



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
27.08.2014 Bulletin 2014/35

(51) Int Cl.:
F25B 41/04 (2006.01) **F25B 13/00** (2006.01)
F25B 45/00 (2006.01) **F25B 43/02** (2006.01)

(21) Application number: **14154768.7**

(22) Date of filing: **12.02.2014**

(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

(71) Applicant: **Fujitsu General Limited**
Kawasaki-shi
Kanagawa 213-8502 (JP)

(72) Inventor: **Hayashi, Kuniko**
Kanagawa, 213-8502 (JP)

(30) Priority: **22.02.2013 JP 2013032900**

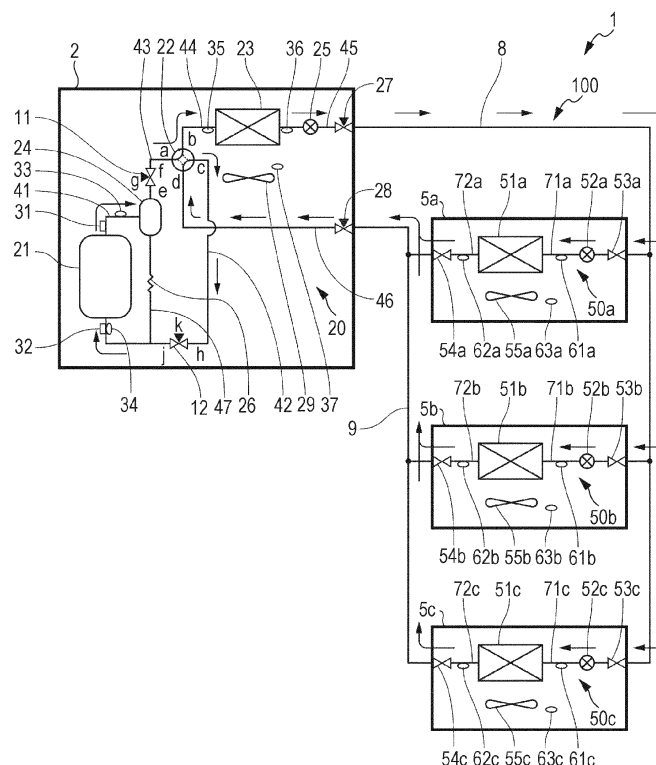
(74) Representative: **Isarpatent**
Patent- und Rechtsanwälte
Friedrichstrasse 31
80801 München (DE)

(54) **Air conditioner outdoor unit and air conditioner**

(57) An air conditioner outdoor unit includes: a compressor; a heat source-side heat exchanger connected to the compressor; an oil separator disposed between a refrigerant discharge opening of the compressor and the heat source-side heat exchanger configured to separate

a refrigerant oil from a refrigerant discharged from the compressor; and a first three-way valve fitted to a refrigerant pipe between the oil separator and the heat source-side heat exchange.

FIG. 1



Description

BACKGROUND

1. Technical Field

[0001] The present disclosure relates to an air conditioner having an outdoor unit and an indoor unit, which are connected to each other through a plurality of refrigerant pipes.

2. Related Art

[0002] Conventionally, there is known an air conditioner having an outdoor unit and an indoor unit connected in parallel through a plurality of refrigerant pipes. In this air conditioner, a refrigerant circuit includes devices that are connected to refrigerant pipes by welding, and the refrigerant pipes themselves are also connected together by welding, and the refrigerant pipes are also connected to each other by welding. The refrigerant circuit is filled with a refrigerant.

[0003] The refrigerant circuit is connected to a compressor. The compressor compresses a low-pressure refrigerant suctioned in through a refrigerant suction opening into a high-pressure refrigerant, and discharges the high-pressure refrigerant through a refrigerant discharge opening. In case of failure, the compressor is detached from the refrigerant circuit for replacement. When the compressor is detached from the refrigerant circuit, the refrigerant filled in the refrigerant circuit should be prevented from escaping into the atmosphere. Thus, there is a need of recovering the refrigerant from the refrigerant circuit before the compressor is detached. However, recovering the refrigerant from the refrigerant circuit is a time consuming process. Particularly, for example, a multi-type air conditioner (an air conditioner having a plurality of outdoor units and indoor units) installed in a building or housing complex has long refrigerant pipes and a large amount of refrigerant sealed in the refrigerant circuit. Thus, recovering the refrigerant from the refrigerant circuit is a time consuming process, resulting in poor maintainability of the air conditioner.

[0004] JP-A-7-332784 (Patent Document 1) proposes an air conditioner in which open/close valves are fitted to a discharge pipe (a refrigerant pipe connected to a refrigerant discharge opening) of a compressor and to an intake pipe (a refrigerant pipe connected to a refrigerant intake opening) of the compressor. The compressor of the air conditioner is detached from the refrigerant circuit after the open/close valves are closed. Thus, there is no need to recover the refrigerant from the refrigerant circuit. The air conditioner can be therefore maintained in a short time.

SUMMARY

[0005] An air conditioner outdoor unit includes: a com-

pressor; a heat source-side heat exchanger connected to the compressor; an oil separator disposed between a refrigerant discharge opening of the compressor and the heat source-side heat exchanger configured to separate a refrigerant oil from a refrigerant discharged from the compressor; and a first three-way valve fitted to a refrigerant pipe between the oil separator and the heat source-side heat exchanger.

10 BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

FIG. 1 is a diagram illustrating a refrigerant circuit of an air conditioner according to an embodiment of the present disclosure;

FIG. 2 is a diagram illustrating a refrigerant circuit of an outdoor unit of the air conditioner illustrated in FIG. 1, illustrating the detaching or attaching of the compressor; and

FIG. 3 is a diagram illustrating the refrigerant circuit of the outdoor unit of the air conditioner illustrated in FIG. 1 in a case where a first three-way valve fails.

25 DESCRIPTION OF EMBODIMENTS

[0007] In the following detailed description, for purpose of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

[0008] The air conditioner described in Patent Document 1 includes an open/close valve fitted to the discharge pipe. This air conditioner is more likely to cause the following disadvantages than other air conditioners where the open/close valve is not fitted to the discharge pipe. Namely, when the driving of the compressor causes vibration in the discharge pipe, a large force may be applied to the discharge pipe and to a connection part between the discharge pipe and other devices (such as the compressor or an oil separator) due to the weight of the open/close valve. As a result, the discharge pipe and the connection part of the discharge pipe could be damaged. Generally, the discharge pipe of the compressor has a smaller pipe diameter than the intake pipe. Thus, the discharge pipe has a lower strength than the intake pipe. The open/close valves fitted to both the discharge pipe and the intake pipe increases the likelihood of damage to the discharge pipe due to vibrations is increased.

[0009] When the compressor is re-connected to the refrigerant circuit, the necessity may arise to vacuum the refrigerant circuit and perform refrigerant charging. In this case, for example, the amount of the refrigerant corresponds to the amount of refrigerant decreased by escaping into the air when the compressor is detached from or

attached to the refrigerant circuit. Here, the term "refrigerant charging" used herein refers to injecting refrigerant into the refrigerant circuit. The air conditioner according to Patent Document 1 is additionally provided with a service valve, a branch pipe, and the like for vacuuming and refrigerant charging. However, such additional components may lead to increased costs and poor maintainability.

[0010] An object of the present disclosure is to provide an air conditioner with high compressor maintenance workability.

[0011] An air outdoor unit according to an embodiment of the present disclosure (the present outdoor unit) includes: a compressor; a heat source-side heat exchanger connected to the compressor; an oil separator disposed between a refrigerant discharge opening of the compressor and the heat source-side heat exchanger configured to separate a refrigerant oil from a refrigerant discharged from the compressor; and a first three-way valve fitted to a refrigerant pipe between the oil separator and the heat source-side heat exchanger.

[0012] The present outdoor unit may further include a flow path switching unit for switching the direction of flow of refrigerant in the heat source-side heat exchanger. The flow path switching unit may be disposed between the heat source-side heat exchanger and the oil separator, and the first three-way valve is disposed on a refrigerant pipe between the flow path switching unit and the oil separator.

[0013] In this case, the present outdoor unit may further include: an oil return pipe with one end connected to the oil separator and the other end connected to a refrigerant pipe connected to a refrigerant intake opening of the compressor; and a second three-way valve disposed between a connection part of the refrigerant pipe and the oil return pipe, and the flow path switching unit.

[0014] Moreover, the first three-way valve may include a first port connected to the oil separator, a second port connected to the flow path switching unit, and a third port which is a service port. In addition, the second three-way valve may include a first port connected to the flow path switching unit, a second port connected to the refrigerant intake opening of the compressor, and a third port which is a service port.

[0015] In addition, an air conditioner according to an embodiment of the present disclosure includes the present outdoor unit, and an indoor unit connected to the outdoor unit.

[0016] In the present outdoor unit, the first three-way valve is disposed on a refrigerant pipe between the flow path switching unit and the oil separator. Thus, the force applied to the discharge pipe and to the connection part between the discharge pipe and the other devices is suppressed even when the discharge pipe is vibrated by the vibration of the compressor. As a result, damage to the discharge pipe and the connection part between the discharge pipe and the other devices is suppressed. Further, when re-attaching the detached compressor onto

the refrigerant circuit, vacuuming can be performed through the vacant ports (the ports to which no refrigerant pipe is connected) of the first three-way valve and the second three-way valve. As a result, the cost increase due to separately fitting a service valve and a branch pipe can be suppressed, and high maintainability can be obtained.

[0017] In the following, an embodiment of the present disclosure will be described in detail with reference to the drawings. In an air conditioner according to the present embodiment, three indoor units are parallelly connected to one outdoor unit. The air conditioner can simultaneously perform cooling operation or heating operation in all of the indoor units. It should be noted that the present disclosure is not limited to the following embodiment, and various modifications can be made without departing from the gist of the disclosure.

[0018] As illustrated in FIG. 1, an air conditioner 1 according to the present embodiment includes one outdoor unit 2 installed outside a building or the like, and three indoor units 5a to 5c. The indoor units 5a to 5c are connected to the outdoor unit 2 in parallel through a liquid pipe (refrigerant pipe) 8 and a gas pipe (refrigerant pipe) 9. Specifically, one end of the liquid pipe 8 is connected to an operating valve 27 of the outdoor unit 2. The other end of the liquid pipe 8 is branched and respectively connected to closing valves 53a to 53c of the indoor units 5a to 5c. One end of the gas pipe 9 is connected to an operating valve 28 of the outdoor unit 2. The other end of the gas pipe 9 is branched and connected to closing valves 54a to 54c of the indoor units 5a to 5c, respectively. Thus, a refrigerant circuit 100 of the air conditioner 1 is formed.

[0019] The outdoor unit 2 will be described. The outdoor unit 2 includes a compressor 21, a four-way valve (flow path switching unit) 22, an outdoor heat exchanger (heat source-side heat exchanger) 23, an oil separator 24, an outdoor expansion valve 25, the operating valve 27 to which one end of the liquid pipe 8 is connected, the operating valve 28 to which one end of the gas pipe 9 is connected, a first three-way valve 11, a second three-way valve 12, and an outdoor fan 29. The above members except for the outdoor fan 29 are mutually connected through refrigerant pipes described below. Thus, an outdoor unit refrigerant circuit 20 as part of the refrigerant circuit 100 is formed.

[0020] The compressor 21 is driven by a motor (not shown) whose rotational speed is control by an inverter. Namely, the compressor 21 is a capacity-variable compressor capable of varying operation capacity. A refrigerant discharge side of the compressor 21 is connected to a refrigerant inflow side of the oil separator 24 through a discharge pipe 41. A refrigerant intake side of the compressor 21 is connected to the four-way valve 22 (described later) through an intake pipe 42.

[0021] The four-way valve 22 is a valve for switching the direction of flow of refrigerant, and includes four ports a, b, c, and d. The port a is connected to a refrigerant

outflow side of the oil separator 24 through an outflow pipe 43. The port b is connected to one refrigerant entry/exit opening of the outdoor heat exchanger 23 through a refrigerant pipe 44. The port c is connected to the refrigerant intake side of the compressor 21 through the intake pipe 42. The port d is connected to the operating valve 28 through an outdoor unit gas pipe 46. Thus, the four-way valve 22 is configured to switch the refrigerant flow path between the outdoor heat exchanger 23, the oil separator 24, the compressor 21, and the operating valve 28.

[0022] The four-way valve 22 switches the direction of refrigerant of the outdoor heat exchanger 23. As illustrated in FIG. 1, when the ports a and b of the four-way valve 22 make communication with each other, the refrigerant flows from the refrigerant temperature sensor 35 to the refrigerant temperature sensor 36 through the heat source-side heat exchanger 23 (during cooling operation). On the other hand, the ports b and c of the four-way valve 22 make communication with each other, the refrigerant flows from the refrigerant temperature sensor 36 to the refrigerant temperature sensor 35 through the heat source-side heat exchanger 23 (during heating operation). Thus, the four-way valve 22 serves as a flow path switching unit for switching the direction of flow of the refrigerator in the heat source-side heat exchanger.

[0023] The outdoor heat exchanger 23 carries out heat exchange between the refrigerant and outer air taken into the outdoor unit 2 by the outdoor fan 29 (as will be described below). The one refrigerant entry/exit opening of the outdoor heat exchanger 23 is connected to the port b of the four-way valve 22, as described above. The other refrigerant entry/exit opening of the outdoor heat exchanger 23 is connected to the operating valve 27 through an outdoor unit liquid pipe 45.

[0024] The outdoor expansion valve 25 is an electronic expansion valve fitted to the outdoor unit liquid pipe 45. By adjusting the opening degree of the outdoor expansion valve 25, the amount of refrigerant that flows into the outdoor heat exchanger 23, or the amount of refrigerant that flows out of the outdoor heat exchanger 23 can be adjusted.

[0025] The oil separator 24 is fixed on a casing of the outdoor unit 2 by metal fittings and the like (not shown). As described above, the refrigerant inflow side of the oil separator 24 is connected to the refrigerant discharge opening of the compressor 21 through the discharge pipe 41. The refrigerant outflow side of the oil separator 24 is connected to the port a of the four-way valve 22 through the outflow pipe 43. The oil separator 24 separates refrigerant oil for the compressor 21 contained in the refrigerant discharged out of the compressor 21 from the refrigerant. The separated refrigerant oil is suctioned into the compressor 21 through an oil return pipe 47 (as will be described below).

[0026] The oil return pipe 47 has an end connected to an oil return opening of the oil separator 24 and the other end connected to the intake pipe 42. The oil return pipe

47 is provided with a capillary tube 26.

[0027] The first three-way valve 11 is disposed on the outflow pipe 43. The first three-way valve 11 includes three ports e, f, and g. The port e (a first port of the first three-way valve) is connected to the refrigerant outflow side of the oil separator 24. The port f (a second port of the first three-way valve) is connected to the port a of the four-way valve 22. The port g (a third port of the first three-way valve) is a service port for vacuuming and the like of the refrigerant pipe. The first three-way valve 11 can be switched to make communication at least between the ports e and f, or between the ports e and g.

[0028] The second three-way valve 12 is disposed on the intake pipe 42. More specifically, the second three-way valve 12 is disposed on the four-way valve 22 side with respect to the point of connection of the oil return pipe 47 and the intake pipe 42. The second three-way valve 12 includes three ports h, j, and k. The port h (a first port of the second three-way valve) is connected to the port c of the four-way valve 22. The port j (a second port of the second three-way valve) is connected to the refrigerant intake side of the compressor 21. The port k (a third port of the second three-way valve) is a service port for vacuuming and the like of the refrigerant pipes. The second three-way valve 12 can be switched to make communication at least between the ports h and j, or between the ports j and k.

[0029] The outdoor fan 29 is formed of a resin material and is disposed in the vicinity of the outdoor heat exchanger 23. The outdoor fan 29 is rotated by the fan motor (not shown). Thus, the outer air is taken into the outdoor unit 2, and the outer air that exchanges heat with the refrigerant in the outdoor heat exchanger 23 is released from the outdoor unit 2.

[0030] Other than the configuration described above, the outdoor unit 2 is provided with various sensors. As illustrated in FIG. 1, the discharge pipe 41 is provided with a high pressure sensor 31 and a discharge temperature sensor 33. The high pressure sensor 31 detects the pressure of the refrigerant discharged out of the compressor 21. The discharge temperature sensor 33 detects the temperature of the refrigerant discharged out of the compressor 21. The intake pipe 42 is provided with a low-pressure sensor 32 and an intake temperature sensor 34 in the vicinity of the refrigerant intake side of the compressor 21. The low-pressure sensor 32 detects the pressure of the refrigerant suctioned into the compressor 21. The intake temperature sensor 34 detects the temperature of the refrigerant suctioned into the compressor 21.

[0031] Between the four-way valve 22 and the outdoor heat exchanger 23, the refrigerant pipe 44 is provided with a refrigerant temperature sensor 35. The refrigerant temperature sensor 35 detects the temperature of the refrigerant that flows into the outdoor heat exchanger 23, or the temperature of the refrigerant that flows out of the outdoor heat exchanger 23. Between the outdoor heat exchanger 23 and the outdoor expansion valve 25, the

outdoor unit liquid pipe 45 is provided with a refrigerant temperature sensor 36. The refrigerant temperature sensor 36 detects the temperature of the refrigerant that flows out of the outdoor heat exchanger 23, or the temperature of the refrigerant that flows into the outdoor heat exchanger 23. In the vicinity of the suction opening (not shown) of the outdoor unit 2, an outer air temperature sensor 37 is provided. The outer air temperature sensor 37 detects the temperature of the outer air that flows into the outdoor unit 2, i.e., the outer air temperature.

[0032] Next, the three indoor units 5a to 5c will be described. The three indoor units 5a to 5c are provided with indoor heat exchangers 51a to 51c (user-side heat exchangers), indoor expansion valves 52a to 52c, the closing valves 53a to 53c, the closing valves 54a to 54c, and indoor fans 55a to 55c, respectively. The indoor expansion valves 52a to 52c are indoor refrigerant flow rate adjuster. The closing valves 53a to 53c are connected to the other end of the branched liquid pipe 8. The closing valves 54a to 54c are connected to the other end of the branched gas pipe 9. These members except for the indoor fans 55a to 55c are mutually connected through refrigerant pipes, as will be described below. Thus, indoor unit refrigerant circuits 50a to 50c as part of the refrigerant circuit 100 are formed.

[0033] The indoor units 5a to 5c have identical configurations. Thus, in the following description, the configuration of the indoor unit 5a will be described, and the description of the other indoor units 5b and 5c will be omitted. In FIG. 1, the members of the indoor unit 5b corresponding to the members of the indoor unit 5a are designated with the signs for the members of the indoor unit 5a with the "a" at the end replaced with "b". Similarly, the members of the indoor unit 5c corresponding to the members of the indoor unit 5a are designated with the signs for the members of the indoor unit 5a with the "a" at the end replaced with "c".

[0034] The indoor heat exchanger 51a carries out heat exchange between the refrigerant and the indoor air taken into the indoor unit 5a by an indoor fan 55a (as will be described below). One refrigerant entry/exit opening of the indoor heat exchanger 51a is connected to the closing valve 53a through an indoor unit liquid pipe 71a. The other refrigerant entry/exit opening of the indoor heat exchanger 51a is connected to the closing valve 54a through an indoor unit gas pipe 72a. The indoor heat exchanger 51a functions as an evaporator when the indoor unit 5a performs cooling operation. The indoor heat exchanger 51a functions as a condenser when the indoor unit 5a performs heating operation.

[0035] The indoor expansion valve 52a is an electronic expansion valve fitted to the indoor unit liquid pipe 71a. The opening degree of the indoor expansion valve 52a is adjusted based on the required cooling capacity when the indoor heat exchanger 51a functions as an evaporator. Similarly, the opening degree of the indoor expansion valve 52a is adjusted based on the required heating capacity when the indoor heat exchanger 51a functions as

a condenser.

[0036] The indoor fan 55a is formed of a resin material and is disposed in the vicinity of the indoor heat exchanger 51a. The indoor fan 55a is rotated by a fan motor (not shown). Thus, the indoor air is taken into the indoor unit 5a. Then, the indoor air exchanges heat with the refrigerant in the indoor heat exchanger 51a, followed by being supplied to the indoor space.

[0037] Other than the configuration described above, the indoor unit 5a is provided with various sensors. The indoor unit liquid pipe 71a is provided with a liquid-side temperature sensor 61a between the indoor heat exchanger 51a and the indoor expansion valve 52a. The liquid-side temperature sensor 61a is a heat exchanger entry temperature detector that detects the temperature of the refrigerant that flows into the indoor heat exchanger 51a, or the temperature of the refrigerant that flows out of the indoor heat exchanger 51a. The indoor unit gas pipe 72a is provided with a gas-side temperature sensor 62a. The gas-side temperature sensor 62a detects the temperature of the refrigerant that flows out of the indoor heat exchanger 51a, or the temperature of the refrigerant that flows into the indoor heat exchanger 51a. In the vicinity of the indoor air suction opening (not shown) of the indoor unit 5a, an indoor temperature sensor 63a is provided. The indoor temperature sensor 63a is an indoor temperature detector that detects the temperature of the indoor air that flows into the indoor unit 5a, i.e., the indoor temperature.

[0038] Next, the flow of refrigerant and the operation of each member in the refrigerant circuit 100 of the air conditioner 1 according to the present embodiment during an air-conditioning operation will be described with reference to FIG. 1. In the following description, an example in which the indoor units 5a to 5c perform cooling operation will be described. A detailed description of an example in which the indoor units 5a to 5c perform heating operation will be omitted. The arrows in FIG. 1 indicate the flow of refrigerant during cooling operation.

[0039] As illustrated in FIG. 1, when the indoor units 5a to 5c perform cooling operation, the four-way valve 22 of the outdoor unit 2 is switched to make communication between the ports a and b, and between the ports c and d. The communication between the ports is indicated in FIG. 1 by solid lines. Thus, the outdoor heat exchanger 23 functions as a condenser, while the indoor heat exchangers 51a to 51c function as evaporators.

[0040] The high-pressure refrigerant discharged out of the compressor 21 flows through the discharge pipe 41 and the oil separator 24 into the outflow pipe 43. The refrigerant flows into the four-way valve 22, and then flows out of the four-way valve 22 and into the outdoor heat exchanger 23 through the refrigerant pipe 44. The refrigerant that flows into the outdoor heat exchanger 23 exchanges heat with the outer air taken into the outdoor unit 2 by the rotation of the outdoor fan 29, whereby the refrigerant is condensed. The refrigerant flows out of the outdoor heat exchanger 23 and then flows through the

outdoor unit liquid pipe 45, followed by flowing into the liquid pipe 8 through both the fully opened outdoor expansion valve 25 and the fully opened operating valve 27.

[0041] The refrigerant that flows through the liquid pipe 8 is branched and flows into the indoor units 5a to 5c through the closing valves 53a to 53c, respectively. The refrigerant flows through the indoor unit liquid pipes 71a to 71c, and is depressurized into low-pressure refrigerant when the refrigerant passes the indoor expansion valves 52a to 52c. The refrigerant that flows into the indoor heat exchangers 51a to 51c through the indoor unit liquid pipes 71a to 71c exchanges heat with the indoor air taken into the indoor units 5a to 5c by the rotation of the indoor fans 55a to 55c, whereby the refrigerant is evaporated. Thus, the indoor heat exchangers 51a to 51c function as evaporators, and the indoor air that exchanges heat with the refrigerant in the indoor heat exchangers 51a to 51c is blown indoor out of an outlet (not shown). In this way, the air of the indoor spaces in which the indoor units 5a to 5c are installed is cooled.

[0042] The refrigerant that flows out of the indoor heat exchangers 51a to 51c flows through the indoor unit gas pipes 72a to 72c and into the gas pipe 9 through the closing valves 54a to 54c. The refrigerant flows through the gas pipe 9 and into the outdoor unit 2 through the operating valve 28. The refrigerant then flows through the outdoor unit gas pipe 46, the four-way valve 22, and the intake pipe 42, and is suctioned into the compressor 21 where the refrigerant is compressed again.

[0043] As described above, the refrigerant is circulated through the refrigerant circuit 100 as the air conditioner 1 performs cooling operation.

[0044] When the indoor units 5a to 5c perform heating operation, the four-way valve 22 of the outdoor unit 2 is switched to make communication between the ports a and d. The four-way valve 22 is also switched to make communication between the ports b and c. In

[0045] FIG. 1, the communication between the ports is indicated by broken lines. Thus, the outdoor heat exchanger 23 functions as an evaporator, while the indoor heat exchangers 51a to 51c function as condensers.

[0046] With reference to FIGS. 1 and 2, the effect of disposing the first three-way valve 11 and the second three-way valve 12 in the air conditioner 1 will be described.

[0047] First, with reference to FIG. 1, the effect of the first three-way valve 11 disposed on the outflow pipe 43 will be described. The compressor 21 is driven at a predetermined rotational speed when the air conditioner 1 is performing air-conditioning operation. Vibrations caused by the rotation of the compressor 21 are also transmitted to the discharge pipe 41 connected to the refrigerant discharge opening of the compressor 21.

[0048] If the first three-way valve 11 is fitted to the discharge pipe 41, when the discharge pipe 41 vibrates due to the driving of the compressor 21, a large force may be applied to the body of the discharge pipe 41, the connection part between the discharge pipe 41 and the com-

pressor 21 (on the refrigerant discharge side), and the connection part between the discharge pipe 41 and the oil separator 24 (on the refrigerant inflow side), due to the weight of the first three-way valve 11. As a result, the discharge pipe 41 and the above connection parts may be damaged.

[0049] However, as illustrated in FIG. 1, the first three-way valve 11 of the air conditioner 1 according to the present embodiment is disposed on the outflow pipe 43. Thus, even if the discharge pipe 41 vibrates due to the driving of the compressor 21, the force applied to the discharge pipe 41 and the connection parts between the discharge pipe 41 and the other devices is decreased compared with the case where the first three-way valve 11 is fitted to the discharge pipe 41, whereby the damage to these parts can be suppressed. Further, as described above, the oil separator 24 is fixed to the casing of the outdoor unit 2 using metal fittings and the like. Thus, the occurrence of vibrations in the oil separator 24 due to the driving of the compressor 21 can be suppressed. Moreover, the vibration of the outflow pipe 43 connected to the oil separator 24 can be suppressed. Therefore, due to the weight of the first three-way valve 11 fitted to the outflow pipe 43, application of a large force to the outflow pipe 43 and the connection parts between the outflow pipe 43 and other devices can be also suppressed. As a result, damage to the outflow pipe 43 and the above-mentioned connection parts can be also suppressed.

[0050] Next, with reference to FIGS. 1 and 2, the states of communication in the first three-way valve 11 and the second three-way valve 12 when the compressor 21 is detached from the outdoor unit refrigerant circuit 20, and when the compressor 21 is re-attached to the outdoor unit refrigerant circuit 20, and their effect will be described.

[0051] The case where the compressor 21 is detached from the outdoor unit refrigerant circuit 20 will be described. First, a suction hose (not shown) of a refrigerant recovery machine is connected to the port g of the first three-way valve 11. Then, as illustrated in FIG. 2, when the compressor 21 is detached from the refrigerant circuit, the first three-way valve 11 is switched to make communication between the ports e and g, while the second three-way valve 12 is switched to make communication between the ports j and k. Thus, a part between the port e of the first three-way valve 11 and the port j of the second three-way valve 12 (hereafter referred to as a separated refrigerant circuit) is cut off from the outdoor unit refrigerant circuit 20.

[0052] Next, the refrigerant recovery machine is driven to recover the refrigerant remaining in the separated refrigerant circuit. Thus, the amount of refrigerant that needs to be recovered can be decreased compared with the case where, for example, the refrigerant is recovered from the refrigerant circuit of the outdoor unit 2 as a whole by using the service ports (the blacked-out ports in FIG. 1) of the operating valve 27 and the operating valve 28. Thus, the time required for refrigerant recovery can be

decreased. Preferably, the suction hose of the refrigerant recovery machine may be connected to the port k of the second three-way valve 12 to recover the remaining refrigerant in the separated refrigerant circuit.

[0053] After the refrigerant recovery from the separated refrigerant circuit is completed, the compressor 21 is separated from the discharge pipe 41 and the intake pipe 42 and is thus detached. Thereafter, the detached compressor 21 is maintained and attached to the outdoor unit refrigerator circuit 20. Alternatively, a new compressor 21 is attached to the outdoor unit refrigerant circuit 20.

[0054] When the compressor 21 is attached to the outdoor unit refrigerant circuit 20, the discharge pipe 41 is connected to the refrigerant discharge opening of the compressor 21 and welded, while the intake pipe 42 is connected to the refrigerant intake opening of the compressor 21 and welded. After the welding is completed, a vacuum pump (not shown) is connected to the port g of the first three-way valve 11 to vacuum the separated refrigerant circuit. In this case, too, the amount of air that needs to be removed can be decreased compared with the case where, for example, the refrigerant circuit of the outdoor unit 2 as a whole is vacuumed by using the service ports of the operating valve 27 and the operating valve 28. Thus, the time required for vacuuming can be decreased. Preferably, the vacuum pump may be connected to the port k of the second three-way valve 12 to vacuum the separated refrigerant circuit.

[0055] After the vacuuming of the separated refrigerant circuit is completed, a tank with refrigerant sealed therein (not shown; hereafter referred to as a refrigerant tank) is connected to the service port of the operating valve 27. In the refrigerant tank, an amount of refrigerant sufficient for filling the amount of refrigerant recovered from the separated refrigerant circuit at the time of detaching the compressor 21 is sealed. By connecting the refrigerant tank to the service port of the operating valve 27, the refrigerant flows from the high-pressure refrigerant tank into the outdoor unit liquid pipe 45 and the liquid pipe 8. Thus, the refrigerant is charged in the refrigerant circuit 100. The amount of refrigerant charged is no more than the amount of refrigerant recovered from the separated refrigerant circuit when the compressor 21 is detached. Thus, the time required for refrigerant charging can be decreased.

[0056] After the charging of refrigerant into the refrigerant circuit 100 is completed, the refrigerant tank is detached from the service port of the operating valve 27. Then, the second three-way valve 12 is switched to make communication between the ports h and j, whereby the pressures in the ports h and j are made even (equalized). Then, the first three-way valve 11 is switched to make communication between the ports e and f. In this way, the attaching of the compressor 21 onto the refrigerant circuit is completed.

[0057] As described above, in the air conditioner 1, the first three-way valve 11 and the second three-way valve 12 are operated when the compressor 21 is detached

from the outdoor unit refrigerant circuit 20, and when the compressor 21 is re-attached to the outdoor unit refrigerant circuit 20. Thus, the time required for refrigerant recovery when detaching the compressor 21, and the time for vacuuming and refrigerant charging when attaching the compressor 21 can be significantly decreased. Thus, the maintainability of the air conditioner 1 is improved.

[0058] With reference to FIGS. 1 and 3, the effect of the second three-way valve 12 disposed on the four-way valve 22 side of the intake pipe 42 with respect to the point of connection of the oil return pipe 47 and the intake pipe 42, in addition to the first three-way valve 11 disposed on the outflow pipe 43, will be described.

[0059] As illustrated in FIG. 3, in case that when the air conditioner 1 is performing air-conditioning operation, namely, when the compressor 21 is being driven, the first three-way valve 11 fails and is fixed in a closed state, then the refrigerant discharged out of the compressor 21 flows through the discharge pipe 41 into the oil separator 24, and then flows out of the oil separator 24 into the oil return pipe 47. The refrigerant then flows into the intake pipe 42 through the capillary tube 26, flows through the intake pipe 42, and is then suctioned into the compressor 21.

[0060] If the first three-way valve 11 is fitted to the discharge pipe 41, when the first three-way valve 11 fails and is fixed in the closed state, the refrigerant discharged out of the compressor 21 is blocked by the first three-way valve 11. If the compressor 21 continues to be driven in this state, the compressor 21 may fail.

[0061] In case that when the second three-way valve 12 is disposed on the compressor 21 side of the intake pipe 42 with respect to the point of connection of the oil return pipe 47 and the intake pipe 42, the second three-way valve 12 fails and is in a closed state, then the refrigerant that flows out of the oil return pipe 47 into the intake pipe 42 is blocked by the second three-way valve 12. In this case, the refrigerant cannot be suctioned in, and the compressor 21 may be damaged.

[0062] However, according to the present embodiment, as illustrated in FIGS. 1 and 3, the first three-way valve 11 is disposed on the outflow pipe and the second three-way valve 12 is disposed on the four-way valve 22 side of the intake pipe 42 with respect to the point of connection of the oil return pipe 47 and the intake pipe 42. Thus, the refrigerant discharged out of the compressor 21 flows through the discharge pipe 41, the oil separator 24, the oil return pipe 47, and the intake pipe 42 successively, and is then suctioned into the compressor 21. As a result, even when the first three-way valve 11 and/or the second three-way valve 12 fails and is placed in the closed state, damage to the compressor 21 can be suppressed.

[0063] However, if the driving of the compressor 21 continues while the first three-way valve 11 and/or the second three-way valve 12 is closed, the discharge pressure of the compressor 21 may be increased beyond an

upper-limit value. Thus, a threshold value may be set lower than the upper-limit value of the discharge pressure of the compressor 21 by a predetermined value. Then, high pressure protection control such that the compressor 21 stops when the discharge pressure of the compressor 21 reaches the threshold value may be implemented. The discharge pressure of the compressor 21 is detected by the high pressure sensor 31.

[0064] As described above, in the air conditioner according to the present disclosure, the first three-way valve 11 is disposed on the outflow pipe 43, with one end of the outflow pipe 43 connected to the oil separator 24 fixed onto the casing of the outdoor unit 2. Thus, the discharge pipe 41 and the outflow pipe 43 can be suppressed from greatly vibrating due to vibration of the compressor 21. Thus, damage to the discharge pipe 41 and the connection parts between the discharge pipe 41 and the other devices due to vibrations can be suppressed. Further, damage to the outflow pipe 43 and the connection parts between the outflow pipe 43 and the other devices due to vibrations can be suppressed.

[0065] When the compressor is attached to the refrigerant circuit, vacuuming can be performed from the vacant port of the first three-way valve or the second three-way valve (i.e., the port to which no refrigerant pipe is connected). Thus, the cost increase due to separately fitting the service valve and/or the branch pipe can be limited, whereby the time required for vacuuming can be decreased.

[0066] The embodiment has been described above with reference to the example of the air conditioner in which a plurality (three) of indoor units is connected to one outdoor unit through refrigerant pipes. However, the air conditioner according to the embodiment of the present disclosure is not limited to such a configuration. For example, the air conditioner according to the embodiment of the present disclosure includes an air conditioner in which one outdoor unit and one indoor unit are connected through refrigerant pipes, and an air conditioner in which a plurality of outdoor units and a plurality of indoor units are connected through refrigerant pipes.

[0067] The air conditioner according to the present disclosure may be expressed as a first air conditioner and a second air conditioner as follows.

[0068] The first air conditioner includes a refrigerant circuit including a compressor, a flow path switcher, a heat source-side heat exchanger, at least one expansion valve, and a user-side heat exchanger which are connected through a refrigerant pipe; an oil separator disposed between the compressor and the heat source-side heat exchanger configured to separate a refrigerant oil from a refrigerant discharged from the compressor; an oil return pipe with one end connected to the oil separator and the other end connected to an intake pipe which is a part of a refrigerant pipe connecting a refrigerant intake opening of the compressor and the flow path switcher, and having a capillary tube; and a first three-way valve disposed on an outflow pipe which is a part of a refrigerant

pipe connected to a refrigerant outflow opening of the oil separator.

[0069] The second air conditioner is the first air conditioner further including a second three-way valve fitted to the intake pipe and disposed between a connection part of the oil return pipe to the intake pipe and the flow path switcher.

[0070] According to the above air conditioners, because the first three-way valve is disposed on the outflow pipe, a large force is not applied to the discharge pipe and the connection part between the discharge pipe and other devices even when the discharge pipe is vibrated by the vibration of the compressor, so that the discharge pipe and the connection part between the discharge pipe and the other devices are not damaged. Further, when re-attaching the detached compressor onto the refrigerant circuit, vacuuming can be performed through a vacant port of the first three-way valve and the second three-way valve (the port to which the refrigerant pipe is not connected), whereby the cost increase due to the fitting of separate service valve or branch pipe can be avoided, and high maintainability can be obtained.

[0071] The foregoing detailed description has been presented for the purposes of illustration and description.

Many modifications and variations are possible in light of the above teaching. It is not intended to be exhaustive or to limit the subject matter described herein to the precise form disclosed. Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims appended hereto.

Claims

1. An air conditioner outdoor unit comprising:

a compressor;
a heat source-side heat exchanger connected to the compressor;
an oil separator disposed between a refrigerant discharge opening of the compressor and the heat source-side heat exchanger configured to separate a refrigerant oil from a refrigerant discharged from the compressor; and
a first three-way valve fitted to a refrigerant pipe between the oil separator and the heat source-side heat exchanger.

2. The air conditioner outdoor unit according to claim 1, further comprising a flow path switching unit for switching the direction of flow of refrigerant in the heat source-side heat exchanger, wherein:

the flow path switching unit is disposed between the heat source-side heat exchanger and the oil separator; and
the first three-way valve is disposed on a refrigerant pipe between the flow path switching unit and the oil separator. 5

3. The air conditioner outdoor unit according to claim 2, further comprising:

an oil return pipe with one end connected to the oil separator and the other end connected to a refrigerant pipe connected to a refrigerant intake opening of the compressor; and
a second three-way valve disposed between a connection part of the refrigerant pipe and the oil return pipe, and the flow path switching unit. 10 15

4. The air conditioner outdoor unit according to claim 3, wherein:

the first three-way valve includes a first port connected to the oil separator, a second port connected to the flow path switching unit, and a third port which is a service port; and
the second three-way valve includes a first port connected to the flow path switching unit, a second port connected to the refrigerant intake opening of the compressor, and a third port which is a service port. 20 25 30

5. An air conditioner comprising:

the outdoor unit according to any one of claims 1 to 4; and
an indoor unit connected to the outdoor unit. 35

40

45

50

55

FIG. 1

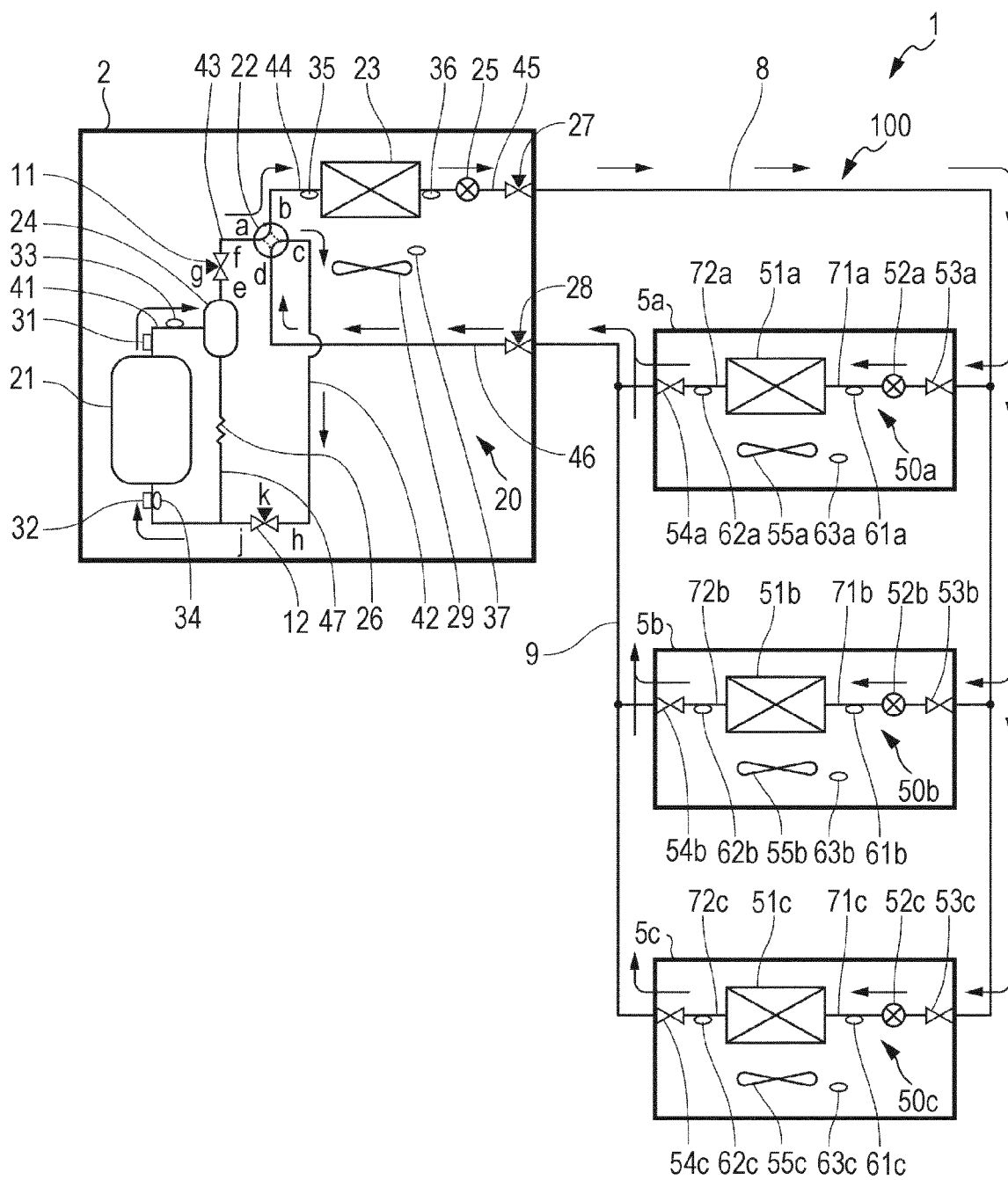


FIG. 2

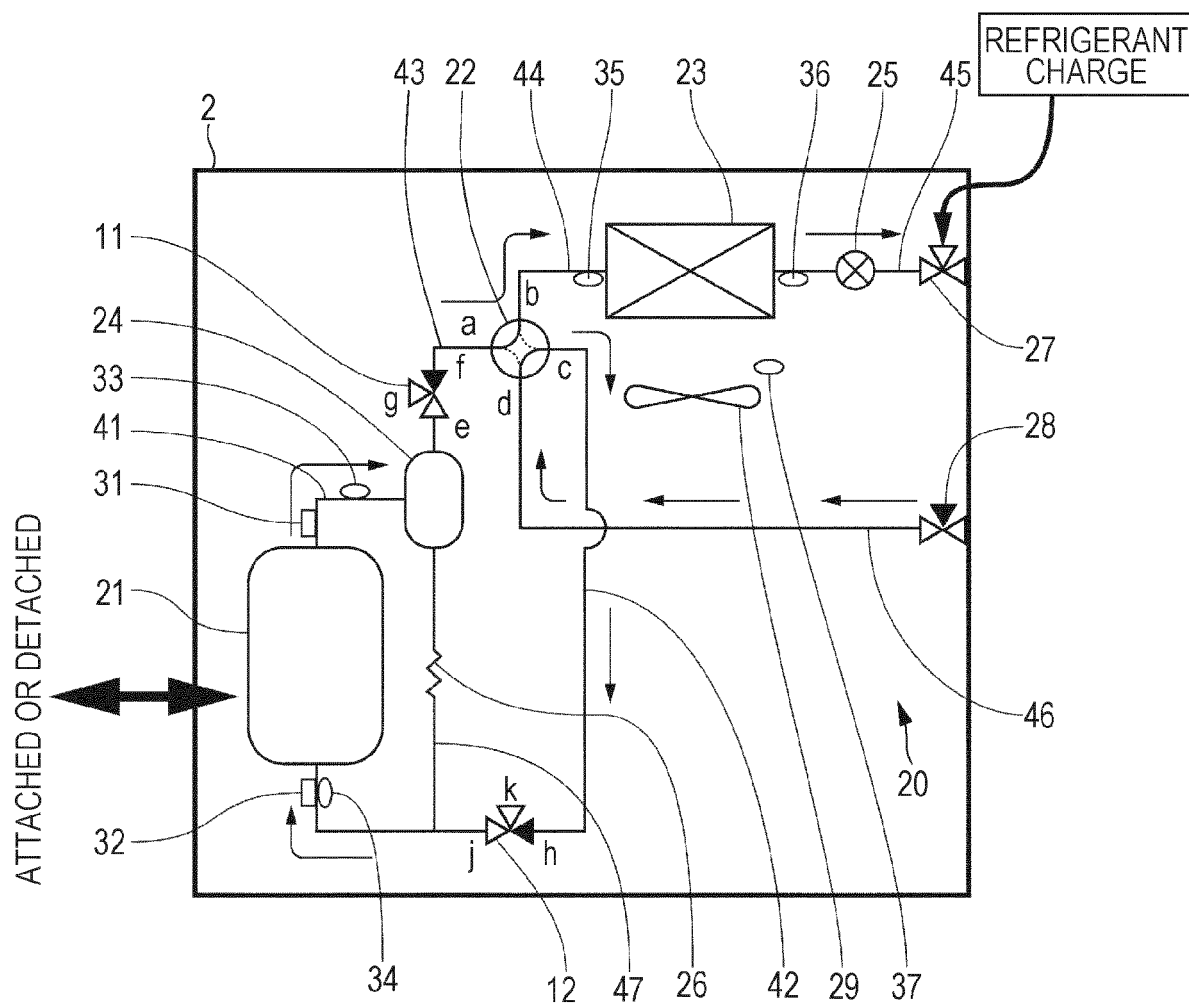
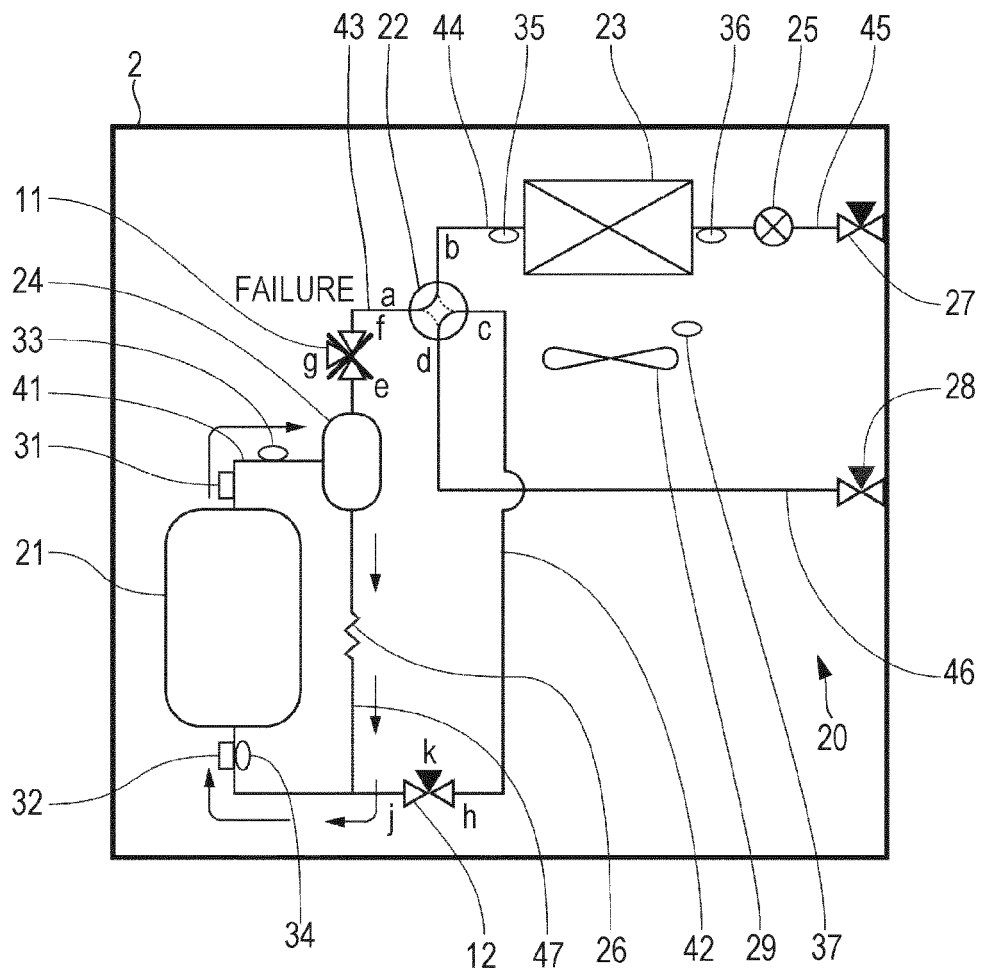


FIG. 3





Europäisches
Patentamt
European
Patent Office
Office européen
des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 14 15 4768

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 956 320 A1 (DAIKIN IND LTD [JP]) 13 August 2008 (2008-08-13)	1-3,5	INV. F25B41/04 F25B13/00 F25B45/00 F25B43/02
Y	* paragraph [0089] - paragraph [0096]; figure 6 *	4	
Y	----- WO 2012/063289 A1 (MITSUBISHI ELECTRIC CORP [JP]; MORIMOTO HIROYUKI [JP]; YAMASHITA KOJI) 18 May 2012 (2012-05-18) * paragraph [0023]; figure 1 *	4	
A	----- US 2008/289353 A1 (MARUYA RICHARD H [US] ET AL) 27 November 2008 (2008-11-27) * the whole document *	1-5	
A	----- EP 2 051 029 A1 (DAIKIN IND LTD [JP]) 22 April 2009 (2009-04-22) * the whole document *	1-5	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			F25B
Place of search		Date of completion of the search	Examiner
Munich		21 July 2014	Ritter, Christoph
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03.92 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 15 4768

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-07-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1956320 A1	13-08-2008	AU 2006319957 A1	07-06-2007
		CN 101317046 A	03-12-2008
		EP 1956320 A1	13-08-2008
		JP 5040104 B2	03-10-2012
		JP 2007147218 A	14-06-2007
		KR 20080068137 A	22-07-2008
		US 2009282849 A1	19-11-2009
		WO 2007063883 A1	07-06-2007

WO 2012063289 A1	18-05-2012	NONE	

US 2008289353 A1	27-11-2008	NONE	

EP 2051029 A1	22-04-2009	AU 2007282495 A1	14-02-2008
		CN 101501423 A	05-08-2009
		EP 2051029 A1	22-04-2009
		JP 4197020 B2	17-12-2008
		JP 2008045769 A	28-02-2008
		KR 20090045273 A	07-05-2009
		KR 20110043793 A	27-04-2011
		TW 200813380 A	16-03-2008
		US 2009133413 A1	28-05-2009
		WO 2008018480 A1	14-02-2008

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 7332784 A [0004]