



(11) **EP 4 354 049 A1**

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

(43) Date of publication:
17.04.2024 Bulletin 2024/16

(21) Application number: **22885426.1**

(22) Date of filing: **05.09.2022**

(51) International Patent Classification (IPC):
F25B 31/00 ^(2006.01) **F25B 43/02** ^(2006.01)
F25B 13/00 ^(2006.01) **F24F 1/0003** ^(2019.01)
F24F 1/06 ^(2011.01) **F24F 1/10** ^(2011.01)

(52) Cooperative Patent Classification (CPC):
F24F 1/0003; F24F 1/06; F24F 1/08; F24F 1/10;
F25B 13/00; F25B 31/00; F25B 41/20; F25B 43/00;
F25B 43/02

(86) International application number:
PCT/CN2022/117115

(87) International publication number:
WO 2023/071536 (04.05.2023 Gazette 2023/18)

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

(30) Priority: **01.11.2021 CN 202111284994**

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(54) **COMPRESSOR ASSEMBLY, AIR CONDITIONER OUTDOOR UNIT, AND AIR CONDITIONING SYSTEM**

(57) A compressor assembly, an air conditioner outdoor unit, and an air conditioning system. The compressor assembly comprises a first compressor (1), a second compressor (2), a first oil separator (3), a second oil separator (4), a first gas-liquid separator (5), a second gas-liquid separator (6), a liquid balance pipe (7), and a gas balance pipe (8). The first compressor (1) has a first gas return port (101); the second compressor (2) has a second gas return port (102); the first oil separator (3)

has a first oil outlet (302); the second oil separator (4) has a second oil outlet (402); the first gas-liquid separator (5) has a first separation chamber (5011), a first separation gas inlet (5031), a first oil return hole (5022), and a first separation gas outlet (5021); the second gas-liquid separator (6) has a second separation chamber (6011), a second separation gas inlet (6031), a second oil return hole (6022), and a second separation gas outlet (6021); both the first separation gas outlet (5021) and the first oil

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return hole (5022) are connected to the first gas return port (101); both the second separation gas outlet (6021) and the second oil return hole (6022) are connected to the second gas return port (102); and both the liquid balance pipe (7) and the gas balance pipe (8) are communicated with the first separation chamber (5011) and the second separation chamber (6011).

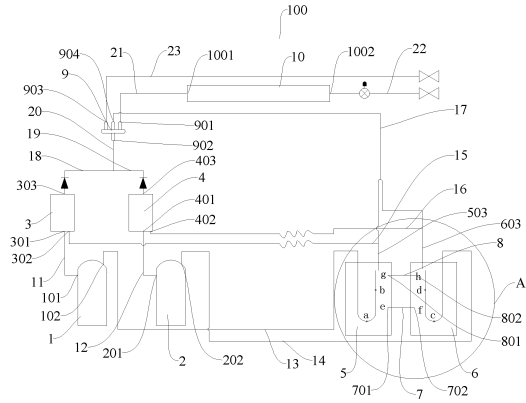


FIG. 1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and claims priority to Chinese Patent Application No. 202111284994.0, filed on November 1, 2021, the entire content of which is incorporated herein by reference.

FIELD

[0002] This application relates to the field of air conditioning equipment, and more particularly to a compressor assembly, an air conditioner outdoor unit, and an air conditioning system.

BACKGROUND

[0003] With social development and technological progress, multi-unit heat pump air conditioning systems have increasing capacity. However, with the increase in the capacity, the multi-unit heat pump air conditioning systems also face problems such as insufficient volume for gas separation and difficulty in recovering refrigeration oil, which limit the development of the multi-unit heat pump air conditioning systems. In the related art, parallel connection is adopted for gas separation to expand the capacity of the air conditioning system, which solves the problem of insufficient gas separation volume, but leads to poor reliability of compressor operation.

SUMMARY

[0004] The present invention aims to solve at least one of the technical problems existing in the related art to a certain extent.

[0005] Accordingly, embodiments of the present invention propose a compressor assembly to improve operational reliability of a compressor.

[0006] Embodiments of the present invention also propose an air conditioner outdoor unit to improve operational reliability of the air conditioner outdoor unit.

[0007] Embodiments of the present invention also propose an air conditioning system to improve operational reliability of the air conditioning system.

[0008] The compressor assembly according to embodiments of the present invention comprises: a first compressor comprising a first exhaust port and a first gas return port; a second compressor comprising a second exhaust port and a second gas return port; a first oil separator comprising a first oil outlet and a first oil separator inlet, the first oil separator inlet being communicated to the first exhaust port; a second oil separator comprising a second oil outlet and a second oil separator inlet, the second oil separator inlet being communicated to the second exhaust port; a first gas-liquid separator comprising a first separation chamber, a first gas separator inlet, a first oil return hole and a first gas separator outlet,

wherein the first gas separator inlet, the first oil return hole and the first gas separator outlet are communicated to the first separation chamber, and wherein the first oil outlet is communicated to the first gas separator inlet, and the first gas separator outlet and the first oil return hole are each communicated to the first gas return port; a second gas-liquid separator comprising a second separation chamber, a second gas separator inlet, a second oil return hole and a second gas separator outlet, wherein the second gas separator inlet, the second oil return hole and the second gas separator outlet are communicated to the second separation chamber, and wherein the second oil outlet is communicated to the second gas separator inlet, and the second gas separator outlet and the second oil return hole are each communicated to the second gas return port; and a liquid balance pipe and a gas balance pipe above the liquid balance pipe. An end of the liquid balance pipe and an end of the gas balance pipe are both communicated to the first separation chamber, while an other end of the liquid balance pipe and an other end of the gas balance pipe are both communicated to the second separation chamber.

[0009] The compressor assembly according to embodiments of the present invention has advantages such as high operational reliability.

[0010] In some embodiments, the first gas-liquid separator comprises: a first cylinder, the first separation chamber being defined in the first cylinder; and a first gas outlet pipe, a portion of the first gas outlet pipe extending into the first separation chamber, the first oil return hole being in the portion of the first gas outlet pipe, and the first gas separator outlet being in an other portion of the first gas outlet pipe. The second gas-liquid separator comprises: a second cylinder, the second separation chamber being defined in the second cylinder; and a second gas outlet pipe, a portion of the second gas outlet pipe extending into the second separation chamber, the second oil return hole being in the portion of the second gas outlet pipe, and the second gas separator outlet being in an other portion of the second gas outlet pipe. The end of the liquid balance pipe is above the first oil return hole or at a same height as the first oil return hole; and the other end of the liquid balance pipe is above the second oil return hole or at a same height as the second oil return hole.

[0011] In some embodiments, the portion of the first gas outlet pipe comprises a third oil return hole communicated to the first separation chamber, and the portion of the second gas outlet pipe comprises a fourth oil return hole communicated to the second separation chamber. The third oil return hole is above the first oil return hole or at a same height as the first oil return hole; and the fourth oil return hole is above the second oil return hole or at a same height as the second oil return hole.

[0012] In some embodiments, the end of the liquid balance pipe is between the first oil return hole and the third oil return hole in an up-down direction, and the other end of the liquid balance pipe is between the second oil return

hole and the fourth oil return hole in the up-down direction.

[0013] In some embodiments, the end of the gas balance pipe is above the third oil return hole or at a same height as the third oil return hole, and the other end of the gas balance pipe is above the fourth oil return hole or at a same height as the fourth oil return hole.

[0014] In some embodiments, the third oil return hole is between the end of the gas balance pipe and the end of the liquid balance pipe in an up-down direction; and the fourth oil return hole is between the other end of the gas balance pipe and the other end of the liquid balance pipe in the up-down direction.

[0015] In some embodiments, the first oil return hole and the second oil return hole are at a same height; and/or a bottom wall surface of the first separation chamber and a bottom wall surface of the second separation chamber are at a same height, the end of the liquid balance pipe and the other end of the liquid balance pipe are at a same height, and the end of the gas balance pipe and the other end of the gas balance pipe are at a same height.

[0016] In some embodiments, the third oil return hole and the fourth oil return hole are at a same height.

[0017] In some embodiments, the portion of the first gas outlet pipe and the portion of the second gas outlet pipe each comprise a U-shaped portion. The U-shaped portion comprises: a first segment and a second segment, the first segment and the second segment extending in an up-down direction; and an intermediate segment, comprising an end connected to a lower end of the first segment, and an other end connected to a lower end of the second segment. The first oil return hole is in the intermediate segment of the first gas outlet pipe; the third oil return hole is in the first segment of the first gas outlet pipe; the second oil return hole is in the intermediate segment of the second gas outlet pipe; and the fourth oil return hole is in the first segment of the second gas outlet pipe.

[0018] The air conditioner outdoor unit according to embodiments of the present invention comprises: a four-way valve, comprising a first interface, a second interface, a third interface, and a fourth interface; an outdoor heat exchanger, a first port of the outdoor heat exchanger being connected to the first interface; and the compressor assembly according to any one of the above embodiments. The first oil separator comprises a first oil separator outlet, and the second oil separator comprises a second oil separator outlet; the first oil separator outlet and the second oil separator outlet are each connected to the second interface; and the first gas separator inlet and the second gas separator inlet are each connected to the fourth interface.

[0019] The air conditioner outdoor unit according to embodiments of the present invention has advantages such as high operational reliability.

[0020] The air conditioning system according to embodiments of the present invention comprises: the air conditioner outdoor unit according to any one of the

above embodiments; and an air conditioner indoor unit comprising an indoor heat exchanger. A second port of the outdoor heat exchanger is connected to a first port of the indoor heat exchanger, and a second port of the indoor heat exchanger is connected to the third interface.

[0021] The air conditioning system according to embodiments of the present invention has advantages such as high operational reliability.

BRIEF DESCRIPTION OF DRAWINGS

[0022]

FIG. 1 is a schematic view of an air conditioner outdoor unit according to an embodiment of the present invention.

FIG. 2 is an enlarged view of part A in FIG. 1.

FIG. 3 is a schematic view of an air conditioner outdoor unit according to another embodiment of the present invention.

FIG. 4 is a schematic view of a first gas inlet pipe and a second gas inlet pipe according to an embodiment of the present invention.

FIG. 5 is a schematic view of a first gas inlet pipe and a second gas inlet pipe according to an embodiment of the present invention.

FIG. 6 is a schematic view of a first gas inlet pipe and a second gas inlet pipe according to an embodiment of the present invention.

Reference numerals:

[0023]

air conditioner outdoor unit 100;
first compressor 1; first exhaust port 101; first gas return port 102;
second compressor 2; second exhaust port 201; second gas return port 202;
first oil separator 3; first oil separator inlet 301; first oil outlet 302; first oil separator outlet 303;
second oil separator 4; second oil separator inlet 401; second oil outlet 402; second oil separator outlet 403;
first gas-liquid separator 5; first cylinder 501; first separation chamber 5011; first gas outlet pipe 502; first gas separator outlet 5021; first oil return hole 5022; third oil return hole 5023; first gas inlet pipe 503; first gas separator inlet 5031;
second gas-liquid separator 6; second cylinder 601; second separation chamber 6011; second gas outlet pipe 602; second gas separator outlet 6021; second oil return hole 6022; fourth oil return hole 6023; second gas inlet pipe 603; second gas separator inlet 6031;
liquid balance pipe 7; first end 701; second end 702; first pipe segment 703; second pipe segment 704; third pipe segment 705;

gas balance pipe 8; third end 801; fourth end 802; four-way valve 9; first interface 901; second interface 902; third interface 903; fourth interface 904; outdoor heat exchanger 10; first port 1001; second port 1002; first pipe 11; second pipe 12; third pipe 13; fourth pipe 14; fifth pipe 15; sixth pipe 16; seventh pipe 17; eighth pipe 18; ninth pipe 19; tenth pipe 20; eleventh pipe 21; twelfth pipe 22; thirteenth pipe 23.

DETAILED DESCRIPTION

[0024] Embodiments of the present invention will be described in detail below, and examples of the embodiments will be shown in the accompanying drawings. The embodiments described below are exemplary and are intended to explain the present invention rather than limit the present invention.

[0025] A compressor assembly according to embodiments of the present invention will be described below with reference to the accompanying drawings.

[0026] As shown in FIGS. 1 to 3, the compressor assembly according to embodiments of the present invention comprise a first compressor 1, a second compressor 2, a first oil separator 3, a second oil separator 4, a first gas-liquid separator 5, a second gas-liquid separator 6, a liquid balance pipe 7, and a gas balance pipe 8.

[0027] The first compressor 1 has a first exhaust port 101 and a first gas return port 102. The second compressor 2 has a second exhaust port 201 and a second gas return port 202. The first oil separator 3 has a first oil outlet 302 and a first oil separator inlet 301 that is communicated to the first exhaust port 101. The second oil separator 4 has a second oil outlet 402 and a second oil separator inlet 401 that is communicated to the second exhaust port 201.

[0028] The first gas-liquid separator 5 has a first separation chamber 5011 and comprises a first gas separator inlet 5031, a first oil return hole 5022 and a first gas separator outlet 5021, all of which are communicated to the first separation chamber 5011. The second gas-liquid separator 6 has a second separation chamber 6011 and comprises a second gas separator inlet 6031, a second oil return hole 6022 and a second gas separator outlet 6021, all of which are communicated to the second separation chamber 6011. The first oil outlet 302 is communicated to the first gas separator inlet 5031, and the second oil outlet 402 is communicated to the second gas separator inlet 6031. The first gas separator outlet 5021 and the first oil return hole 5022 are each communicated to the first gas return port 102. The second gas separator outlet 6021 and the second oil return hole 6022 are each communicated to the second gas return port 202.

[0029] The gas balance pipe 8 is above the liquid balance pipe 7. It can be understood by those skilled in the art that the gas balance pipe 8 being above the liquid balance pipe 7 means that when the first gas-liquid separator 5 and the second gas-liquid separator 6 are in use,

the gas balance pipe 8 is above the liquid balance pipe 7.

[0030] One end of the liquid balance pipe 7 and one end of the gas balance pipe 8 are both communicated to the first separation chamber 5011, while the other end of the liquid balance pipe 7 and the other end of the gas balance pipe 8 are both communicated to the second separation chamber 6011. For example, as shown in FIGS. 1 to 3, the liquid balance pipe 7 has a first end 701 and a second end 702 opposite to each other in its length direction; the gas balance pipe 8 has a third end 801 and a fourth end 802 opposite to each other in its length direction; the first end 701 and the third end 801 are each communicated to the first separation chamber 5011; and the second end 702 and the fourth end 802 are each communicated to the second separation chamber 6011.

[0031] Consequently, the use of the liquid balance pipe 7 and the gas balance pipe 8 can achieve connection between the first separation chamber 5011 and the second separation chamber 6011, thereby achieving liquid balance and gas balance between the first separation chamber 5011 and the second separation chamber 6011.

[0032] During operation of the compressor assembly according to embodiments of the present invention, refrigerant vapor containing refrigeration oil (first oil-containing refrigerant vapor) flowing out of the first exhaust port 101 of the first compressor 1 enters the first oil separator 3 through the first oil separator inlet 301, and the first oil-containing refrigerant vapor is separated into first refrigerant vapor and first refrigeration oil in the first oil separator 3. The first refrigeration oil enters the first separation chamber 5011 of the first gas-liquid separator 5 through the first oil outlet 302 and the first gas separator inlet 5031, and the first refrigerant vapor enters an indoor heat exchanger for heat exchange. Meanwhile, refrigerant vapor containing refrigeration oil (second oil-containing refrigerant vapor) flowing out of the second exhaust port 201 of the second compressor 2 enters the second oil separator 4 through the second oil separator inlet 401, and the second oil-containing refrigerant vapor is separated into second refrigerant vapor and second refrigeration oil in the second oil separator 4. The second refrigeration oil enters the second separation chamber 6011 of the second gas-liquid separator 6 through the second oil outlet 402 and the second gas separator inlet 6031, and the second refrigerant vapor enters the indoor heat exchanger for heat exchange.

[0033] In addition, a part of the refrigerant (a third refrigerant), which flows out of the indoor heat exchanger and needs to return to the first compressor 1 and the second compressor 2, enters the first separation chamber 5011 of the first gas-liquid separator 5 through the first gas separator inlet 5031; and another part of the refrigerant (a fourth refrigerant), which flows out of the indoor heat exchanger and needs to return to the first compressor 1 and the second compressor 2, enters the second separation chamber 6011 of the second gas-liquid separator 6 through the second gas separator inlet 6031.

[0034] Next, in a suction process of the first compressor 1 (the third refrigerant and the fourth refrigerant), the refrigeration oil in the first separation chamber 5011 can return, along with the refrigerant vapor, to the first compressor 1 through the first oil return hole 5022, the first gas separator outlet 5021 and the first gas return port 102; in a suction process of the second compressor 2 (the third refrigerant and the fourth refrigerant), the refrigeration oil in the second separation chamber 6011 can return, along with the refrigerant vapor, to the second compressor 2 through the second oil return hole 6022, the second gas separator outlet 6021 and the second gas return port 202. Thus, recovery of refrigeration oil in the first compressor 1 and the second compressor 2 can be realized.

[0035] For the compressor assembly that returns oil through the gas-liquid separator, there is a relationship between the return oil volume of the compressor and the suction volume of the compressor - the return oil volume of the compressor increases with an increase in the suction volume of the compressor, while the return oil volume of the compressor decreases with a decrease in the suction volume of the compressor. Accordingly, when compressors with different capacities are used in a common system, if a deviation among suction volumes of compressors with different capacities is too large (exceeding a design deviation), a deviation in the amount of refrigeration oil returned to the compressor along with refrigerant vapor during the suction process of the compressor will also be large, cause some compressors (usually small-capacity compressors) to suffer from insufficient return oil or inability to return oil.

[0036] In the related art, parallel connection is adopted for gas separation to expand the capacity of the air conditioning system, which solves the problem of insufficient gas separation volume, but cannot solve the problem concerning refrigeration oil recovery, and there is a significant risk of delay or inability of oil return, resulting in poor reliability of compressor operation.

[0037] For the compressor assembly according to embodiments of the present invention, since the first separation chamber 5011 of the first gas-liquid separator 5 and the second separation chamber 6011 of the second gas-liquid separator 6 are connected through the liquid balance pipe 7 and the gas balance pipe 8, it can be ensured that the first separation chamber 5011 of the first gas-liquid separator 5 and the second separation chamber 6011 of the second gas-liquid separator 6 both have refrigeration oil and refrigerant therein, which can reduce or even avoid a large refrigerant distribution deviation (i.e., there is a large amount of refrigerant at the gas separator inlet of the gas-liquid separator corresponding to the large capacity compressor, while there is very little refrigerant at the gas separator inlet of the gas-liquid separator corresponding to the small capacity compressor) at the first gas separator inlet 5031 of the first gas-liquid separator 5 and the second gas separator inlet 6031 of the second gas-liquid separator 6 caused

by different capacities of the first compressor 1 and the second compressor 2. Furthermore, the problem of insufficient return oil or even inability to return oil for small capacity compressors due to the different capacities of the first compressor 1 and the second compressor 2 can be relieved or even avoided, thereby preventing compressor wear for lack of lubrication caused by untimely oil return or inability to return oil, and greatly improving the reliability of the compressor assembly.

[0038] Therefore, the compressor assembly according to embodiments of the present invention has advantages such as high reliability.

[0039] In addition, each compressor according to embodiments of the present invention has its corresponding oil separator and gas-liquid separator, allowing each compressor to form a relatively independent refrigeration oil circulation system.

[0040] In some embodiments of the present invention, as shown in FIGS. 1 and 2, the compressor assembly comprises a first pipe 11, a second pipe 12, a third pipe 13, a fourth pipe 14, a fifth pipe 15, and a sixth pipe 16. The first exhaust port 101 is connected to the first oil separator inlet 301 through the first pipe 11, and the second exhaust port 201 is connected to the second oil separator inlet 401 through the second pipe 12. The first oil outlet 302 is communicated to the first gas separator inlet 5031 through the fifth pipe 15, and the second oil outlet 402 is communicated to the second gas separator inlet 6031 through the sixth pipe 16. The first gas separator outlet 5021 is connected to the first return gas outlet 102 through the third pipe 13, and the second gas separator outlet 6021 is connected to the second return gas outlet 202 through the fourth pipe 14.

[0041] In some embodiments, as shown in FIGS. 1 to 3, the first gas-liquid separator 5 comprises a first cylinder 501 and a first gas outlet pipe 502. The first separation chamber 5011 is defined in first cylinder 501, and a part of the first gas outlet pipe 502 extends into the first separation chamber 5011. The first oil return hole 5022 is in the part of the first gas outlet pipe 502, and the first gas separator outlet 5021 is in another part of the first gas outlet pipe 502.

[0042] For example, the first gas outlet pipe 502 comprises a first portion and a second portion, the first portion extends into the first separation chamber 5011, and the second portion is outside the first separation chamber 5011. The first oil return hole 5022 is in the first portion of the first gas outlet pipe 502, and the first gas separator outlet 5021 is in the second portion of the first gas outlet pipe 502.

[0043] The second gas-liquid separator 6 comprises a second cylinder 601 and a second gas outlet pipe 602. The second separation chamber 6011 is defined in the second cylinder 601, and a part of the second gas outlet pipe 602 extends into the second separation chamber 6011. The second oil return hole 6022 is in the part of the second gas outlet pipe 602, and the second gas separator outlet 6021 is in another part of the second gas

outlet pipe 602.

[0044] For example, the second gas outlet pipe 602 comprises a first portion and a second portion, the first portion extends into the second separation chamber 6011, and the second portion is outside the second separation chamber 6011. The second oil return hole 6022 is in the first portion of the second gas outlet pipe 602, and the second gas separator outlet 6021 is in the second portion of the second gas outlet pipe 602.

[0045] One end of the liquid balance pipe 7 is above the first oil return hole 5022 or at a same height as the first oil return hole 5022; the other end of the liquid balance pipe 7 is above the second oil return hole 6022 or at a same height as the second oil return hole 6022.

[0046] It can be understood by those skilled in the art that when the first gas-liquid separator 5 and the second gas-liquid separator 6 are in use, one end of the liquid balance pipe 7 is above the first oil return hole 5022 or at the same height as the first oil return hole 5022, and the other end of the liquid balance pipe 7 is above the second oil return hole 6022 or at the same height as the second oil return hole 6022.

[0047] For example, as shown in FIGS. 1 and 2, a bottom wall surface of the first separation chamber 5011 and a bottom wall surface of the second separation chamber 6011 are at the same height. A distance between the first end 701 (e) of the liquid balance pipe 7 and the bottom wall surface of the first separation chamber 5011 is denoted as L1; a distance between the first oil return hole 5022 (a) and the bottom wall surface of the first separation chamber 5011 is denoted as L2; a distance between the second end 702 (f) of the liquid balance pipe 7 and the bottom wall surface of the second separation chamber 6011 is denoted as L3; and a distance between the second oil return hole 6022 (c) and the bottom wall surface of the second separation chamber 6011 is L4, in which $L1 \geq L2$ and $L3 \geq L4$.

[0048] Therefore, the refrigeration oil in the first separation chamber 5011 can enter the second separation chamber 6011 through the liquid balance pipe 7 only when a liquid level of the refrigeration oil in the first separation chamber 5011 is not lower than the first oil return hole 5022; the refrigeration oil in the second separation chamber 6011 can enter the first separation chamber 5011 through the liquid balance pipe 7 only when a liquid level of the refrigeration oil in the second separation chamber 6011 is not lower than the second oil return hole 6022. Hence, the refrigeration oil in the first separation chamber 5011 first return to the first compressor 1, and only on the premise that the first compressor 1 has returned oil, the refrigeration oil in the first separation chamber 5011 can enter the second separation chamber 6011 to provide refrigeration oil for the second compressor 2; and the refrigeration oil in the second separation chamber 6011 first return to the second compressor 2, and only on the premise that the second compressor 2 has returned oil, the refrigeration oil in the second separation chamber 6011 can enter the first separation chamber

5011 to provide refrigeration oil for the first compressor 1. In such a way, the reliability of the compressor assembly can be further enhanced.

[0049] In some embodiments of the present invention, the first gas-liquid separator 5 comprises a first gas inlet pipe 503, and a part of the first gas inlet pipe 503 extends into the first separation chamber 5011, the first gas separator inlet 5031 being in the part of the first gas inlet pipe 503. The second gas-liquid separator 6 comprises a second gas inlet pipe 603 that extends into the second separation chamber 6011. A part of the second gas inlet pipe 603 extends into the second separation chamber 6011, and the second gas separator inlet 6031 is in the part of the second gas inlet pipe 603.

[0050] The first gas inlet pipe 503 and the first oil outlet 302 are connected through the fifth pipe 15, and the second gas inlet pipe 603 and the second oil outlet 402 are connected through the sixth pipe 16.

[0051] In some embodiments of the present invention, one end of the liquid balance pipe 7 extends into an interior of the first cylinder 501, so that one end of the liquid balance pipe 7 is communicated to the first separation chamber 5011; the other end of the liquid balance pipe 7 extends into an interior of the second cylinder 601, so that the other end of the liquid balance pipe 7 is communicated to the second separation chamber 6011.

[0052] For example, as shown in FIGS. 1 to 3, the first end 701 of the liquid balance pipe 7 extends into the interior of the first cylinder 501, and the second end 702 of the liquid balance pipe 7 extends into the interior of the second cylinder 601.

[0053] In some embodiments, the first oil return hole 5022 and the second oil return hole 6022 are at the same height.

[0054] For example, when the bottom wall surface of the first separation chamber 5011 and the bottom wall surface of the second separation chamber 6011 are at the same height, $L2=L4$.

[0055] Consequently, the problem of large refrigerant distribution deviation caused by the different capacities of the first compressor 1 and the second compressor 2 can be relieved or even avoided, which is conducive to further improving the reliability of the compressor assembly.

[0056] In some embodiments of the present invention, each of the liquid balance pipe 7 and the gas balance pipe 8 is a straight pipe.

[0057] For example, as shown in FIGS. 1 and 2, the liquid balance pipe 7 is a straight pipe, a connection port between the liquid balance pipe 7 and the first gas-liquid separator 5 is denoted as e, and a connection port between the liquid balance pipe 7 and the second gas-liquid separator 6 is denoted as f, in which e and f are at the same height. The first end 701 of the liquid balance pipe 7 and the second end 702 of the liquid balance pipe 7 are both at the same height as the connection port e (the connection port f).

[0058] In some embodiments of the present invention,

at least one of the liquid balance pipe 7 and the gas balance pipe 8 is a bent pipe.

[0059] For example, as shown in FIG. 3, the liquid balance pipe 7 comprises a first pipe segment 703, a second pipe segment 704, and a third pipe segment 705. The second pipe segment 704 is horizontally arranged, and the first and third pipe segments 703 and 705 are both obliquely arranged. One end of the second pipe segment 704 is connected to a lower end of the first pipe segment 703, and the other end of the second pipe segment 704 is connected to a lower end of the third pipe segment 705.

[0060] The two ends of the second pipe segment 704 are connected to the first gas-liquid separator 5 and the second gas-liquid separator 6, respectively. A connection port between the second pipe segment 704 and the first gas-liquid separator 5 is denoted as e2; and a connection port between the second pipe segment 704 and the second gas-liquid separator 6 is denoted as f2. The first pipe segment 703 extends into the first separation chamber 5011, and the third pipe segment 705 extends into the second separation chamber 6011. An end e1 of the first pipe segment 703 away from the second pipe segment 704 is the first end 701 of the liquid balance pipe 7, and an end f1 of the third pipe segment 705 away from the second pipe segment 704 is the second end 702 of the liquid balance pipe 7. In such a case, the connection port e2 and the end e1 are at different heights, and the connection port f2 and the end f1 are at different heights.

[0061] In some embodiments, a part of the first gas outlet pipe 502 has a third oil return hole 5023 communicated to the first separation chamber 5011, and a part of the second gas outlet pipe 602 has a fourth oil return hole 6023 communicated to the second separation chamber 6011. The third oil return hole 5023 is above the first oil return hole 5022, or the third oil return hole 5023 and the first oil return hole 5022 are at a same height. The fourth oil return hole 6023 is above the second oil return hole 6022, or the fourth oil return hole 6023 and the second oil return hole 6022 are at a same height.

[0062] For example, as shown in FIGS. 1 to 3, when the bottom wall surface of the first separation chamber 5011 and the bottom wall surface of the second separation chamber 6011 are at the same height, a distance between the third oil return hole 5023 (b) and the bottom wall surface of the first separation chamber 5011 is L5, and a distance between the fourth oil return hole 6023 (d) and the bottom wall surface of the second separation chamber 6011 is L6, in which $L5 \geq L2$ and $L6 \geq L4$.

[0063] As a result, when the first compressor 1 fails to return oil in time through the first oil return hole 5022 or when oil cannot return through the first oil return hole 5022 for some reason, the first compressor 1 can achieve oil return through the third oil return hole 5023; and when the second compressor 2 fails to return oil in time through the second oil return hole 6022 or when oil cannot return through the second oil return hole 6022 for some reason, the second compressor 2 can achieve oil return through

the fourth oil return hole 6023. It is possible to further prevent the compressor from being worn out for lack of lubrication due to untimely oil return or inability to return oil, thereby further improving the reliability of the compressor assembly.

[0064] In some embodiments, one end of the liquid balance pipe 7 is between the first oil return hole 5022 and the third oil return hole 5023 in an up-down direction, and the other end of the liquid balance pipe 7 is between the second oil return hole 6022 and the fourth oil return hole 6023 in the up-down direction.

[0065] For example, as shown in FIGS. 1 to 3, when the bottom wall surface of the first separation chamber 5011 and the bottom wall surface of the second separation chamber 6011 are at the same height, $L5 \geq L1 \geq L2$, and $L6 \geq L3 \geq L4$.

[0066] Hence, it is beneficial to further improving the reliability of the compressor assembly.

[0067] In some embodiments, the third oil return hole 5023 and the fourth oil return hole 6023 are at the same height.

[0068] For example, when the bottom wall surface of the first separation chamber 5011 and the bottom wall surface of the second separation chamber 6011 are at the same height, $L5=L6$.

[0069] Hence, it is possible to further relieve or even avoid the problem of the large refrigerant distribution deviation caused by the different capacities of the first compressor 1 and the second compressor 2, which is conducive to further improving the reliability of the compressor assembly.

[0070] In some embodiments, one end of the gas balance pipe 8 is above the third oil return hole 5023 or at the same height as the third oil return hole 5023, while the other end of the gas balance pipe 8 is above the fourth oil return hole 6023 or at the same height as the fourth oil return hole 6023.

[0071] For example, as shown in FIGS. 1 to 3, when the bottom wall surface of the first separation chamber 5011 and the bottom wall surface of the second separation chamber 6011 are at the same height, a distance between one end (g) of the gas balance pipe 8 and the bottom wall surface of the first separation chamber 5011 is L7, in which $L7 \geq L5$, and a distance between the other end (h) of the gas balance pipe 8 and the bottom wall surface of the second separation chamber 6011 is L8, in which $L8 \geq L6$.

[0072] Therefore, the compressor assembly according to embodiments of the present invention can better utilize the gas balance pipe 8 to achieve gas balance in the first separation chamber 5011 and the second separation chamber 6011 and utilize the liquid balance pipe 7 to achieve liquid balance in the first separation chamber 5011 and the second separation chamber 6011, which will be conducive to further improving the reliability of the compressor assembly.

[0073] In some embodiments, the third oil return hole 5023 is between one end of the gas balance pipe 8 and

one end of the liquid balance pipe 7 in the up-down direction, while the fourth oil return hole 6023 is between the other end of the gas balance pipe 8 and the other end of the liquid balance pipe 7 in the up-down direction.

[0074] For example, when the bottom wall surface of the first separation chamber 5011 and the bottom wall surface of the second separation chamber 6011 are at the same height, $L7 > L5 > L1$ and $L8 > L6 > L3$.

[0075] Thus, the reliability of the compressor assembly can be further enhanced.

[0076] In some embodiments, the bottom wall surface of the first separation chamber 5011 and the bottom wall surface of the second separation chamber 6011 are at the same height. One end of the liquid balance pipe 7 is at the same height as the other end of the liquid balance pipe 7, that is, the liquid balance pipe 7 is arranged horizontally. One end of the gas balance pipe 8 is at the same height as the other end of the gas balance pipe 8, that is, the gas balance pipe 8 is arranged horizontally.

[0077] Therefore, when the compressor assembly is mounted, it is only necessary to position the bottom wall surface of the first separation chamber 5011 and the bottom wall surface of the second separation chamber 6011 at the same installation height, which facilitates the installation of the compressor assembly.

[0078] In some embodiments, a part of the first gas outlet pipe 502 and a part of the second gas outlet pipe 602 each comprise a U-shaped portion.

[0079] The U-shaped portion comprises a first segment, a second segment and an intermediate segment. The first segment and the second segment both extend in the up-down direction. One end of the intermediate segment is connected to a lower end of the first segment, and the other end of the intermediate segment is connected to a lower end of the second segment.

[0080] The first oil return hole 5022 is in the intermediate segment of the first gas outlet pipe 502; the third oil return hole 5023 is in the first segment of the first gas outlet pipe 502; the second oil return hole 6022 is in the intermediate segment of the second gas outlet pipe 602; and the fourth oil return hole 6023 is in the first segment of the second gas outlet pipe 602.

[0081] In the present invention, the first segment of the U-shaped portion of the first gas outlet pipe 502 may be located between the intermediate segment of the U-shaped portion of the first gas outlet pipe 502 and the first gas separator outlet 5021, and the second segment of the U-shaped portion of the first gas outlet pipe 502 is opposite to the first segment of the U-shaped portion of the first gas outlet pipe 502, and vice versa. Similarly, the first segment of the U-shaped portion of the second gas outlet pipe 602 may be located between the intermediate segment of the U-shaped portion of the second gas outlet pipe 602 and the first gas separator outlet 6021, and the second segment of the U-shaped portion of the second gas outlet pipe 602 is opposite to the first segment of the U-shaped portion of the second gas outlet pipe 602, and vice versa.

[0082] For ease of description, the following situation will serve as an example. The first segment of the U-shaped portion of the first gas outlet pipe 502 is between the intermediate segment of the U-shaped portion of the first gas outlet pipe and the first gas separator outlet 5021, and the second segment of the U-shaped portion of the first gas outlet pipe 502 is opposite to the first segment of the U-shaped portion of the first gas outlet pipe 502. The first segment of the U-shaped portion of the second gas outlet pipe 602 is between the intermediate segment of the U-shaped portion of the second gas outlet pipe and the second gas separator outlet 6021, and the second segment of the U-shaped portion of the second gas outlet pipe 602 is opposite to the first segment of the U-shaped portion of the second gas outlet pipe 602.

[0083] In some embodiments, the third oil return hole 5023 is on the first segment of the first gas outlet pipe 502, and the fourth oil return hole 6023 is on the first segment of the second gas outlet pipe 602, as shown in FIG. 4.

[0084] In some embodiments, the third oil return hole 5023 is on the second segment of the first gas outlet pipe 502, and the fourth oil return hole 6023 is on the second segment of the second gas outlet pipe 602, as shown in FIG. 2.

[0085] In some embodiments, the third oil return hole 5023 is on the first segment of the first gas outlet pipe 502, and the fourth oil return hole 6023 is on the second segment of the second gas outlet pipe 602, as shown in FIG. 5;

[0086] In some embodiments, the third oil return hole 5023 is on the second segment of the first gas outlet pipe 502, and the fourth oil return hole 6023 is on the first segment of the second gas outlet pipe 602, as shown in FIG. 6.

[0087] An air conditioner outdoor unit 100 according to embodiments of the present invention will be described below with reference to the accompanying drawings.

[0088] As shown in FIGS. 1 to 3, the air conditioner outdoor unit 100 according to embodiments of the present invention comprises a four-way valve 9, an outdoor heat exchanger 10, and a compressor assembly.

[0089] The four-way valve 9 comprises a first interface 901, a second interface 902, a third interface 903, and a fourth interface 904. A first port 1001 of the outdoor heat exchanger 10 is connected to the first interface 901.

[0090] The compressor assembly is the compressor assembly described in any of the above embodiments. The first oil separator 3 has a first oil separator outlet 303, and the second oil separator 4 has a second oil separator outlet 403. The first oil separator outlet 303 and the second oil separator outlet 403 are each connected to the second interface 902. The first gas separator inlet 5031 and the second gas separator inlet 6031 are each connected to the fourth interface 904.

[0091] Therefore, the air conditioner outdoor unit 100 according to embodiments of the present invention has advantages such as high operational reliability.

[0092] In some embodiments of the present invention, the air conditioner outdoor unit 100 comprises a seventh pipe 17, an eighth pipe 18, a ninth pipe 19, a tenth pipe 20, and an eleventh pipe 21. The first gas inlet pipe 503 and the second gas inlet pipe 603 are each connected to the fourth interface 904 through the seventh pipe 17. One end of the eighth pipe 18 is connected to the first oil separator outlet 303; one end of the ninth pipe 19 is connected to the second oil separator outlet 403; and the other end of the eighth pipe 18 and the other end of the ninth pipe 19 are each connected to the second interface 902 through the tenth pipe 20. The first port 1001 of the outdoor heat exchanger 10 is connected to the first port 901 through the eleventh pipe 21.

[0093] An air conditioning system according to embodiments of the present invention will be described below with reference to the accompanying drawings.

[0094] The air conditioning system according to embodiments of the present invention comprises an air conditioner outdoor unit and an air conditioner indoor unit. The air conditioner outdoor unit is the air conditioner outdoor unit 100 described in any of the above embodiments. The air conditioner indoor unit comprises an indoor heat exchanger. A second port 1002 of the outdoor heat exchanger 10 is connected to a first port of the indoor heat exchanger, and a second port of the indoor heat exchanger is connected to the third interface 903.

[0095] Therefore, the air conditioning system according to embodiments of the present invention has advantages such as high operational reliability.

[0096] In some embodiments of the present invention, the air conditioning system comprises a twelfth pipe 22 and a thirteenth pipe 23. The second port 1002 of the outdoor heat exchanger 10 is connected to the first port of the indoor heat exchanger through the twelfth pipe 22, and the second port of the indoor heat exchanger is connected to the third interface 903 through the thirteenth pipe 23.

[0097] In the description of the present invention, it is to be understood that terms such as "central," "longitudinal," "transverse," "length," "width," "thickness," "upper," "lower," "front," "rear," "left," "right," "vertical," "horizontal," "top," "bottom," "inner," "outer," "clockwise," "counterclockwise," "axial," "radial" and "circumferential" should be construed to refer to the orientation as then described or as shown in the drawings under discussion. These relative terms are for convenience and simplicity of description and do not indicate or imply that the devices or elements referred to have a particular orientation and be constructed or operated in a particular orientation. Thus, these terms shall not be construed as limitation on the present invention.

[0098] In addition, terms such as "first" and "second" are used herein for purposes of description and are not intended to indicate or imply relative importance or significance or to imply the number of indicated technical features. Thus, the feature defined with "first" and "second" may comprise one or more of this feature. In the

description of the present invention, the term "a plurality of" means at least two, such as two or three, unless specified otherwise.

[0099] In the present invention, unless specified or limited otherwise, the terms "mounted," "connected," "coupled," "fixed" and the like are used broadly, and may be, for example, fixed connections, detachable connections, or integral connections; may also be mechanical or electrical connections; may also be direct connections or indirect connections via intervening structures; may also be inner connection or interaction of two elements, which can be understood by those skilled in the art according to specific situations.

[0100] In the present invention, unless specified or limited otherwise, a structure in which a first feature is "on" or "below" a second feature may comprise an embodiment in which the first feature is in direct contact with the second feature, and may also comprise an embodiment in which the first feature and the second feature are not in direct contact with each other, but are contacted via an additional feature formed therebetween. Further, a first feature "on," "above," or "on top of" a second feature may comprise an embodiment in which the first feature is right or obliquely "on," "above," or "on top of" the second feature, or just means that the first feature is at a height higher than that of the second feature; while a first feature "below," "under," or "on bottom of" a second feature may comprise an embodiment in which the first feature is right or obliquely "below," "under," or "on bottom of" the second feature, or just means that the first feature is at a height lower than that of the second feature.

[0101] Reference throughout this specification to "an embodiment," "some embodiments," "an example," "a specific example," or "some examples," means that a particular feature, structure, material, or characteristic described connected to the embodiment or example is comprised in at least one embodiment or example of the present invention. Thus, the above terms throughout this specification are not necessarily referring to the same embodiment or example of the present invention. Further, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples. Moreover, those skilled in the art can integrate and combine the different embodiments or examples and the features of the different embodiments or examples described in this specification without contradicting each other.

[0102] Although embodiments of the present invention have been shown and described, it can be appreciated by those skilled in the art that the above embodiments are merely exemplary and are not intended to limit the present invention, and various changes, modifications, alternatives and variations may be made to the embodiments within the scope of the present invention.

Claims**1.** A compressor assembly, comprising:

a first compressor comprising a first exhaust port and a first gas return port;
 a second compressor comprising a second exhaust port and a second gas return port;
 a first oil separator comprising a first oil outlet and a first oil separator inlet, the first oil separator inlet being communicated to the first exhaust port;
 a second oil separator comprising a second oil outlet and a second oil separator inlet, the second oil separator inlet being communicated to the second exhaust port;
 a first gas-liquid separator comprising a first separation chamber, a first gas separator inlet, a first oil return hole and a first gas separator outlet, wherein the first gas separator inlet, the first oil return hole and the first gas separator outlet are communicated to the first separation chamber, and wherein the first oil outlet is communicated to the first gas separator inlet, and the first gas separator outlet and the first oil return hole are each communicated to the first gas return port;
 a second gas-liquid separator comprising a second separation chamber, a second gas separator inlet, a second oil return hole and a second gas separator outlet, wherein the second gas separator inlet, the second oil return hole and the second gas separator outlet are communicated to the second separation chamber, and wherein the second oil outlet is communicated to the second gas separator inlet, and the second gas separator outlet and the second oil return hole are each communicated to the second gas return port; and
 a liquid balance pipe and a gas balance pipe located above the liquid balance pipe, wherein an end of the liquid balance pipe and an end of the gas balance pipe are both communicated to the first separation chamber, while an other end of the liquid balance pipe and an other end of the gas balance pipe are both communicated to the second separation chamber.

2. The compressor assembly according to claim 1, wherein:

the first gas-liquid separator comprises:

a first cylinder, the first separation chamber being defined in the first cylinder; and
 a first gas outlet pipe, a portion of the first gas outlet pipe extending into the first separation chamber, the first oil return hole be-

ing in the portion of the first gas outlet pipe, and the first gas separator outlet being in another portion of the first gas outlet pipe,

the second gas-liquid separator comprises:

a second cylinder, the second separation chamber being defined in the second cylinder; and
 a second gas outlet pipe, a portion of the second gas outlet pipe extending into the second separation chamber, the second oil return hole being in the portion of the second gas outlet pipe, and the second gas separator outlet being in another portion of the second gas outlet pipe.

wherein the end of the liquid balance pipe is above the first oil return hole or at a same height as the first oil return hole; and the other end of the liquid balance pipe is above the second oil return hole or at a same height as the second oil return hole.

3. The compressor assembly according to claim 2, wherein the portion of the first gas outlet pipe comprises a third oil return hole communicated to the first separation chamber, and the portion of the second gas outlet pipe comprises a fourth oil return hole communicated to the second separation chamber, wherein the third oil return hole is above the first oil return hole or at the same height as the first oil return hole; and the fourth oil return hole is above the second oil return hole or at the same height as the second oil return hole.

4. The compressor assembly according to claim 3, wherein the end of the liquid balance pipe is between the first oil return hole and the third oil return hole in an up-down direction, and the other end of the liquid balance pipe is between the second oil return hole and the fourth oil return hole in the up-down direction.

5. The compressor assembly according to claim 3 or 4, wherein the end of the gas balance pipe is above the third oil return hole or at a same height as the third oil return hole, and the other end of the gas balance pipe is above the fourth oil return hole or at a same height as the fourth oil return hole.

6. The compressor assembly according to any one of claims 3 to 5, wherein the third oil return hole is between the end of the gas balance pipe and the end of the liquid balance pipe in the up-down direction; and the fourth oil return hole is between the other end of the gas balance pipe and the other end of the liquid balance pipe in the up-down direction.

7. The compressor assembly according to any one of claims 1 to 6, wherein the first oil return hole and the second oil return hole are at a same height; and/or a bottom wall surface of the first separation chamber and a bottom wall surface of the second separation chamber are at a same height, the end of the liquid balance pipe and the other end of the liquid balance pipe are at a same height, and the end of the gas balance pipe and the other end of the gas balance pipe are at a same height. 5
8. The compressor assembly according to any one of claims 3 to 7, wherein the third oil return hole and the fourth oil return hole are at a same height. 10
9. The compressor assembly according to any one of claims 3 to 7, wherein the portion of the first gas outlet pipe and the portion of the second gas outlet pipe each comprise a U-shaped portion, wherein the U-shaped portion comprises: 15
- a first segment and a second segment, the first segment and the second segment extending in the up-down direction; and
- an intermediate segment, comprising an end connected to a lower end of the first segment, and an other end connected to a lower end of the second segment, 20
- wherein the first oil return hole is in the intermediate segment of the first gas outlet pipe; the third oil return hole is in the first segment of the first gas outlet pipe; the second oil return hole is in the intermediate segment of the second gas outlet pipe; and the fourth oil return hole is in the first segment of the second gas outlet pipe. 25
10. The compressor assembly according to claim 9, wherein the first segment of the U-shaped portion of the first gas outlet pipe is between the intermediate segment of the U-shaped portion of the first gas outlet pipe and the first gas separator outlet; and 30
- the first segment of the U-shaped portion of the second gas outlet pipe is between the intermediate segment of the U-shaped portion of the second gas outlet pipe and the second gas separator outlet. 35
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11. An air conditioner outdoor unit, comprising:

a four-way valve, comprising a first interface, a second interface, a third interface, and a fourth interface; 50

an outdoor heat exchanger, a first port of the outdoor heat exchanger being connected to the first interface; and

a compressor assembly according to any one of claims 1 to 10, 55

wherein a first oil separator comprises a first oil separator outlet, and a second oil separator

comprises a second oil separator outlet; the first oil separator outlet and the second oil separator outlet are each connected to the second interface; and a first gas separator inlet and a second gas separator inlet are each connected to the fourth interface.

12. An air conditioning system, comprising:

an air conditioner outdoor unit according to claim 11; and

an air conditioner indoor unit comprising an indoor heat exchanger, wherein a second port of an outdoor heat exchanger is connected to a first port of the indoor heat exchanger, and a second port of the indoor heat exchanger is connected to a third interface.

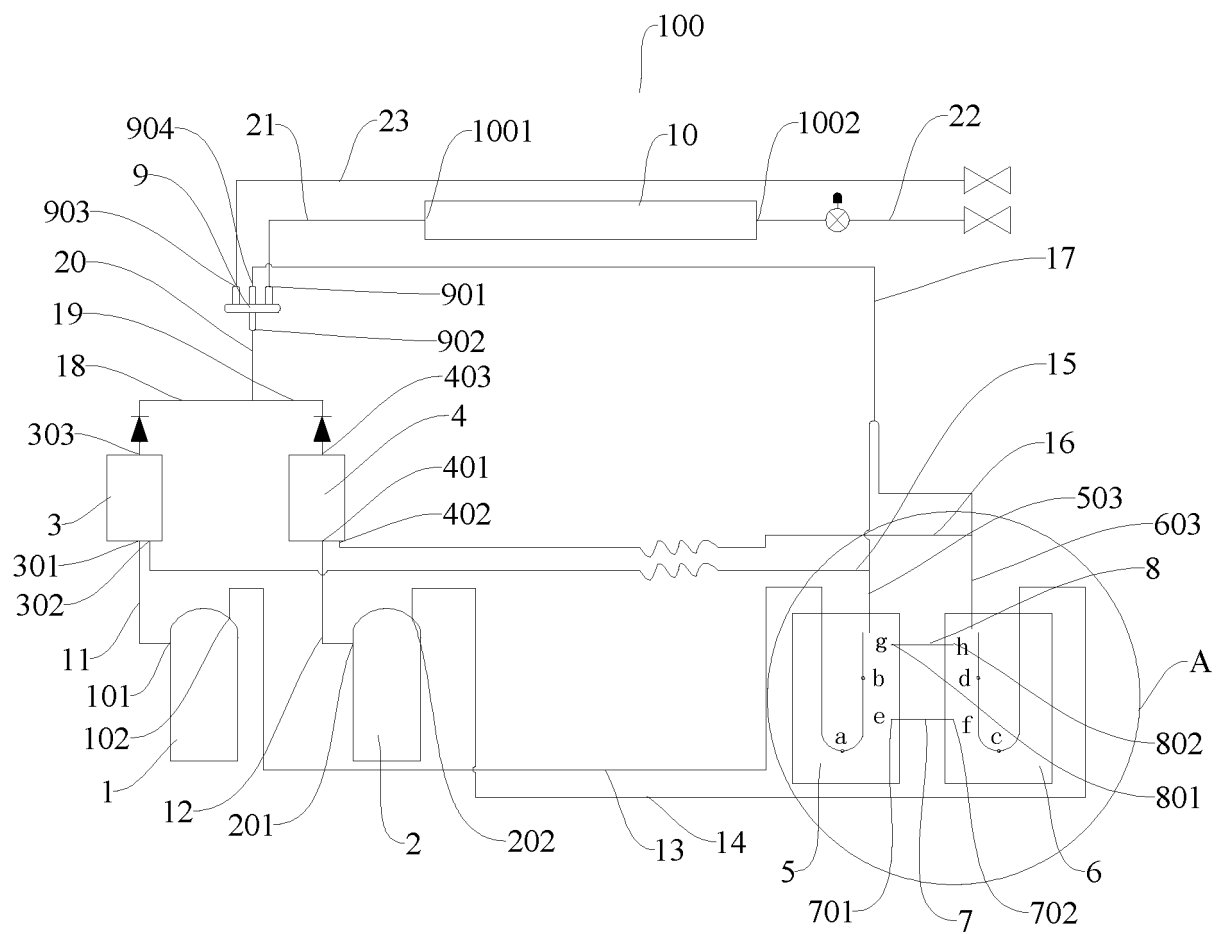


FIG. 1

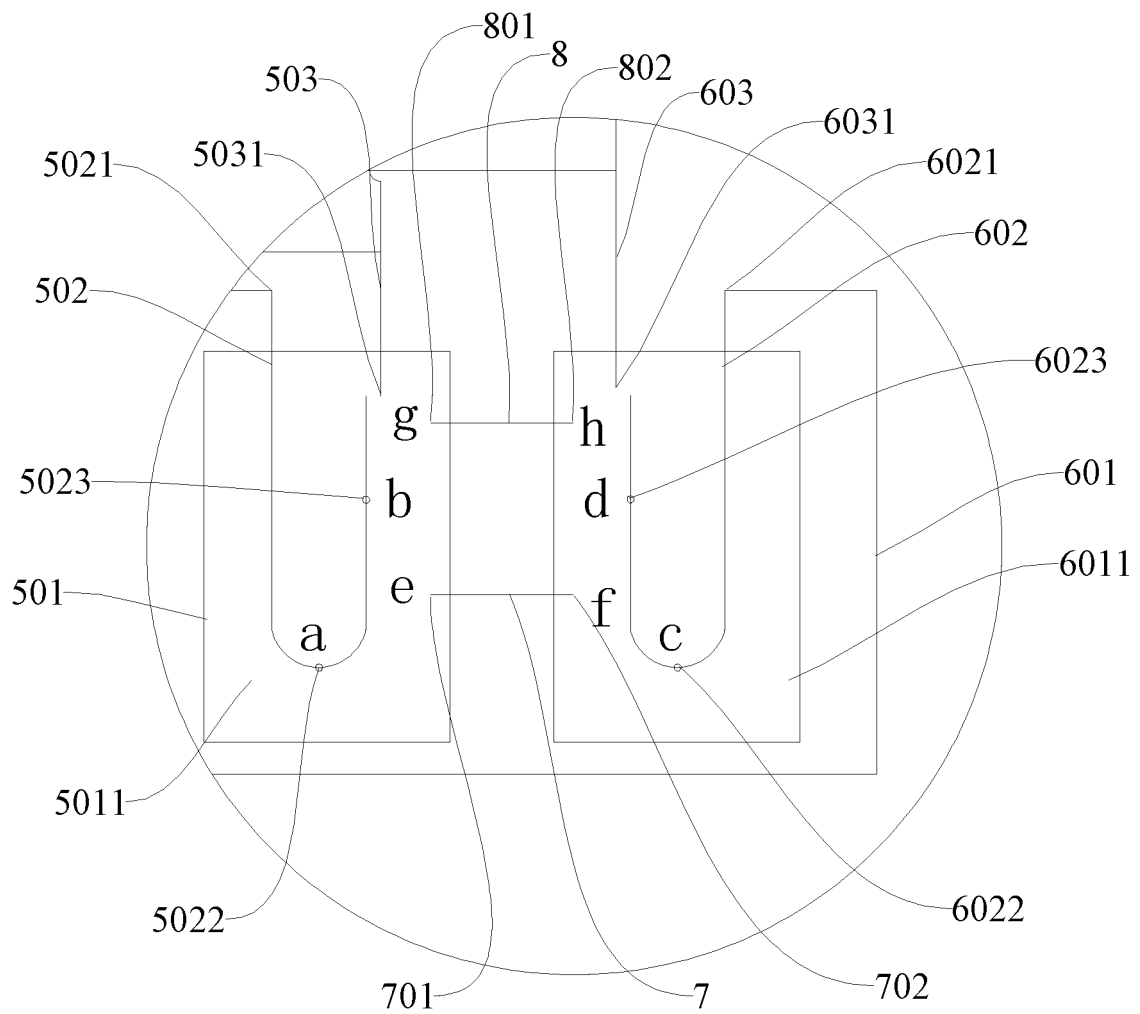


FIG. 2

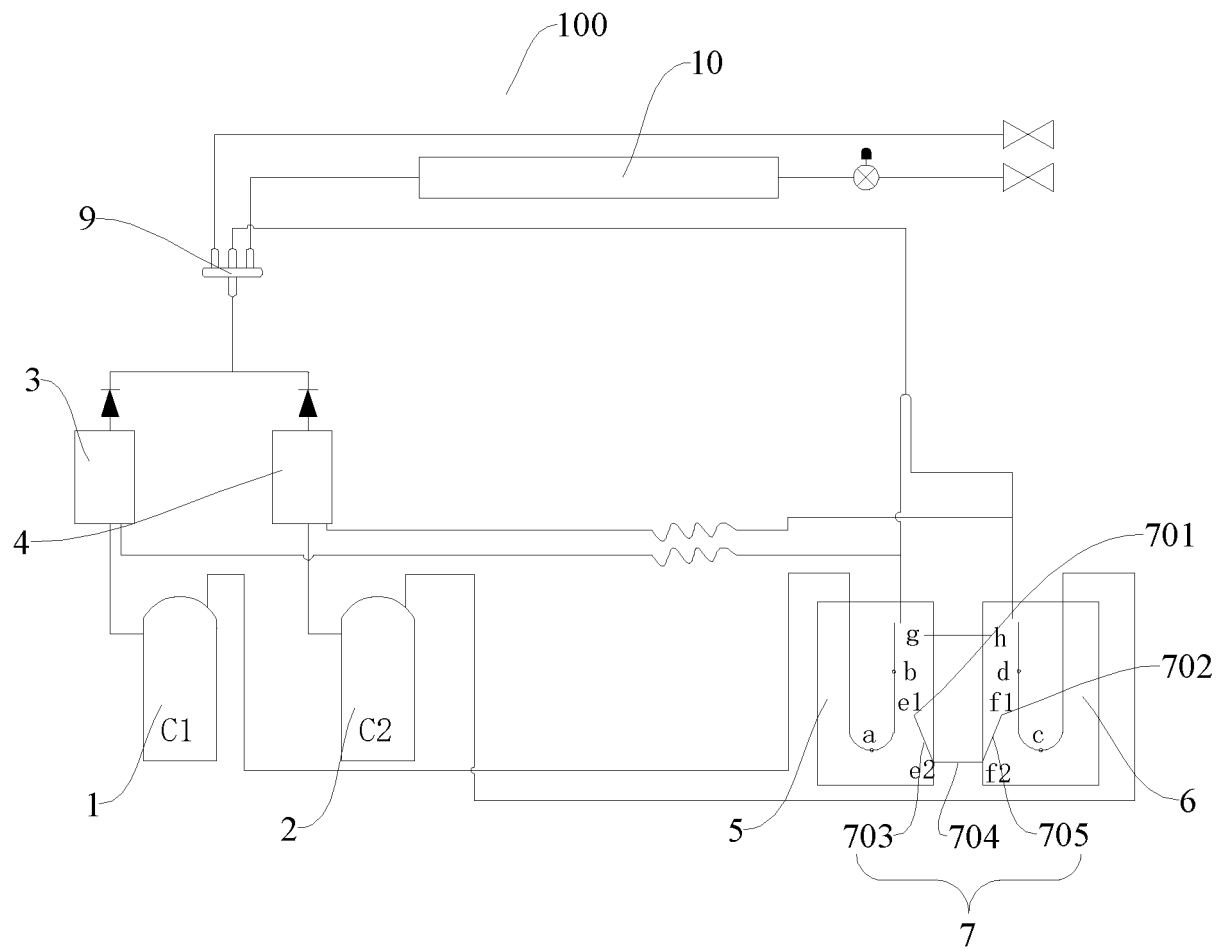


FIG. 3

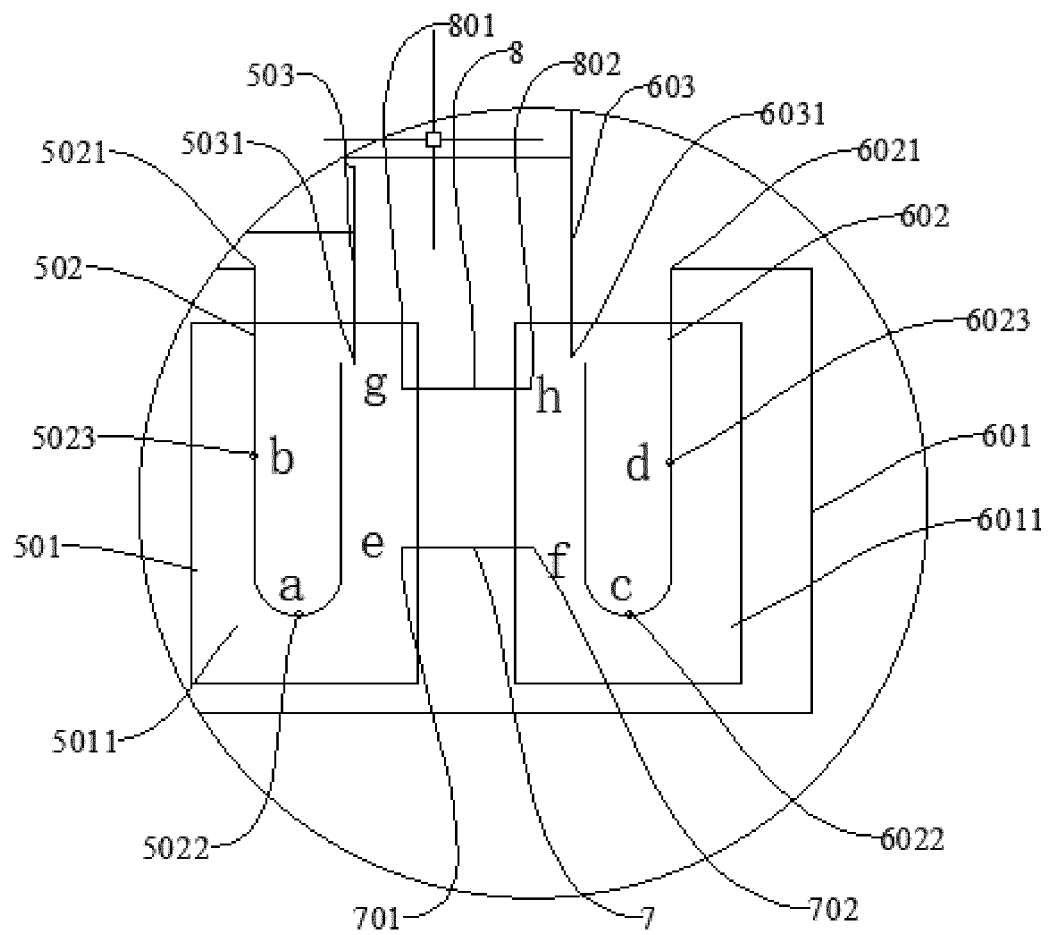


FIG. 4

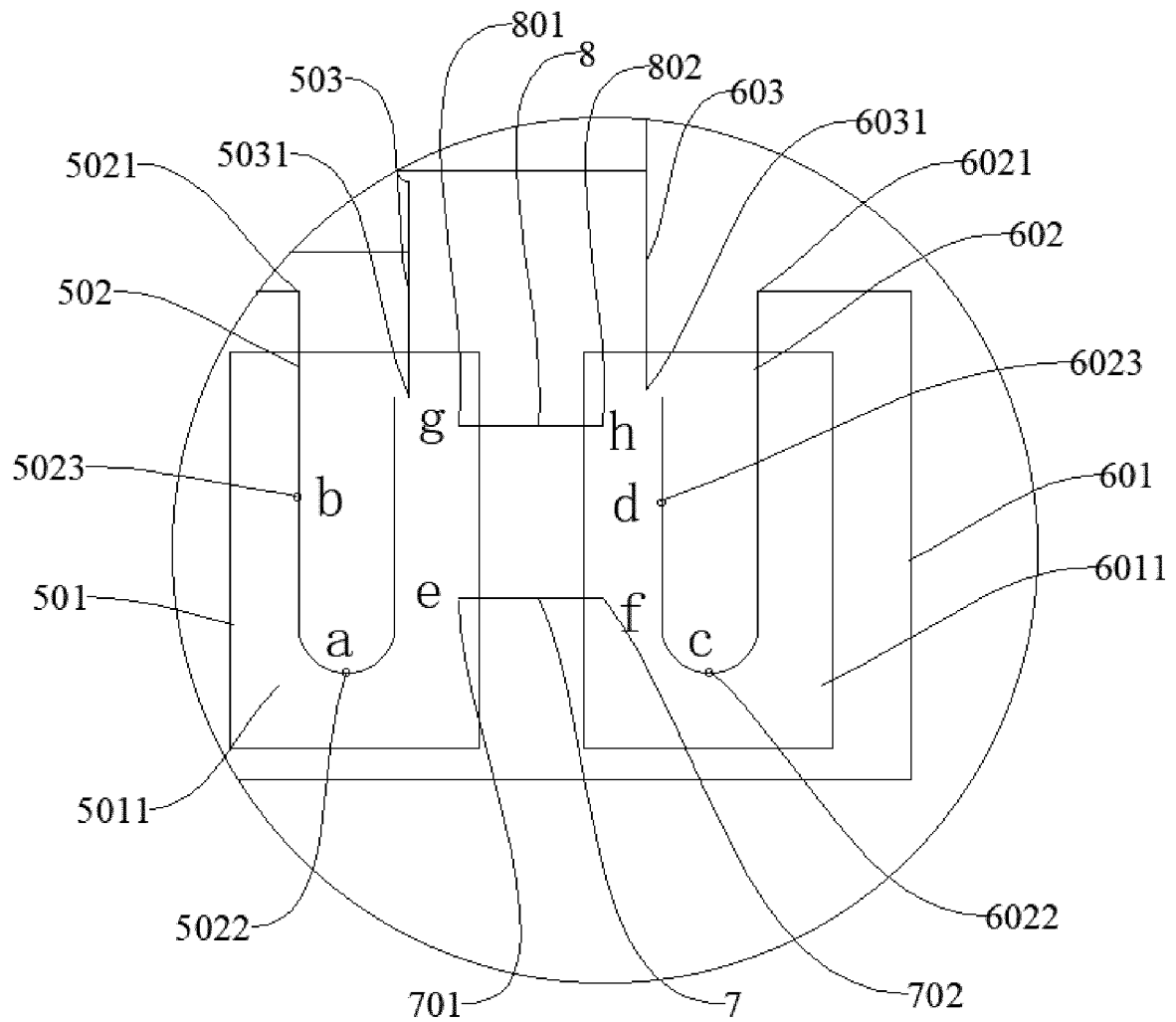


FIG. 5

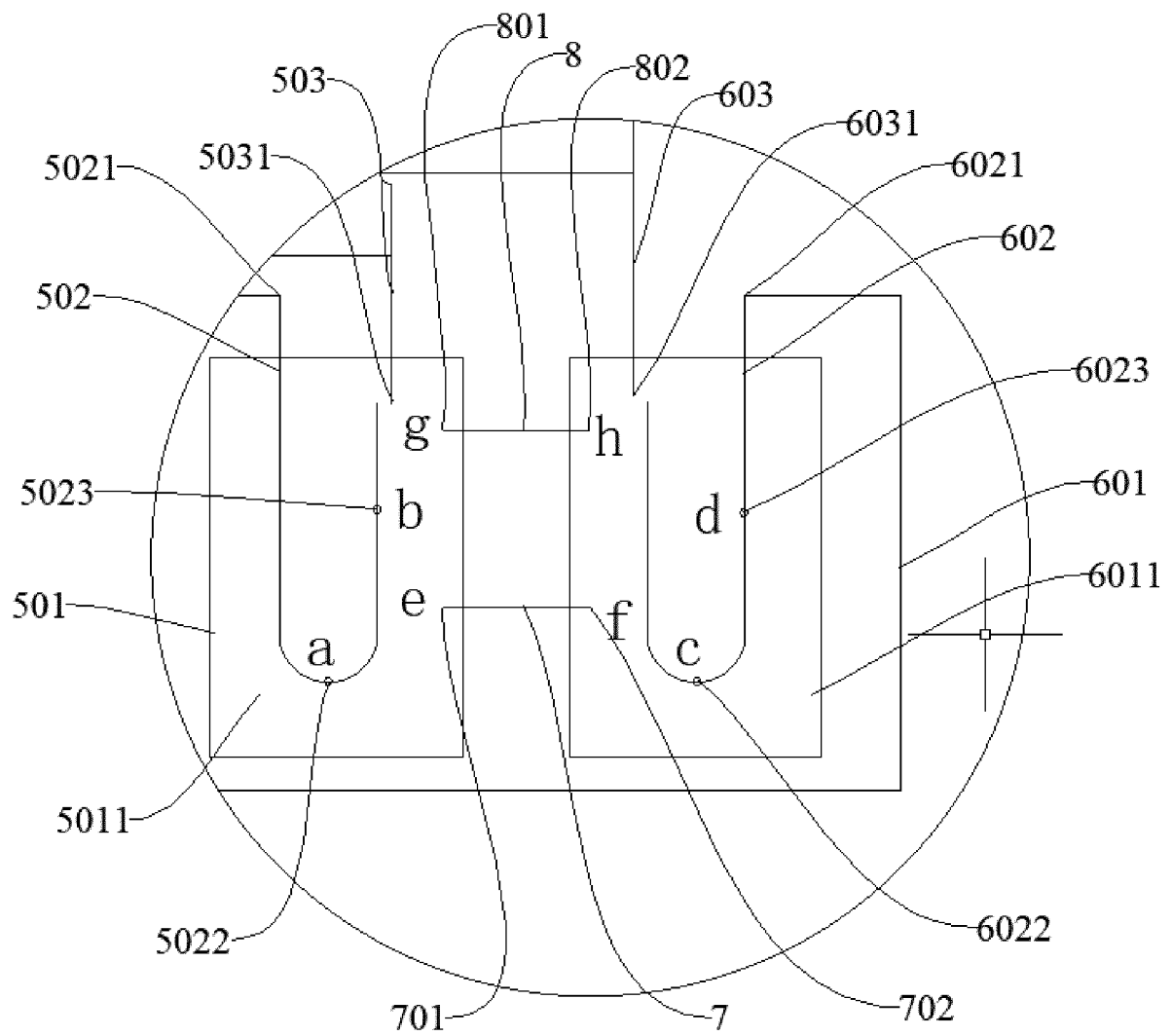


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/117115

A. CLASSIFICATION OF SUBJECT MATTER

F25B 31/00(2006.01)i; F25B 43/02(2006.01)i; F25B 13/00(2006.01)i; F24F 1/0003(2019.01)i; F24F 1/06(2011.01)i; F24F 1/10(2011.01)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)

F25B; F24F

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNTXT, CNKI, ENTXT, ENTXTC, WPABS, DWPI: 压缩机, 油分离器, 气液分离器, 平衡管, 均油管, 回油孔, compressor, oil Separator, vapor liquid separator, balancing pipe, equating pipe, oil return

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

11 November 2022

Date of mailing of the international search report

01 December 2022

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT

International application No.
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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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International application No.

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