oil having flowed out of the downstream end of the second intake passage 36 does not collide with a flow of the high pressure refrigerant gas spouting from the downstream end of the inner pipe 38, thereby reliably preventing the refrigerator oil from being raised and spattered by the flow of the refrigerant gas. In Embodiment 3, the refrigerator oil having flowed out of the downstream end of the second intake passage 36 can reliably fall into the oil reservoir 312 in the lower portion of the internal space 311 of the sealed container 31 and be separated. Thus, mixture of the high pressure refrigerant gas and the refrigerator oil flowing from the second intake passage 36 to the internal space 311 of the sealed container 31 can be reliably prevented to reliably separate the high pressure refrigerant gas and the refrigerator oil. This can provide similar advantage as of Embodiment 1.

[0056] In Embodiment 3, the inner pipe 38 described above corresponds to non-rotational oil separation means (non-rotational oil separator) included with the second intake passage 36. Thus, in this embodiment, a cross-sectional area of the second intake passage 36 may not satisfy the conditions described in Embodiment 1.

[0057] In Embodiment 3, the grooves 364 are formed in the inner wall of the second intake passage 36, and thus the refrigerator oil flowing in the second intake passage 36 is reliably captured in the grooves 364 by surface tension. Thus, the refrigerator oil is reliably prevented from being spattered and atomized in the high pressure refrigerant gas in the center of the second intake passage 36 to more reliably guide the refrigerator oil into the gap between the inner wall of the second intake passage 36 and the outer wall of the inner pipe 38. This can more reliably prevent mixture of the high pressure refrigerant gas and the refrigerator oil flowing to the internal space 311 of the sealed container 31.

[0058] In Embodiment 3, no grooves 364 may be provide in the inner wall of the second intake passage 36. Specifically, the inner wall of the second intake passage 36 may be smooth. In Embodiment 3, a space through which the refrigerator oil can pass will suffice, the space being provided between the inner wall of the second intake passage 36 and the outer wall of the inner pipe 38. In Embodiment 3, even without the grooves 364, the refrigerator oil having flowed into the sealed container 31 can be prevented from colliding with the flow of the high pressure refrigerant gas, thereby reliably preventing the refrigerator oil from being raised and spattered by the flow of the high pressure refrigerant gas. Also in Embodiment 3, for the same reason as in Embodiment 1, the second intake passage 36 preferably includes a first portion 361 directed downward, and a second portion 362 bent from the first portion 361 and laterally directed.

Embodiment 4

[0059] Next, with reference to Figure 9, Embodiment 4 of the present invention will be described. Differences from the embodiments described above will be mainly described, and like or corresponding parts are denoted by like reference numerals and descriptions thereof will be omitted. Figure 9 is a view of around a downstream end of a second intake passage 36 included in a compressor 3 according to Embodiment 4 of the present invention. Embodiment 4 is the same as Embodiment 1 other than a different configuration of non-rotational oil separation means included with the second intake passage 36.

[0060] As shown in Figure 9, in a sealed container 31, a tubular mesh member 39 is connected to the downstream end of the second intake passage 36. The mesh member 39 is made of, for example, a metal material, and has substantially the same diameter as the second intake passage 36. A central axis of the mesh member 39 is substantially horizontal. Refrigerator oil having flowed out of the downstream end of the second intake passage 36 is captured by the mesh member 39, collected along a peripheral surface of the mesh member 39 in a lower portion of the mesh member 39, and falls into an oil reservoir 312 in a lower portion of an internal space 311 of the sealed container 31. An end surface of the mesh member 39 has an opening. A high pressure refrigerant gas spouts through the opening in the end surface of the mesh member 39 rather than meshes (pores) of the mesh member 39 to the internal space 311 of the sealed

container 31. With such a configuration, in Embodiment 4, the refrigerator oil having flowed out of the downstream end of the second intake passage 36 can be reliably prevented from being raised and spattered by the flow of the high pressure refrigerant gas. Thus, mixture of the high pressure refrigerant gas and the refrigerator oil flowing from the second intake passage 36 to the internal space 311 of the sealed container 31 can be reliably prevented to reliably

separate the high pressure refrigerant gas and the refrigerator oil. This can provide similar advantage as of Embodiment 1. **[0061]** In Embodiment 4, the mesh member 39 described above corresponds to non-rotational oil separation means (non-rotational oil separator) included with the second intake passage 36. Thus, in Embodiment 4, a cross-sectional area of the second intake passage 36 may not satisfy the conditions described in Embodiment 1.

[0062] In Embodiment 4, grooves 364 as in Embodiment 2 are desirably formed in an inner wall of the second intake passage 36. Thus, the refrigerator oil flowing in the second intake passage 36 is reliably captured in the grooves 364 by surface tension. Thus, the refrigerator oil is reliably prevented from being spattered and atomized in the high pressure refrigerant gas in a center of the second intake passage 36 to more reliably guide the refrigerator oil as a liquid film to the mesh member 39. This can more reliably prevent mixture of the high pressure refrigerant gas and the refrigerator oil flowing to the internal space 311 of the sealed container 31 to more reliably separate both. Also in Embodiment 4, for the same reason as in Embodiment 1, the second intake passage 36 preferably includes a first portion 361 directed downward, and a second portion 362 bent from the first portion 361 and laterally directed.

Reference Signs List

[0063]

1	heat pump hot-water supply device
1a	water inlet
1b	hot water outlet
2	tank unit
2a	hot water storage tank
2b	water pump
2c	hot-water supplying mixing valve
3	compressor
4	first water-refrigerant heat exchanger
5	second water-refrigerant heat exchanger
6	expansion valve
7	evaporator
8	fan
9	high and low pressures heat exchanger
10, 11, 12	pipe
13	water supply pipe
14	hot water delivery pipe
15	water supply branch pipe
16	hot-water supply pipe
17, 18, 19, 20, 21	pipe
23, 24, 26	water channel
27	accumulator
31	sealed container
32	compressing element
33	electric actuating element
34	first intake passage
35	first discharge passage
36	second intake passage
37	second discharge passage
38	inner pipe
39	mesh member
50	control unit
311	internal space
312	oil reservoir
321	compression chamber
322	muffler
323	frame

331	rotating shaft
361	first portion
362	second portion
363	curved portion
5 364	groove

Claims

- 10 1. A compressor comprising:
- a sealed container;
- a compressing element provided in the sealed container;
- 15 an electric actuating element provided in the sealed container, the electric actuating element driving the compressing element;
- a first intake passage for guiding sucked low pressure refrigerant to the compressing element without releasing the low pressure refrigerant to an internal space of the sealed container;
- a first discharge passage for discharging high pressure refrigerant compressed by the compressing element and refrigerator oil from the compressing element directly to an outside of the sealed container without releasing
- 20 the high pressure refrigerant to the internal space of the sealed container and without separating the high pressure refrigerant and the refrigerator oil;
- a second intake passage for guiding the high pressure refrigerant and the refrigerator oil having passed through the first discharge passage and an external heat exchanger provided downstream of the first discharge passage to the internal space of the sealed container;
- 25 non-rotational oil separation means included with the second intake passage, for separating the high pressure refrigerant and the refrigerator oil without rotating the high pressure refrigerant and the refrigerator oil; and
- a second discharge passage for discharging the high pressure refrigerant in the internal space of the sealed container, the high pressure refrigerant having been separated from the refrigerator oil by the non-rotational oil separation means, to the outside of the sealed container without compressing the high pressure refrigerant.
- 30 2. The compressor according to claim 1, wherein the refrigerator oil separated by the non-rotational oil separation means returns to an oil reservoir in the sealed container without contact with the electric actuating element.
3. The compressor according to claim 1 or 2, wherein a position where the refrigerator oil separated by the non-rotational oil separation means flows to the internal space of the sealed container is lower than the electric actuating element.
- 35 4. The compressor according to any one of claims 1 to 3, wherein the high pressure refrigerant separated from the refrigerator oil by the non-rotational oil separation means passes through a gap in the electric actuating element.
- 40 5. The compressor according to any one of claims 1 to 4, comprising, as the non-rotational oil separation means, a configuration with a cross-sectional area of the second intake passage being larger than a cross-sectional area of the first discharge passage.
- 45 6. The compressor according to any one of claims 1 to 5, comprising, as the non-rotational oil separation means, a configuration with a cross-sectional area of the second intake passage being set so that a flow speed of the refrigerant passing through the second intake passage is 1 m/s or less.
- 50 7. The compressor according to any one of claims 1 to 4, comprising, as the non-rotational oil separation means, a configuration with a longitudinal groove being formed in an inner wall of the second intake passage.
8. The compressor according to any one of claims 1 to 4, comprising, as the non-rotational oil separation means, an inner pipe provided inside the second intake passage,
- wherein a downstream end of the inner pipe protrudes from a downstream end of the second intake passage,
- 55 the high pressure refrigerant is able to pass through an inside of the inner pipe, and
- the refrigerator oil is able to pass between an inner wall of the second intake passage and an outer wall of the inner pipe.

9. The compressor according to any one of claims 1 to 4, comprising, as the non-rotational oil separation means, a tubular mesh member connected to a downstream end of the second intake passage.

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10. The compressor according to claim 8 or 9, wherein a longitudinal groove is formed in the inner wall of the second intake passage.

11. The compressor according to any one of claims 1 to 10, wherein the second intake passage includes a first portion directed downward, and a second portion bent from the first portion and laterally directed.

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12. The compressor according to any one of claims 1 to 11, wherein pressure on a high pressure side of the refrigerant exceeds critical pressure.

13. A refrigeration cycle device comprising:

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the compressor according to any one of claims 1 to 12;
a first heat exchanger, as the external heat exchanger, for making the high pressure refrigerant and the refrigerator oil discharged from the first discharge passage of the compressor release heat; and
a second heat exchanger for making the high pressure refrigerant discharged from the second discharge passage of the compressor release heat.

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14. A heat pump hot-water supply device comprising:

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the compressor according to any one of claims 1 to 12;
a first water-refrigerant heat exchanger, as the external heat exchanger, for performing heat exchange between the high pressure refrigerant and the refrigerator oil discharged from the first discharge passage of the compressor and water; and
a second water-refrigerant heat exchanger for performing heat exchange between the high pressure refrigerant discharged from the second discharge passage of the compressor and water.

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FIG. 1

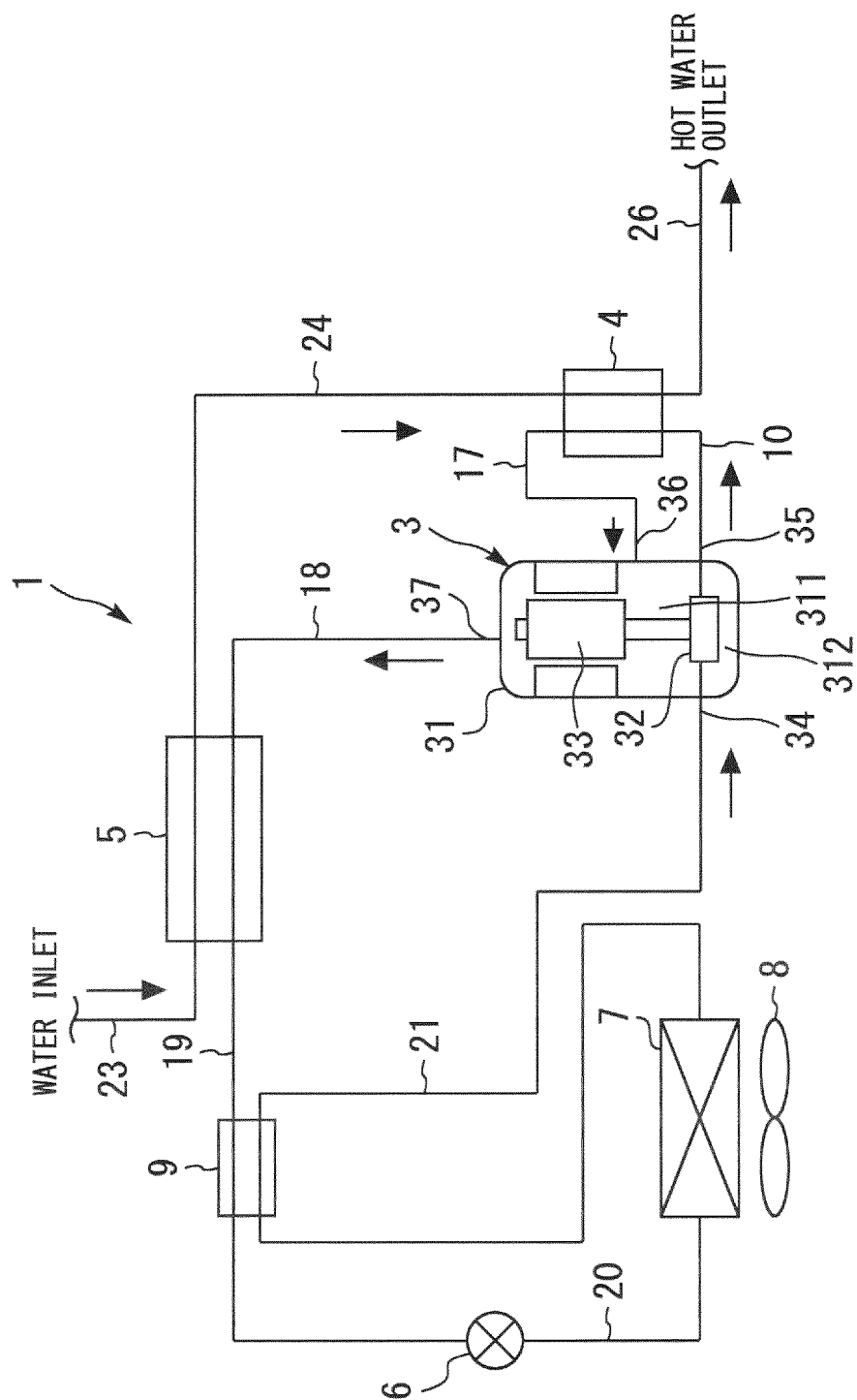


FIG. 2

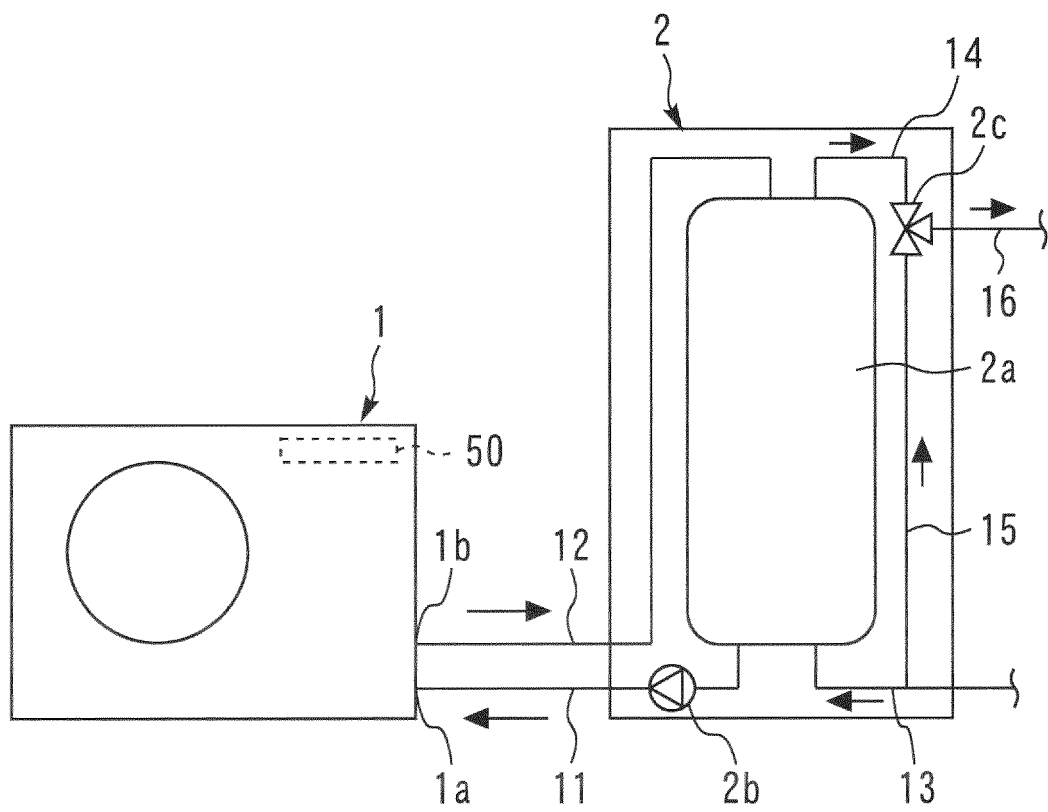


FIG. 3

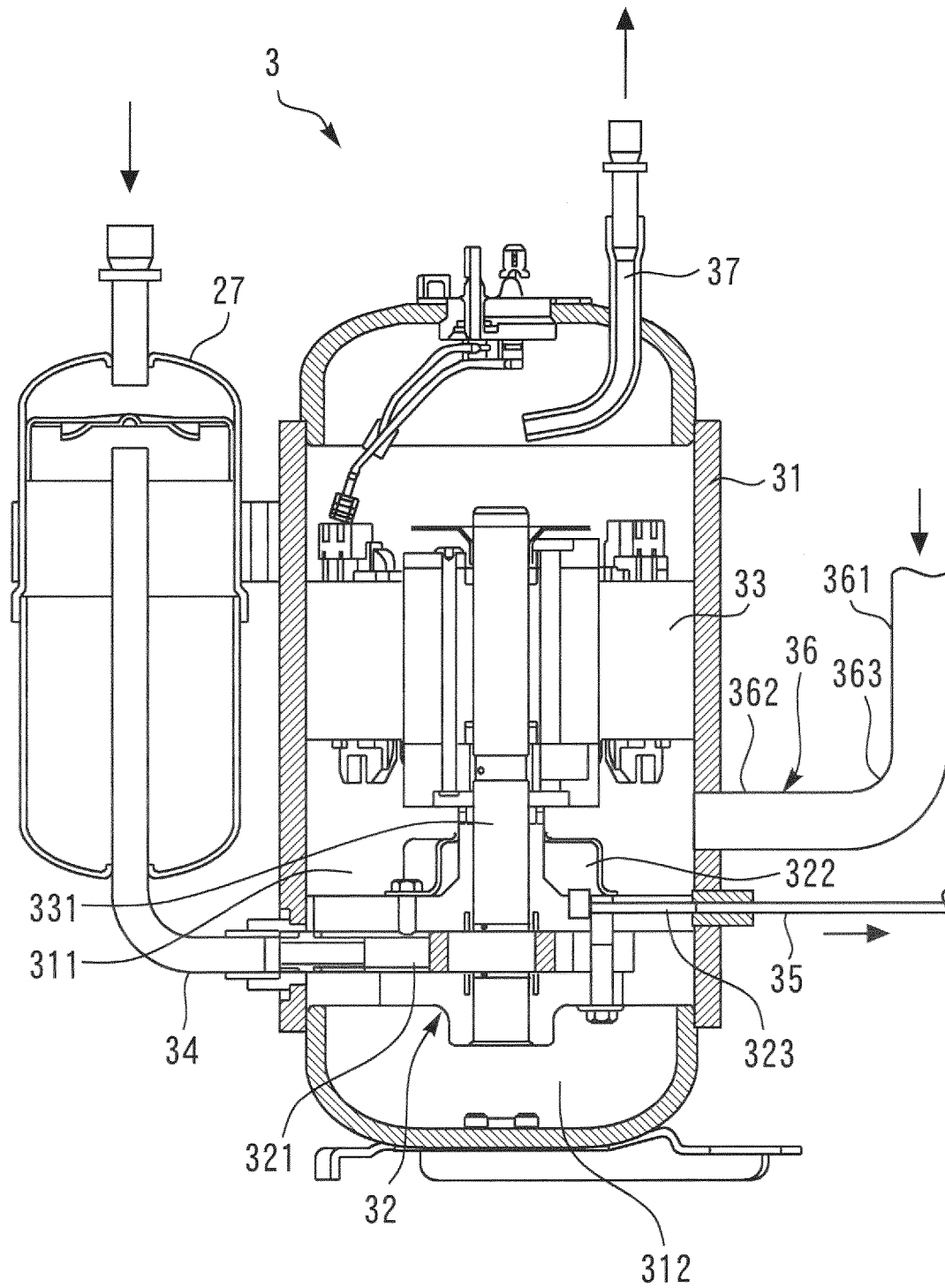


FIG. 4

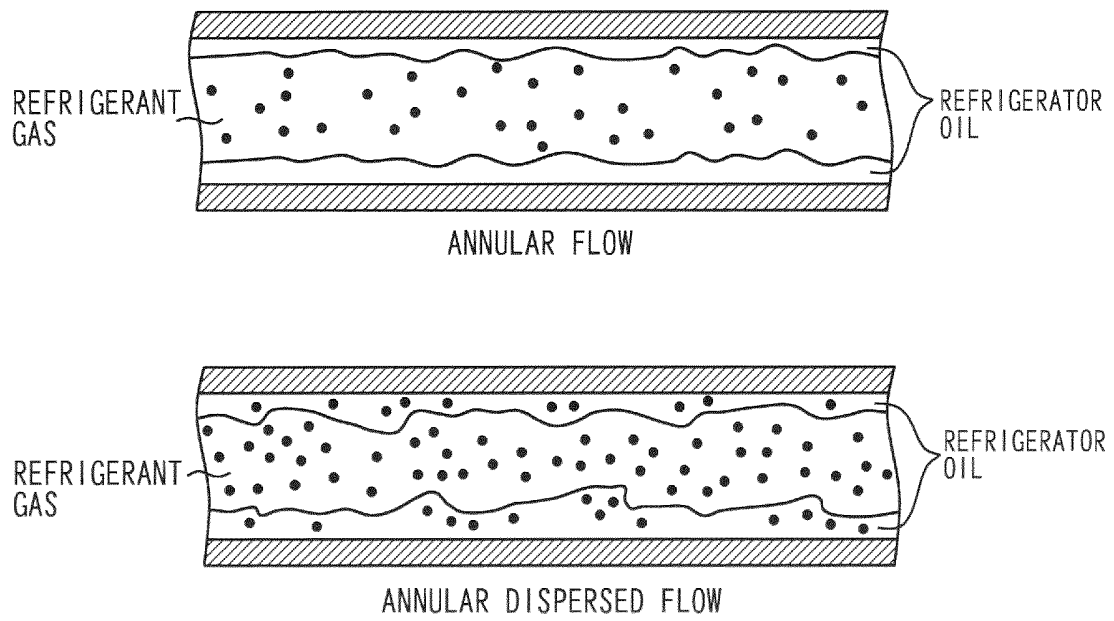


FIG. 5

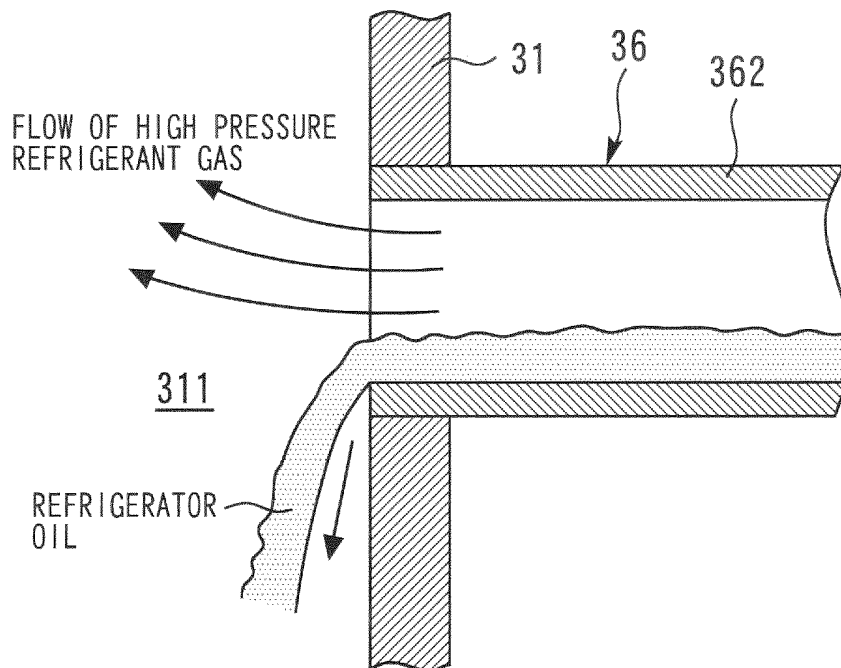


FIG. 6

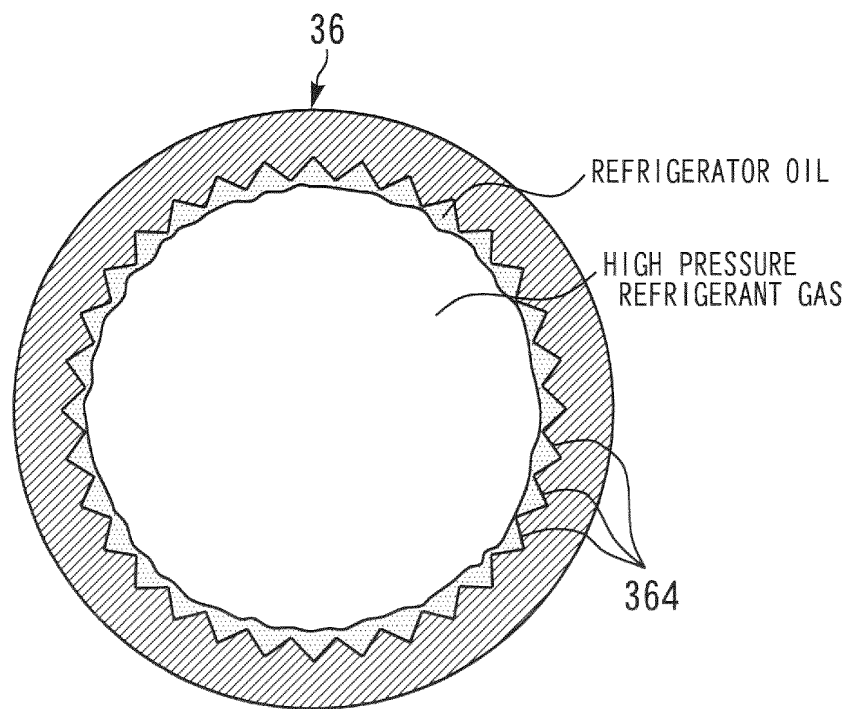


FIG. 7

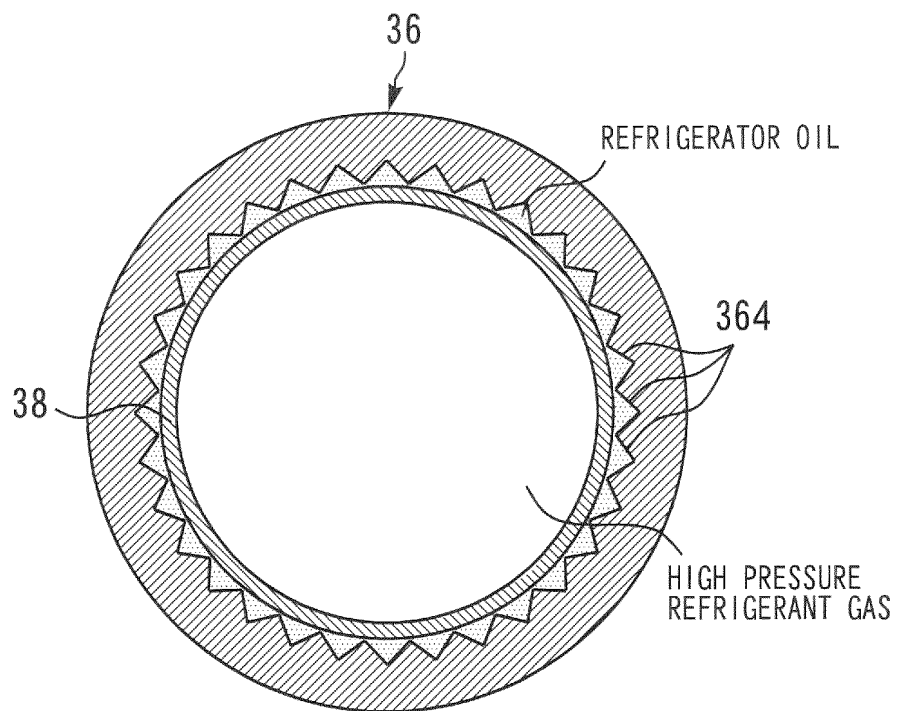


FIG. 8

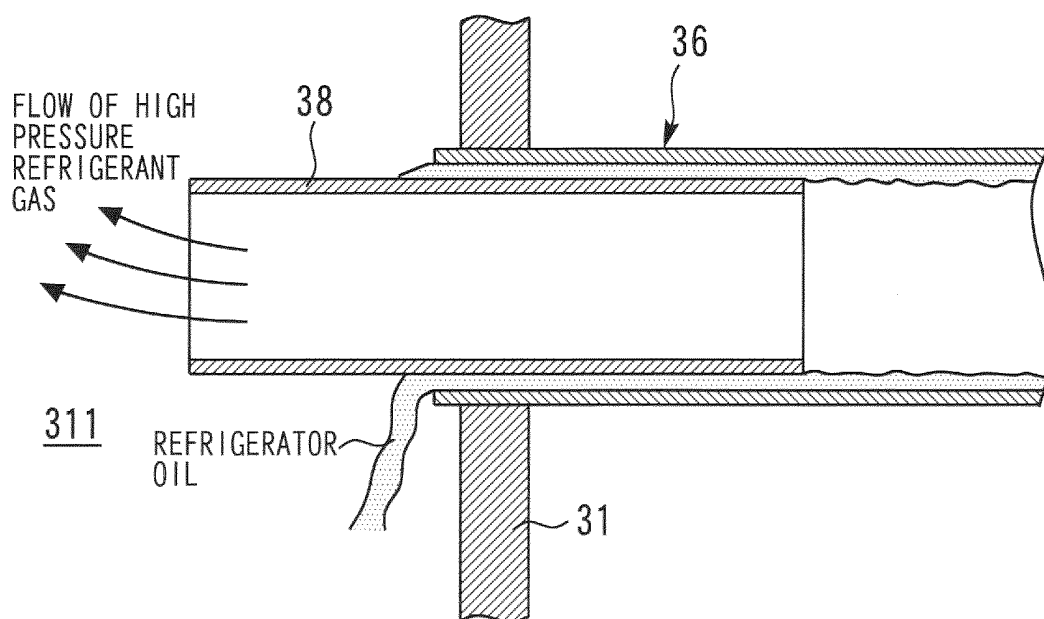
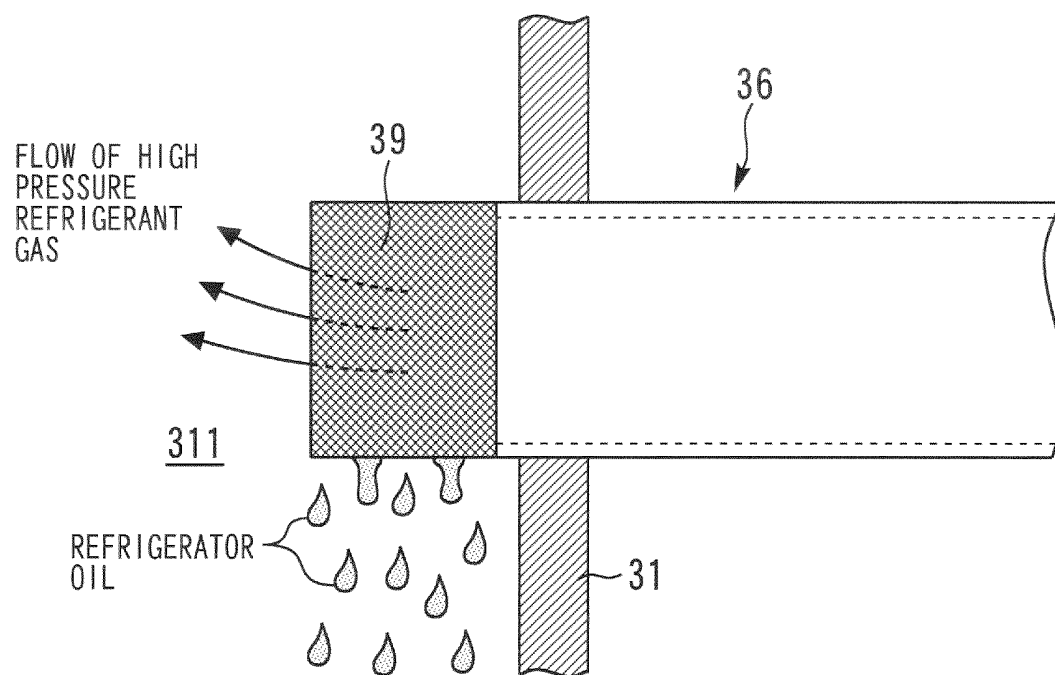


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/073334

A. CLASSIFICATION OF SUBJECT MATTER

F25B43/02(2006.01) i, F25B1/00(2006.01) i

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)

F25B43/02, F25B1/00, F04B39/00-39/16, F04C29/00-29/12

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013

Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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.
A	JP 2006-132427 A (Mitsubishi Electric Corp.), 25 May 2006 (25.05.2006), entire text; all drawings (Family: none)	1-14
A	JP 2008-88975 A (Denso Corp.), 17 April 2008 (17.04.2008), entire text; all drawings (Family: none)	1-14

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

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"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
11 September, 2013 (11.09.13)Date of mailing of the international search report
24 September, 2013 (24.09.13)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/073334

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 24367/1990 (Laid-open No. 114585/1991) (Sanyo Electric Co., Ltd.), 25 November 1991 (25.11.1991), entire text; all drawings (Family: none)	1-14
A	JP 2006-322701 A (LG Electronics Inc.), 30 November 2006 (30.11.2006), entire text; all drawings & EP 1724537 A1 & KR 10-0619785 B1 & CN 1865818 A	1-14
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