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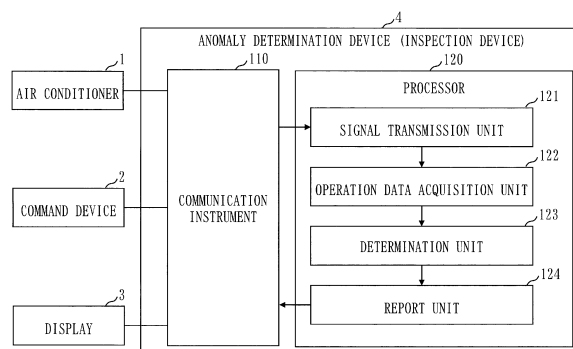
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(54) **INSPECTION DEVICE AND INSPECTION METHOD**

(57) When there exists in an outdoor unit a second refrigerant path which enables circulation of refrigerant in the outdoor unit even if circulation of the refrigerant through a first refrigerant path is blocked by closure of a first valve provided in the first refrigerant path which circulates the refrigerant between an indoor unit and the outdoor unit of an air conditioner (1), a signal transmission unit (121) transmits to the outdoor unit, a command

signal commanding the outdoor unit to close a second valve which is provided in the second refrigerant path and closure of which blocks the circulation of the refrigerant through the second refrigerant path. A determination unit (123) determines whether the first valve is closed or not after the command signal is transmitted from the signal transmission unit (121) to the outdoor unit.

Fig. 1



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Description

Technical Field

[0001] The present disclosure relates to a technique of inspecting whether a valve provided in a refrigerant path of an air conditioner is closed or not.

Background Art

[0002] A liquid pipe valve and a gas pipe valve are placed in inlet and outlet portions of a refrigerant path (to be referred to below as a first refrigerant path) to circulate refrigerant between an outdoor unit and an outdoor unit of an air conditioner. Hereinbelow, the liquid pipe valve and the gas pipe valve are also referred to collectively as a first valve.

[0003] When an air conditioner is installed, commonly, commissioning of the air conditioner is carried out and absence of inadequacy in installation work is checked.

[0004] The first valve needs to be brought into an open state by an operator when the air conditioner is installed. When the first valve is in a closed state or when the first valve is not fully opened, the first refrigerant path is blocked so that the refrigerant is not circulated. Accordingly, it is assumed that an expected air conditioning capability is not fulfilled. Otherwise, it is assumed that power consumption may increase with increase in pressure loss.

[0005] Further, when the first valve is in the closed state, a pressure difference between a low pressure (inlet pressure) and a high pressure (discharge pressure) may increase, so that the air conditioner may be stopped due to protective control for protection of the air conditioner. When the air conditioner is stopped in this manner, the operator needs to examine a cause of stoppage. Meanwhile, when operation of the air conditioner continues in spite of the protective control, the operator needs to avoid overlooking the first valve in the closed state.

[0006] Thus, detecting the closed state of the first valve and making the operator recognize that the first valve is in the closed state are required in the commissioning of the air conditioner following the installation, in particular.

[0007] From such a viewpoint, a technique of detecting whether the first valve is in the closed state or not is disclosed in Patent Literature 1.

Citation List

Patent Literature

[0008] Patent Literature 1: JP 2007-107820

Summary of Invention

Technical Problem

[0009] In some outdoor units, there may be a second

refrigerant path that enables circulation of the refrigerant in the outdoor unit even if the circulation of the refrigerant through the first refrigerant path is blocked by closure of the first valve. In such an outdoor unit, the pressure difference between the low pressure and the high pressure does not increase even if the first valve is closed, because the refrigerant is circulated through the second refrigerant path. Therefore, the technique of Patent Literature 1 has a problem in that it may be incorrectly determined that the first valve is open though the first valve is closed.

[0010] The present disclosure mainly aims at solving such a problem. More specifically, the present disclosure mainly aims at making it possible to correctly determine whether the first valve is closed or not even if an outdoor unit in which the second refrigerant path exists is used.

Solution to Problem

[0011] An inspection device according to the present disclosure includes:

a signal transmission unit, when there exists in an outdoor unit a second refrigerant path which enables circulation of refrigerant in the outdoor unit even if circulation of the refrigerant through a first refrigerant path is blocked by closure of a first valve provided in the first refrigerant path which circulates the refrigerant between an indoor unit and the outdoor unit of an air conditioner, to transmit to the outdoor unit, a command signal commanding the outdoor unit to close a second valve which is provided in the second refrigerant path and closure of which blocks the circulation of the refrigerant through the second refrigerant path; and
a determination unit to determine whether the first valve is closed or not after the command signal is transmitted from the signal transmission unit to the outdoor unit.

Advantageous Effects of Invention

[0012] According to the present disclosure, it can be correctly determined whether the first valve is closed or not even if the outdoor unit in which the second refrigerant path exists is used.

Brief Description of Drawings

[0013]

Fig. 1 is a diagram illustrating a configuration example of an anomaly detection system according to Embodiment 1.

Fig. 2 is a diagram illustrating a configuration example of an air conditioner according to Embodiment 1. Fig. 3 is a diagram illustrating a first refrigerant path according to Embodiment 1.

Fig. 4 is a diagram illustrating a second refrigerant

path according to Embodiment 1.

Fig. 5 is a flowchart illustrating an example of operation of an anomaly determination device according to Embodiment 1.

Fig. 6 is a diagram illustrating a configuration example of an air conditioner according to Embodiment 2.

Fig. 7 is a diagram illustrating a first refrigerant path according to Embodiment 2.

Fig. 8 is a diagram illustrating a second refrigerant path according to Embodiment 2.

Fig. 9 is a diagram illustrating a configuration example of an air conditioner according to Embodiment 3.

Fig. 10 is a diagram illustrating a first refrigerant path according to Embodiment 3.

Fig. 11 is a diagram illustrating a second refrigerant path according to Embodiment 3.

Description of Embodiments

[0014] Hereinbelow, embodiments will be described with use of the drawings. In following description on the embodiments and the drawings, elements provided with identical reference numerals represent identical parts or corresponding parts.

Embodiment 1.

*** Description of configuration ***

[0015] Fig. 1 illustrates a configuration example of an anomaly detection system according to the present embodiment.

[0016] The anomaly detection system includes an air conditioner 1, a command device 2, a display 3, and an anomaly determination device 4.

[0017] The air conditioner 1, the command device 2, and the display 3 are connected to the anomaly determination device 4.

[0018] The command device 2 commands the air conditioner 1 to start commissioning. The command device 2 is a remote controller for the air conditioner 1 or a PC (Personal Computer) connected to the air conditioner 1, for instance.

[0019] When a closed state of a liquid pipe valve 15 and/or a gas pipe valve 16 that will be described later is detected, the display 3 displays a message making notification that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state. Display of the message by the display 3 makes it possible for an operator who does installation work for the air conditioner 1 to recognize that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state.

[0020] The display 3 is a remote controller for the air conditioner 1 or a PC connected to the air conditioner 1, for instance.

[0021] The command device 2 and the display 3 may be implemented as the same device.

[0022] The anomaly determination device 4 is a com-

puter. If the command device 2 and/or the display 3 is implemented by the PC, the anomaly determination device 4 may be implemented by the same PC as the command device 2 and/or the display 3.

[0023] The anomaly determination device 4 includes a communication instrument 110 and a processor 120. Further, a storage device such as a RAM (Random Access Memory) or an HDD (Hard Disk Drive) is supposed to be included in the anomaly determination device 4, though not illustrated.

[0024] The communication instrument 110 communicates with the air conditioner 1, the command device 2, and the display 3.

[0025] The processor 120 executes programs that realize functions of a signal transmission unit 121, an operation data acquisition unit 122, a determination unit 123, and a report unit 124. The processor 120 executes the programs to function as the signal transmission unit 121, the operation data acquisition unit 122, the determination unit 123, and the report unit 124. Details of the signal transmission unit 121, the operation data acquisition unit 122, the determination unit 123, and the report unit 124 will be described later.

[0026] Incidentally, the anomaly determination device 4 is equivalent to an inspection device. Further, an operation procedure of the anomaly determination device 4 is equivalent to an inspection method.

[0027] Fig. 2 illustrates a configuration example of the air conditioner 1.

[0028] The air conditioner 1 includes an outdoor unit 10, indoor units 20, and connection pipes 30 to connect the outdoor unit 10 and the indoor units 20.

[0029] Fig. 2 illustrates a configuration in which the plurality of indoor units 20 are connected to the one outdoor unit 10. The configuration of the air conditioner 1, however, is not limited to that illustrated in Fig. 2. The air conditioner 1 may have a configuration in which one indoor unit 20 is connected to the one outdoor unit 10. Alternatively, a plurality of outdoor units 10 may be included in the air conditioner 1.

[0030] The outdoor unit 10 includes a compressor 11, a four-way valve 12, an outdoor heat exchanger 13, an outdoor unit fan 14, the liquid pipe valve 15, the gas pipe valve 16, a subcool coil 17, and an expansion valve 18 for subcool coil.

[0031] The indoor units 20 each include an expansion valve 21, an indoor heat exchanger 22, and an indoor unit fan 23.

[0032] A refrigeration cycle is configured by ring-like connection of the compressor 11, the four-way valve 12, the outdoor heat exchanger 13, the expansion valve 21, and the indoor heat exchanger 22 through refrigerant pipes.

[0033] Incidentally, the outdoor unit 10 includes a communication instrument to receive a command signal from the anomaly determination device 4, though not illustrated in Fig. 2. Further, the outdoor unit 10 includes a valve control mechanism to close the expansion valve 18 for

subcool coil based on the command signal. The command signal is a signal by which the anomaly determination device 4 commands the outdoor unit 10 to close the expansion valve 18 for subcool coil.

[0034] The compressor 11 compresses refrigerant having a low temperature and a low pressure and thereby converts the refrigerant having the low temperature and the low pressure into the refrigerant having a high temperature and a high pressure. The compressor 11 is driven by an inverter, for instance, and has a controlled capacity (amount of the refrigerant to be discharged per unit time).

[0035] The four-way valve 12 switches flow of the refrigerant, in accordance with an operation mode of the air conditioner 1, such as cooling operation or heating operation.

[0036] The outdoor heat exchanger 13 carries out heat exchange between the refrigerant flowing through the refrigeration cycle and outdoor air. The outdoor unit fan 14 adjoins the outdoor heat exchanger 13.

[0037] The outdoor unit fan 14 blows air against the outdoor heat exchanger 13. An amount of the blown air can be adjusted by control over the number of revolutions of the outdoor unit fan 14.

[0038] The expansion valve 21 includes a valve whose opening can be variably controlled, such as an electronic expansion valve. A pressure reduction amount for the refrigerant is controlled by control over the opening of the expansion valve 21.

[0039] The indoor heat exchanger 22 carries out heat exchange between the refrigerant flowing through the refrigeration cycle and indoor air. The indoor unit fan 23 adjoins the indoor heat exchanger 22.

[0040] The indoor unit fan 23 blows air against the indoor heat exchanger 22. An amount of the blown air can be adjusted by control over the number of revolutions of the indoor unit fan 23.

[0041] A high-pressure sensor 41 and a low-pressure sensor 42 are installed ahead and behind the compressor 11 of the outdoor unit 10. The high-pressure sensor 41 measures a high pressure value (discharge pressure value) of the refrigerant in the compressor 11. The low-pressure sensor 42 measures a low pressure value (inlet pressure value) of the refrigerant in the compressor 11.

[0042] The high-pressure sensor 41 and the low-pressure sensor 42 are used when control for making the high pressure and the low pressure close to target values is exerted. Further, the high-pressure sensor 41 and the low-pressure sensor 42 are used for protective control for preventing the outdoor unit 10 from being damaged by increase in the high pressure and decrease in the low pressure.

[0043] The liquid pipe valve 15 and the gas pipe valve 16 are provided in connection portions between the outdoor unit 10 and the connection pipes 30.

[0044] The operator who does the installation work installs the air conditioner 1 by connecting the outdoor unit 10, the indoor units 20, and the connection pipes 30 at

an installation site. During shipment and transfer, the liquid pipe valve 15 and the gas pipe valve 16 are closed. After the outdoor unit 10, the indoor units 20, and the connection pipes 30 are connected at the installation site, the operator opens the liquid pipe valve 15 and the gas pipe valve 16. Opening the liquid pipe valve 15 and the gas pipe valve 16 enables circulation of the refrigerant.

[0045] The liquid pipe valve 15 and the gas pipe valve 16 are equivalent to first valves.

[0046] In the cooling operation, degree of undercooling can be increased by reduction in pressure of a portion of the refrigerant, having gone out of the outdoor heat exchanger 13 and having a high pressure, by the expansion valve 18 for subcool coil and heat exchange in the subcool coil 17 between the refrigerant reduced in the pressure and the refrigerant before diverging. The refrigerant reduced in the pressure is returned to the compressor 11.

[0047] The expansion valve 18 for subcool coil is equivalent to a second valve.

[0048] In the outdoor unit 10 illustrated in Fig. 2, two refrigerant paths to circulate the refrigerant exist.

[0049] Figs. 3 and 4 illustrate the two refrigerant paths existing in the outdoor unit 10.

[0050] Fig. 3 illustrates a first refrigerant path and Fig. 4 illustrates a second refrigerant path.

[0051] In the first refrigerant path of Fig. 3, the refrigerant that flows in from the indoor units 20 is returned through the gas pipe valve 16, the low-pressure sensor 42, the compressor 11, the high-pressure sensor 41, the outdoor heat exchanger 13, the subcool coil 17, and the liquid pipe valve 15 to the indoor units 20. The first refrigerant path makes the refrigerant circulate between the outdoor unit 10 and the indoor units 20.

[0052] The second refrigerant path of Fig. 4 is a path to make the refrigerant circulate in the outdoor unit 10. That is, the second refrigerant path is a path extending through the outdoor heat exchanger 13, the subcool coil 17, the expansion valve 18 for subcool coil, the low-pressure sensor 42, the compressor 11, and the high-pressure sensor 41.

[0053] In a case where either or both of the liquid pipe valve 15 and the gas pipe valve 16 are closed in a configuration in which the second refrigerant path does not exist, a high-low pressure difference increases when the compressor 11 operates, compared with a case where both the valves are normally open. When the high-low pressure difference exceeds a predetermined threshold, it can be determined that the liquid pipe valve 15 and/or the gas pipe valve 16 may be in the closed state.

[0054] In the configuration in which the second refrigerant path exists, however, the refrigerant is allowed to circulate through the second refrigerant path by the expansion valve 18 for subcool coil being open even if the circulation of the refrigerant through the first refrigerant path is blocked by closure of the liquid pipe valve 15 and the gas pipe valve 16. When the refrigerant circulates through the second refrigerant path even though the liquid pipe valve 15 and the gas pipe valve 16 are closed,

the high-low pressure difference does not increase to be greater than or equal to the threshold. Thus, there is a problem of failing to correctly determine a state of the liquid pipe valve 15 and/or the gas pipe valve 16 when the expansion valve 18 for subcool coil is open.

[0055] In regard to such a problem, the anomaly determination device 4 according to the present embodiment has a configuration that enables correctly determining whether the liquid pipe valve 15 and/or the gas pipe valve 16 is closed or not even though the second refrigerant path exists in the outdoor unit 10.

[0056] Hereinbelow, the configuration of the anomaly determination device 4 according to the present embodiment will be described.

[0057] The signal transmission unit 121 transmits a command signal to the outdoor unit 10 in the commissioning of the air conditioner 1. The command signal is a signal that commands closure of the expansion valve 18 for subcool coil.

[0058] The outdoor unit 10 having received the command signal closes the expansion valve 18 for subcool coil, if the expansion valve 18 for subcool coil is open. The circulation of the refrigerant in a second refrigerant circuit is blocked by closure of the expansion valve 18 for subcool coil.

[0059] Blockage of the circulation of the refrigerant in the second refrigerant circuit by the closure of the expansion valve 18 for subcool coil makes it possible for the determination unit 123 that will be described later to correctly determine the state of the liquid pipe valve 15 and/or the gas pipe valve 16.

[0060] The operation data acquisition unit 122 acquires operation data on the air conditioner 1. The operation data is sensor values obtained from a sensor provided in the air conditioner 1, for instance. Further, the operation data is controlling values for the air conditioner 1. In the sensor values, the high pressure value measured by the high-pressure sensor 41 and the low pressure value measured by the low-pressure sensor 42 are included. In the controlling values, such values as a frequency of the compressor 11, the number of revolutions of the outdoor unit fan 14, and the valve opening of the expansion valve 21 are included.

[0061] The operation data acquisition unit 122 acquires the high pressure value measured by the high-pressure sensor 41 and the low pressure value measured by the low-pressure sensor 42 after transmission of the command signal from the signal transmission unit 121.

[0062] The determination unit 123 determines whether the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state or not, based on the high pressure value and the low pressure value acquired as the operation data by the operation data acquisition unit 122. As described above, the determination unit 123 determines that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state, when the high-low pressure difference which is the pressure difference between the high pressure value and the low pressure value exceeds the

threshold.

[0063] Alternatively, the determination unit 123 may determine that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state, when the high pressure exceeds a predetermined threshold. Meanwhile, the determination unit 123 may determine that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state, when the low pressure is lower than a predetermined threshold.

[0064] Further, the determination unit 123 may determine that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state, when operation of the air conditioner 1 is stopped by exercise of the protective function due to increase in the high pressure or decrease in the low pressure.

[0065] In a case where it is determined by the determination unit 123 that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state, the report unit 124 reports to the operator that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state. Specifically, the report unit 124 outputs to the display 3, a message of notification that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state.

*** Description of operation ***

[0066] Fig. 5 illustrates an example of operation of the anomaly determination device 4 according to the present embodiment. Hereinbelow, the operation of the anomaly determination device 4 according to the present Embodiment 1 will be described with reference to a flow of Fig. 5.

[0067] Upon a command from the command device 2 to start the commissioning of the air conditioner 1, the commissioning of the air conditioner 1 is started. Once the commissioning of the air conditioner 1 is started, the operation data acquisition unit 122 acquires the controlling values as the operation data and recognizes the start of the commissioning of the air conditioner 1.

[0068] Subsequently, in step ST01, the signal transmission unit 121 transmits the command signal to the outdoor unit 10. The outdoor unit 10 having received the command signal closes the expansion valve 18 for subcool coil, based on the command signal.

[0069] In step ST02, the operation data acquisition unit 122 acquires the high pressure value from the high-pressure sensor 41. Further, the operation data acquisition unit 122 acquires the low pressure value from the low-pressure sensor 42. Further, the determination unit 123 calculates the high-low pressure difference ΔP (high pressure value minus low pressure value) that is the difference between the high pressure value and the low pressure value.

[0070] Subsequently, in step ST03, the determination unit 123 determines whether the high-low pressure difference ΔP exceeds the predetermined threshold or not.

[0071] When the high-low pressure difference ΔP exceeds the threshold, processing proceeds to step ST04. On the other hand, when the high-low pressure difference

ΔP is smaller than or equal to the threshold, the processing is ended.

[0072] In step ST04, the determination unit 123 determines that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state. Then, the report unit 124 outputs to the display 3, the message of notification that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state. The display 3 displays the message of the notification that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state.

[0073] The operator having looked at the message displayed by the display 3 checks the liquid pipe valve 15 and the gas pipe valve 16 and, if the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state, does opening work for the liquid pipe valve 15 and/or the gas pipe valve 16.

[0074] Incidentally, in regard to step ST03, the determination unit 123 may make a comparison between the high pressure value and the threshold instead of a comparison between the high-low pressure difference ΔP and the threshold, as described above. When the high pressure value then exceeds the threshold, the determination unit 123 determines that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state. In step ST02, in this case, it is sufficient if the operation data acquisition unit 122 acquires only the high pressure value and the determination unit 123 does not need to calculate the high-low pressure difference ΔP .

[0075] Alternatively, in regard to step ST03, the determination unit 123 may make a comparison between the low pressure value and the threshold instead of a comparison between the high-low pressure difference ΔP and the threshold, as described above. When the low pressure value is then less than the threshold, the determination unit 123 determines that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state. In step ST02, in this case, it is sufficient if the operation data acquisition unit 122 acquires only the low pressure value and the determination unit 123 does not need to calculate the high-low pressure difference ΔP .

[0076] Alternatively, in regard to step ST03, the determination unit 123 may make a determination of whether the operation of the air conditioner 1 is stopped or not by the exercise of the protective function due to the increase in the high pressure or the decrease in the low pressure, instead of the comparison between the high-low pressure difference ΔP and the threshold, as described above. When the operation of the air conditioner 1 is then stopped by the exercise of the protective function due to the increase in the high pressure or the decrease in the low pressure, the determination unit 123 may determine that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state. In this case, the operation data acquisition unit 122 acquires the controlling values representing stoppage of the operation of the air conditioner 1, as the operation data, in step ST02. Then, the determination unit 123 analyzes the controlling values and recognizes that the operation of the air conditioner 1 is

stopped by the exercise of the protective function due to the increase in the high pressure or the decrease in the low pressure.

[0077] Further, the threshold to be compared with the high-low pressure difference ΔP may be a fixed value or may be a variable value. In a case where the variable threshold is used, it is conceived that the determination unit 123 changes the threshold in accordance with an operating condition of the air conditioner 1, such as the frequency of the compressor 11 or the opening of the expansion valve 21 of the indoor unit 20. Detection accuracy under a condition that the liquid pipe valve 15 and/or the gas pipe valve 16 is not fully-closed can be improved by such change in the threshold in accordance with the operating condition by the determination unit 123.

[0078] Further, when the high pressure value is compared with the threshold instead of the high-low pressure difference ΔP , the determination unit 123 may use a variable threshold that changes in accordance with the operating condition of the air conditioner 1, as the threshold to be compared with the high pressure value.

[0079] Similarly, when the low pressure value is compared with the threshold instead of the high-low pressure difference ΔP , the determination unit 123 may use a variable threshold that changes in accordance with the operating condition of the air conditioner 1, as the threshold to be compared with the low pressure value.

[0080] Further, above description presupposes that the operator having looked at the message displayed by the display 3 does the opening work for the liquid pipe valve 15 and/or the gas pipe valve 16.

[0081] Alternatively, the anomaly determination device 4 may command opening of the liquid pipe valve 15 and/or the gas pipe valve 16 to the outdoor unit 10, so that the liquid pipe valve 15 and/or the gas pipe valve 16 may be automatically opened. In this case, the outdoor unit 10 is supposed to include the valve control mechanism, not illustrated in Fig. 2, to control opening and closure of the liquid pipe valve 15 and the gas pipe valve 16.

[0082] Specifically, in a case where it is determined by the determination unit 123 that the liquid pipe valve 15 and/or the gas pipe valve 16 is closed, the signal transmission unit 121 transmits to the outdoor unit 10, a command signal commanding the opening of the liquid pipe valve 15 and/or the gas pipe valve 16. The outdoor unit 10 having received the command signal opens the liquid pipe valve 15 and/or the gas pipe valve 16 through control over the valve control mechanism.

[0083] A work burden on the operator can be relieved by such automatic opening of the liquid pipe valve 15 and/or the gas pipe valve 16. Incidentally, in this case, output of the message to the display 3 by the report unit 124 may be omitted.

*** Description of effects of embodiment ***

[0084] In the present embodiment, as described

above, the anomaly determination device 4 transmits to the outdoor unit 10, the command signal commanding the closure of the expansion valve 18 for subcool coil, and the outdoor unit 10 closes the expansion valve 18 for subcool coil. According to the present embodiment, therefore, the anomaly determination device 4 is capable of correctly determining whether the liquid pipe valve 15 and/or the gas pipe valve 16 is closed or not even though the second refrigerant path exists in the outdoor unit 10. As a result, the operator can be notified in the commissioning that the liquid pipe valve 15 and/or the gas pipe valve 16 is in the closed state even if the operator forgets to open the liquid pipe valve 15 and/or the gas pipe valve 16 in the installation work. Further, shortening of working hours is facilitated because, even if abnormal stoppage occurs in the commissioning, the operator can recognize that the abnormal stoppage has been caused by the closure of the liquid pipe valve 15 and/or the gas pipe valve 16.

Embodiment 2.

[0085] In Embodiment 1, the outdoor unit 10 having the configuration illustrated in Fig. 2, that is, the outdoor unit 10 including the subcool coil 17 and the expansion valve 18 for subcool coil and including the second refrigerant path illustrated in Fig. 4 has been described.

[0086] In the present embodiment, the outdoor unit 10 having another configuration will be described.

[0087] As for the present embodiment, differences from Embodiment 1 will be principally described.

[0088] Incidentally, particulars that will not be described below are similar to particulars of Embodiment 1.

[0089] Fig. 6 illustrates a configuration example of the air conditioner 1 according to the present embodiment.

[0090] The indoor units 20 and the connection pipes 30 are the same as those illustrated in Fig. 2 and description thereof is therefore omitted.

[0091] Further, the four-way valve 12, the outdoor heat exchanger 13, the outdoor unit fan 14, the liquid pipe valve 15, the gas pipe valve 16, the high-pressure sensor 41, and the low-pressure sensor 41 in the outdoor unit 10 are the same as those illustrated in Fig. 2 and description thereof is therefore omitted.

[0092] In the outdoor unit 10 illustrated in Fig. 6, an injection compressor 111 is provided in place of the compressor 11 illustrated in Fig. 2. The injection compressor 111 has a connection opening for intermediate pressure in addition to a connection opening for discharge pressure and a connection opening for inlet pressure.

[0093] Further, in the outdoor unit 10 illustrated in Fig. 6, an expansion valve 118 for injection is provided in place of the expansion valve 18 for subcool coil illustrated in Fig. 2. The expansion valve 118 for injection adjusts an injection amount to be injected from an injection pipe 119 into the intermediate pressure of the injection compressor 111. The expansion valve 118 for injection is equivalent to the second valve.

[0094] Further, in the outdoor unit 10 illustrated in Fig. 6, an economizer 117 is provided in place of the subcool coil 17 illustrated in Fig. 2. The economizer 117 recovers heat from liquid refrigerant having flowed out of the outdoor heat exchanger 13, by the refrigerant with the intermediate pressure.

[0095] In the outdoor unit 10 illustrated in Fig. 6, refrigeration cycle efficiency can be improved in the cooling operation by diverging of a portion of the liquid refrigerant having flowed out of the outdoor heat exchanger 13 and injection thereof into the intermediate pressure of the injection compressor 111.

[0096] Incidentally, the outdoor unit 10 is supposed to include a valve control mechanism that is not illustrated in Fig. 6 and that is to close the expansion valve 118 for injection based on a command signal.

[0097] In the outdoor unit 10 according to the present embodiment as well, a first refrigerant path and a second refrigerant path exist.

[0098] Fig. 7 illustrates the first refrigerant path according to the present embodiment, and Fig. 8 illustrates the second refrigerant path according to the present embodiment.

[0099] In the first refrigerant path of Fig. 7, the refrigerant that flows in from the indoor units 20 is returned through the gas pipe valve 16, the low-pressure sensor 42, the injection compressor 111, the high-pressure sensor 41, the outdoor heat exchanger 13, the economizer 117, and the liquid pipe valve 15 to the indoor units 20. The first refrigerant path makes the refrigerant circulate between the outdoor unit 10 and the indoor units 20.

[0100] In the present embodiment as well, the second refrigerant path is a path to make the refrigerant circulate in the outdoor unit 10. In the present embodiment, as illustrated in Fig. 8, the second refrigerant path is a path extending through the outdoor heat exchanger 13, the economizer 117, the expansion valve 118 for injection, the injection pipe 119, the injection compressor 111, and the high-pressure sensor 41.

[0101] In the outdoor unit 10 according to the present embodiment as well, the refrigerant is allowed to circulate through the second refrigerant path by the expansion valve 118 for injection being open even if the circulation of the refrigerant through the first refrigerant path is blocked by closure of the liquid pipe valve 15 and the gas pipe valve 16. When the refrigerant circulates through the second refrigerant path even though the liquid pipe valve 15 and the gas pipe valve 16 are closed, the high-low pressure difference does not increase to be greater than or equal to the threshold. Thus, there is a problem of failing to correctly determine a state of the liquid pipe valve 15 and/or the gas pipe valve 16 when the expansion valve 118 for injection is open.

[0102] A configuration of the anomaly determination device 4 according to the present embodiment is as illustrated in Fig. 1.

[0103] In the present embodiment as well, for solution of the above problem, the signal transmission unit 121

transmits to the outdoor unit 10, a command signal commanding closure of the expansion valve 118 for injection.

[0104] The outdoor unit 10 having received the command signal closes the expansion valve 118 for injection, if the expansion valve 118 for injection is open. The circulation of the refrigerant in a second refrigerant circuit is blocked by closure of the expansion valve 118 for injection.

[0105] In the present embodiment as well, blockage of the circulation of the refrigerant in the second refrigerant circuit by the closure of the expansion valve 118 for injection makes it possible for the determination unit 123 to correctly determine the state of the liquid pipe valve 15 and/or the gas pipe valve 16.

[0106] An example of operation of the anomaly determination device 4 according to the present embodiment is as illustrated in Fig. 5. Therefore, description of details of the operation of the anomaly determination device 4 according to the present embodiment is omitted.

[0107] Thus, the anomaly determination device 4 is capable of correctly determining whether the liquid pipe valve 15 and/or the gas pipe valve 16 is closed or not, even though the second refrigerant path having a configuration illustrated in Fig. 8 is included in the outdoor unit 10.

Embodiment 3.

[0108] In the present embodiment, the outdoor unit 10 having a configuration differing from configurations of Embodiment 1 and Embodiment 2 will be described.

[0109] As for the present embodiment, differences from Embodiment 1 will be principally described.

[0110] Incidentally, particulars that will not be described below are similar to particulars of Embodiment 1.

[0111] Fig. 9 illustrates a configuration example of the air conditioner 1 according to the present embodiment.

[0112] The indoor units 20 and the connection pipes 30 are the same as those illustrated in Fig. 2 and description thereof is therefore omitted.

[0113] Further, the compressor 11, the four-way valve 12, the outdoor heat exchanger 13, the outdoor unit fan 14, the liquid pipe valve 15, the gas pipe valve 16, the high-pressure sensor 41, and the low-pressure sensor 42 in the outdoor unit 10 are the same as those illustrated in Fig. 2 and description thereof is therefore omitted.

[0114] In the outdoor unit 10 according to the present embodiment, an oil separator 51, a capillary tube 52, and an oil return valve 53 are provided.

[0115] The oil separator 51 separates refrigerant oil included in the refrigerant discharged from the compressor 11.

[0116] The capillary tube 52 functions as a flow path resistance for adequate adjustment in flow rates of the refrigerant oil and the refrigerant to be returned from the oil separator 51 to an inlet side of the compressor 11.

[0117] The oil return valve 53 is opened during operation of the compressor 11. The oil return valve 53 is

equivalent to the second valve.

[0118] The refrigerant oil discharged from the compressor 11 is quickly recovered into the compressor 11 through an oil return path including the oil separator 51, the capillary tube 52, and the oil return valve 53. Thus, distribution throughout the refrigerant path of the refrigerant oil having flowed out of the outdoor unit 10, which may result in poor lubrication of the compressor 11, can be prevented. As a result, a refrigeration cycle that is highly reliable can be implemented.

[0119] Incidentally, the outdoor unit 10 is supposed to include a valve control mechanism that is not illustrated in Fig. 9 and that is to close the oil return valve 53 based on a command signal.

[0120] In the outdoor unit 10 according to the present embodiment as well, a first refrigerant path and a second refrigerant path exist.

[0121] Fig. 10 illustrates the first refrigerant path according to the present embodiment, and Fig. 11 illustrates the second refrigerant path according to the present embodiment.

[0122] In the first refrigerant path of Fig. 10, the refrigerant that flows in from the indoor units 20 is returned through the gas pipe valve 16, the low-pressure sensor 42, the compressor 11, the high-pressure sensor 41, the oil separator 51, the outdoor heat exchanger 13, and the liquid pipe valve 15 to the indoor units 20. The first refrigerant path makes the refrigerant circulate between the outdoor unit 10 and the indoor units 20.

[0123] In the present embodiment as well, the second refrigerant path is a path to make the refrigerant circulate in the outdoor unit 10. In the present embodiment, as illustrated in Fig. 11, the second refrigerant path is a path extending through the compressor 11, the high-pressure sensor 41, the oil separator 51, the capillary tube 52, the oil return valve 53, and the low-pressure sensor 42.

[0124] In the outdoor unit 10 according to the present embodiment as well, the refrigerant is allowed to circulate through the second refrigerant path by the oil return valve 53 being open even if the circulation of the refrigerant through the first refrigerant path is blocked by closure of the liquid pipe valve 15 and the gas pipe valve 16. When the refrigerant circulates through the second refrigerant path even though the liquid pipe valve 15 and the gas pipe valve 16 are closed, the high-low pressure difference does not increase to be greater than or equal to the threshold. Thus, there is a problem of failing to correctly determine a state of the liquid pipe valve 15 and/or the gas pipe valve 16 when the oil return valve 53 is open.

[0125] A configuration of the anomaly determination device 4 according to the present embodiment is as illustrated in Fig. 1.

[0126] In the present embodiment as well, for solution of the above problem, the signal transmission unit 121 transmits to the outdoor unit 10, a command signal commanding closure of the oil return valve 53.

[0127] The outdoor unit 10 having received the command signal closes the oil return valve 53, if the oil return

valve 53 is open. The circulation of the refrigerant in a second refrigerant circuit is blocked by closure of the oil return valve 53.

[0128] In the present embodiment as well, blockage of the circulation of the refrigerant in the second refrigerant circuit by the closure of the oil return valve 53 makes it possible for the determination unit 123 to correctly determine the state of the liquid pipe valve 15 and/or the gas pipe valve 16.

[0129] An example of operation of the anomaly determination device 4 according to the present embodiment is as illustrated in Fig. 5. Therefore, description of details of the operation of the anomaly determination device 4 according to the present embodiment is omitted.

[0130] Thus, the anomaly determination device 4 is capable of correctly determining whether the liquid pipe valve 15 and/or the gas pipe valve 16 is closed or not, even though the second refrigerant path having a configuration illustrated in Fig. 11 is included in the outdoor unit 10.

*** Supplementary description of hardware configuration ***

[0131] Lastly, supplementary description of a hardware configuration of the anomaly determination device 4 will be given.

[0132] The processor 120 illustrated in Fig. 1 is an IC (Integrated Circuit) to carry out processing.

[0133] The processor 120 is a CPU (Central Processing Unit), a DSP (Digital Signal Processor), or the like.

[0134] The communication instrument 110 illustrated in Fig. 1 is an electronic circuit to execute communication processing for data.

[0135] The communication instrument 110 is a communication chip or an NIC (Network Interface Card), for instance.

[0136] Further, an OS (Operating System) is stored in a storage device not illustrated in Fig. 1.

[0137] At least a portion of the OS is executed by the processor 120.

[0138] The processor 120 executes the programs that realize the functions of the signal transmission unit 121, the operation data acquisition unit 122, the determination unit 123, and the report unit 124, while executing at least the portion of the OS.

[0139] The processor 120 executes the OS and task management, memory management, file management, communication control, or the like is thereby carried out.

[0140] At least any of information, data, signal values, and variable values that indicate results of processing in the signal transmission unit 121, the operation data acquisition unit 122, the determination unit 123, and the report unit 124 is stored in at least any of a storage device, and a register and a cache memory in the processor 120.

[0141] Further, the programs that realize the functions of the signal transmission unit 121, the operation data acquisition unit 122, the determination unit 123, and the

report unit 124 may be stored in a portable storage medium such as a magnetic disc, a flexible disc, an optical disc, a compact disc, a Blu-ray (registered trademark) disc, or a DVD. Moreover, portable storage media in which the programs that realize the functions of the signal transmission unit 121, the operation data acquisition unit 122, the determination unit 123, and the report unit 124 are stored may be distributed.

[0142] Further, "unit" of the signal transmission unit 121, the operation data acquisition unit 122, the determination unit 123, and the report unit 124 may be read as "circuit", "step", "procedure", "process", or "circuitry".

[0143] Further, the anomaly determination device 4 may be implemented by a processing circuit. The processing circuit is a logic IC (Integrated Circuit), a GA (Gate Array), an ASIC (Application Specific Integrated Circuit), or an FPGA (Field-Programmable Gate Array), for instance.

[0144] In this case, the signal transmission unit 121, the operation data acquisition unit 122, the determination unit 123, and the report unit 124 are each implemented as a portion of the processing circuit.

[0145] Incidentally, a broader concept of processor and processing circuit is referred to as "processing circuitry", herein.

[0146] That is, processor and processing circuit are specific examples of "processing circuitry".

[0147] Embodiments 1 to 3 have been described above and two or more of these embodiments may be implemented in combination.

[0148] Alternatively, one of these embodiments may be partially implemented.

[0149] Alternatively, two or more of these embodiments may be implemented partially in combination.

[0150] Further, the configurations and procedures described as to these embodiments may be modified as appropriate.

Reference Signs List

[0151] 1: air conditioner; 2: command device; 3: display; 4: anomaly determination device; 10: outdoor unit; 11: compressor; 12: four-way valve; 13: outdoor heat exchanger; 14: outdoor unit fan; 15: liquid pipe valve; 16: gas pipe valve; 17: subcool coil; 18: expansion valve for subcool coil; 20: indoor unit; 21: expansion valve; 22: indoor heat exchanger; 23: indoor unit fan; 30: connection pipe; 41: high-pressure sensor; 42: low-pressure sensor; 51: oil separator; 52: capillary tube; 53: oil return valve; 110: communication instrument; 111: injection compressor; 117: economizer; 118: expansion valve for injection; 119: injection pipe; 120: processor; 121: signal transmission unit; 122: operation data acquisition unit; 123: determination unit; 124: report unit

Claims**1.** An inspection device comprising:

a signal transmission unit, when there exists in an outdoor unit a second refrigerant path which enables circulation of refrigerant in the outdoor unit even if circulation of the refrigerant through a first refrigerant path is blocked by closure of a first valve provided in the first refrigerant path which circulates the refrigerant between an indoor unit and the outdoor unit of an air conditioner, to transmit to the outdoor unit, a command signal commanding the outdoor unit to close a second valve which is provided in the second refrigerant path and closure of which blocks the circulation of the refrigerant through the second refrigerant path; and
a determination unit to determine whether the first valve is closed or not after the command signal is transmitted from the signal transmission unit to the outdoor unit.

2. The inspection device according to claim 1, wherein the determination unit determines whether the first valve is closed or not with use of at least either of a high pressure value and a low pressure value of the refrigerant in a compressor included in the outdoor unit.**3.** The inspection device according to claim 2, wherein the determination unit determines whether the first valve is closed or not by comparing any of the high pressure value, the low pressure value, and a pressure difference between the high pressure value and the low pressure value with a variable threshold that changes in accordance with an operating condition of the air conditioner.**4.** The inspection device according to claim 1, wherein when it is determined by the determination unit that the first valve is closed, the signal transmission unit transmits to the outdoor unit, a command signal commanding opening of the first valve.**5.** The inspection device according to claim 1, wherein the second refrigerant path is a refrigerant path in which a subcool coil is included and in which an expansion valve for subcool coil is provided as the second valve.**6.** The inspection device according to claim 1, wherein the second refrigerant path is a refrigerant circuit in which an economizer is included and in which an expansion valve for injection for adjustment of an injection amount to be injected into an injection compressor included in the outdoor unit is provided as the second valve.**7.** The inspection device according to claim 1, wherein the second refrigerant path is a refrigerant circuit which includes an oil separator to separate refrigerant oil included in the refrigerant discharged from a compressor included in the outdoor unit and a capillary tube to adjust flow rates of the refrigerant oil and the refrigerant to be returned from the oil separator to the compressor and in which an oil return valve to return the refrigerant oil and the refrigerant to the compressor is provided as the second valve.**8.** An inspection method comprising:

when there exists in an outdoor unit a second refrigerant path which enables circulation of refrigerant in the outdoor unit even if circulation of the refrigerant through a first refrigerant path is blocked by closure of a first valve provided in the first refrigerant path which circulates the refrigerant between an indoor unit and the outdoor unit of an air conditioner, transmitting, by a computer, to the outdoor unit, a command signal commanding the outdoor unit to close a second valve which is provided in the second refrigerant path and closure of which blocks the circulation of the refrigerant through the second refrigerant path; and

determining, by the computer, whether the first valve is closed or not after the command signal is transmitted to the outdoor unit.

Fig. 1

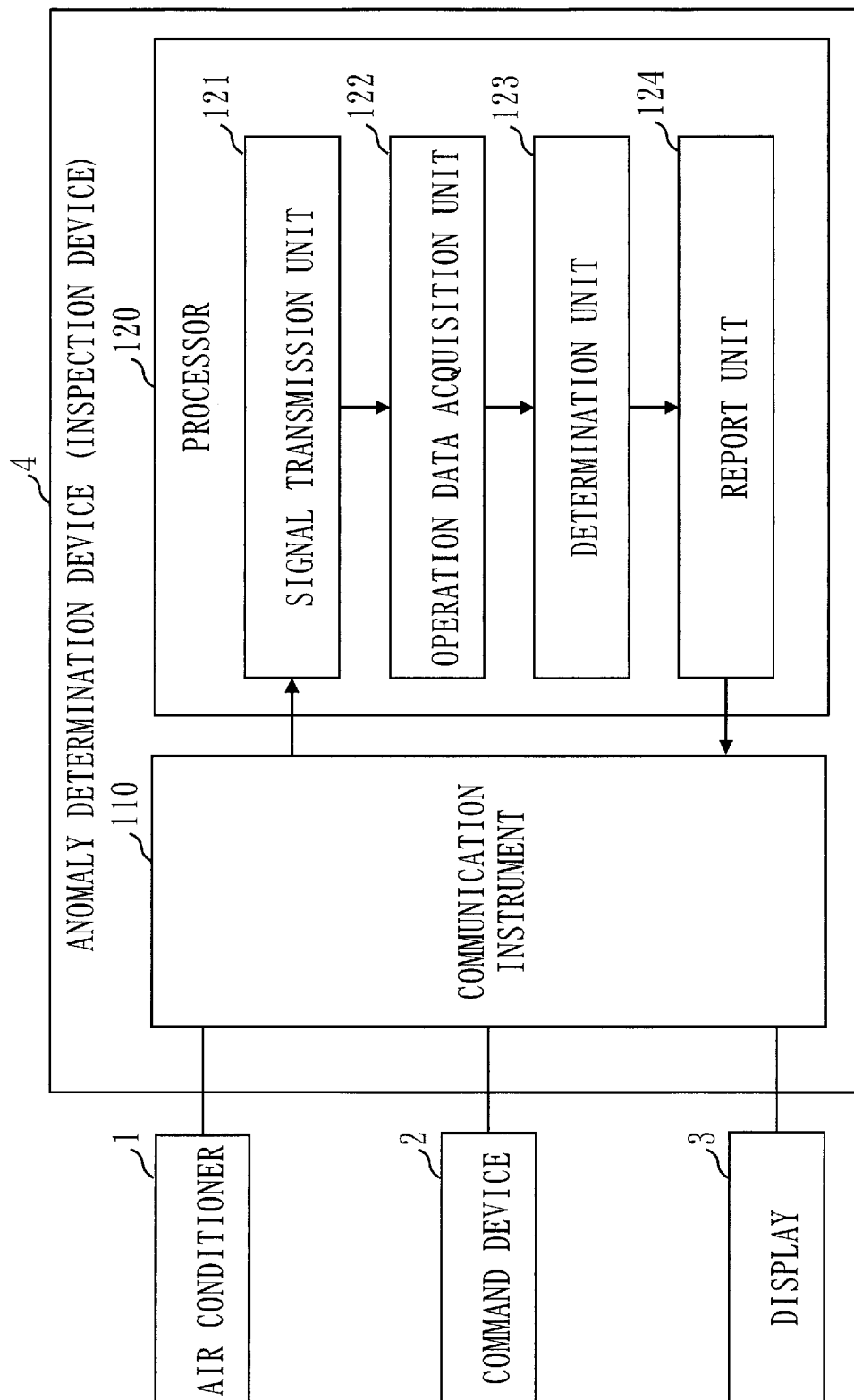


Fig. 2

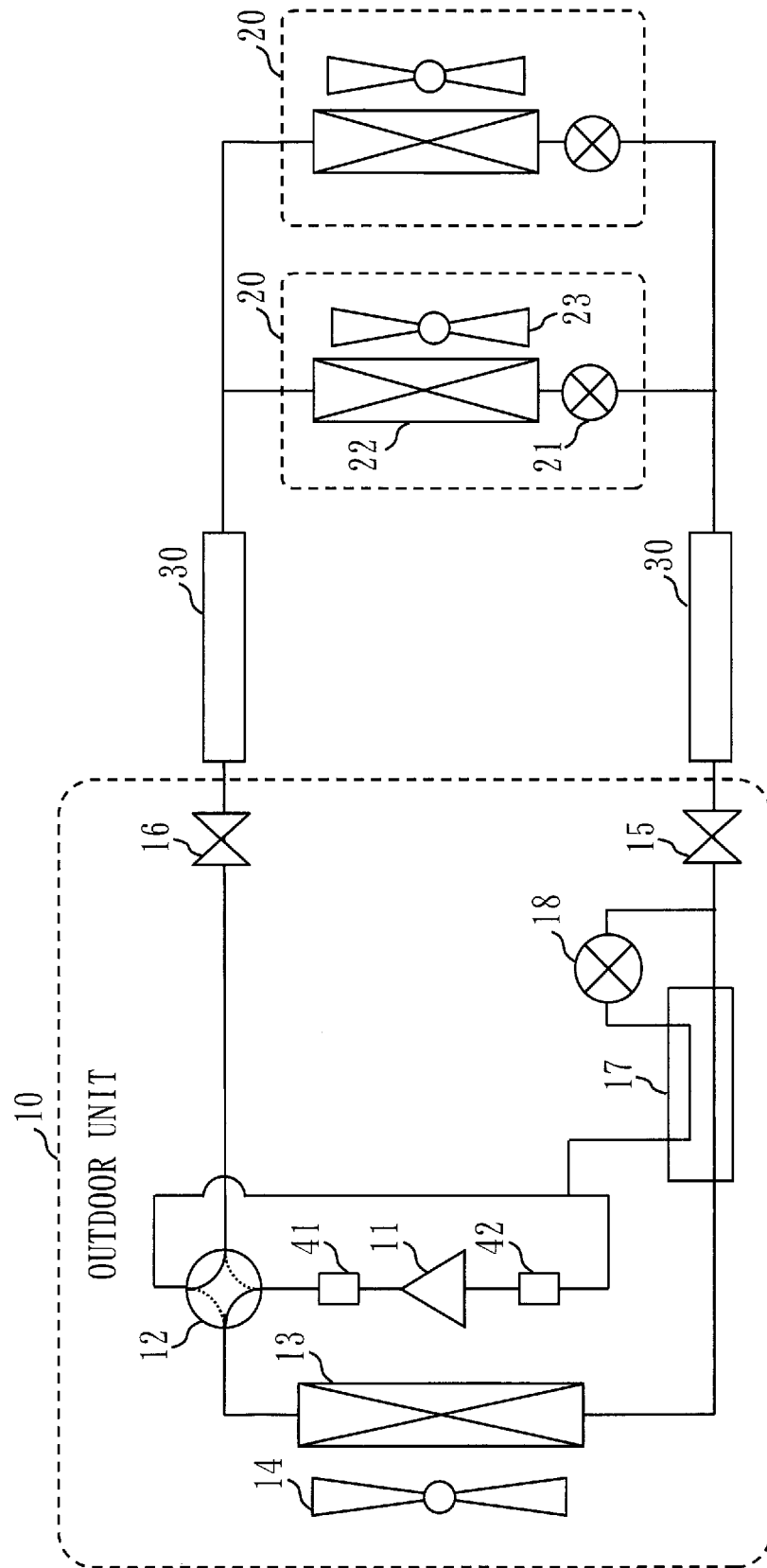


Fig. 3

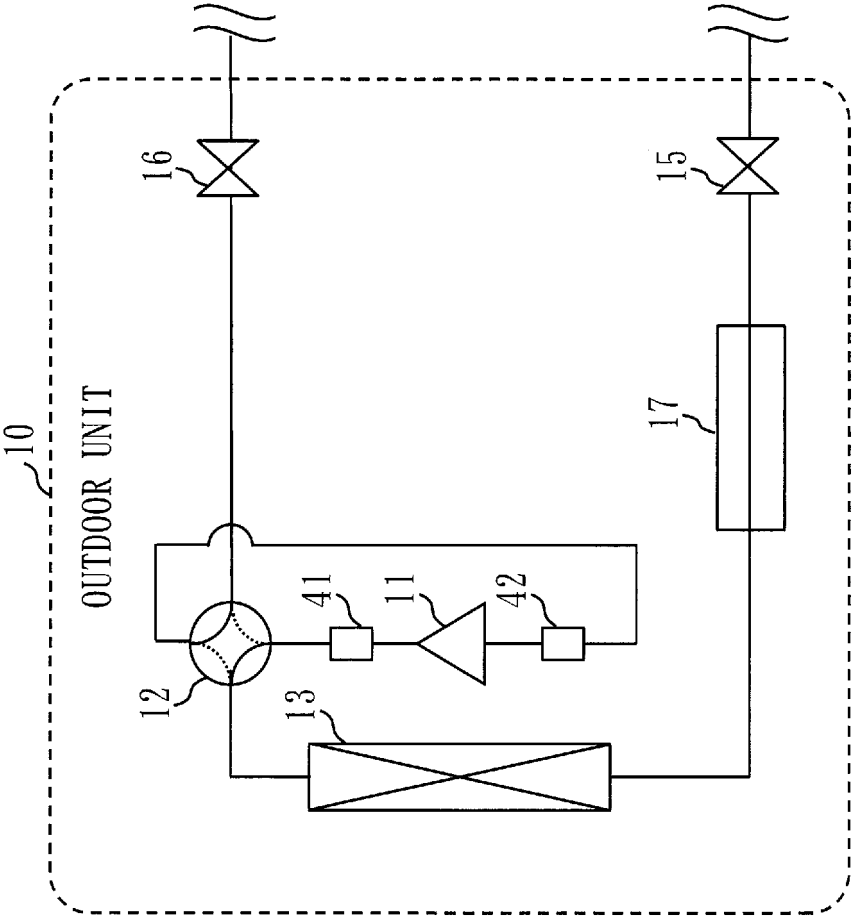


Fig. 4

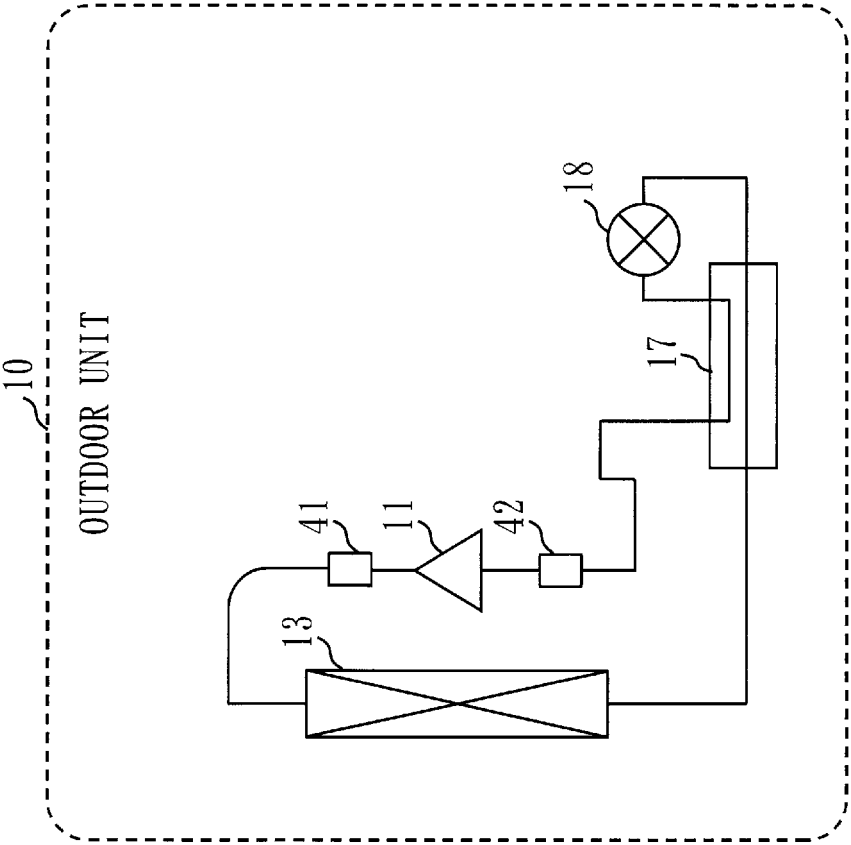


Fig. 5

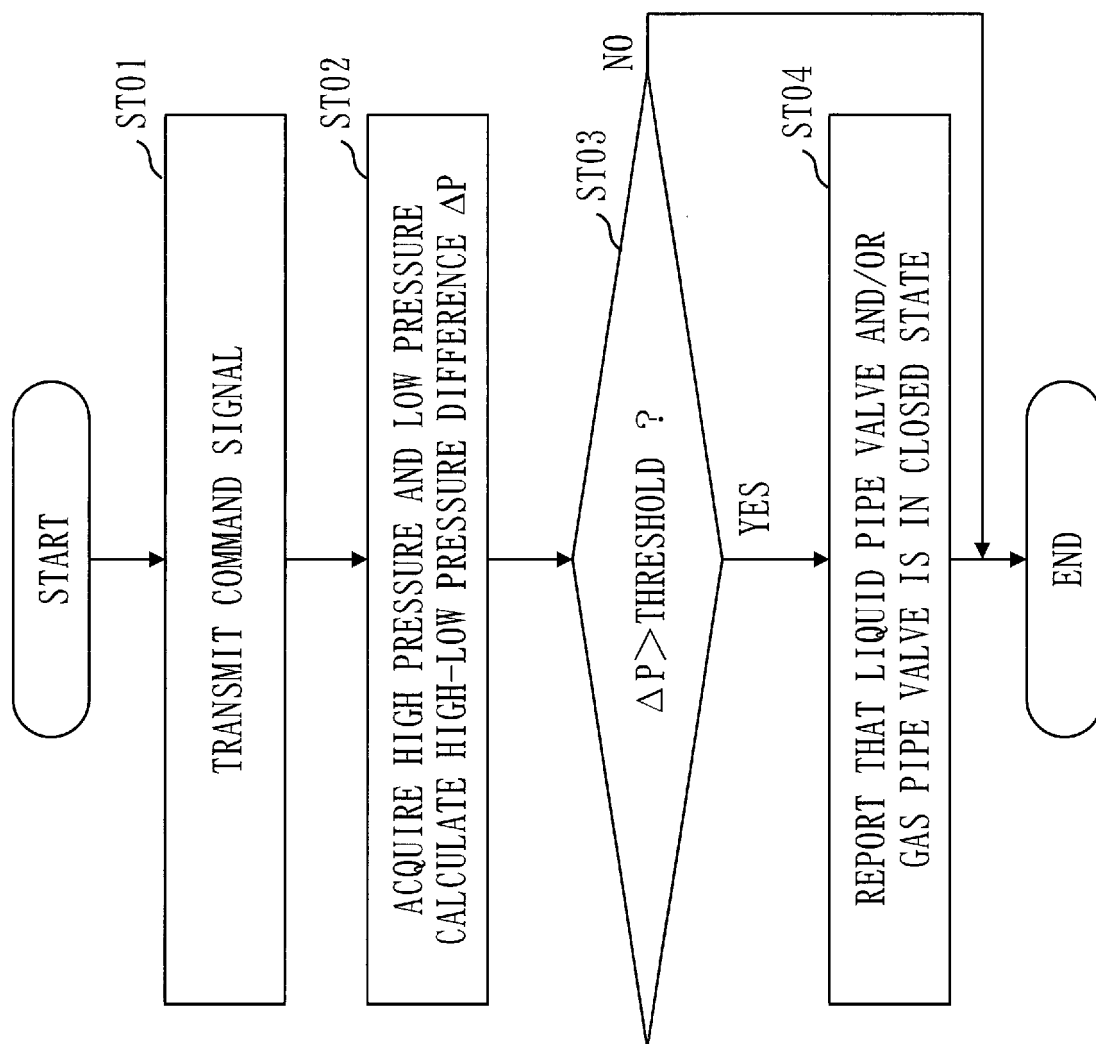


Fig. 6

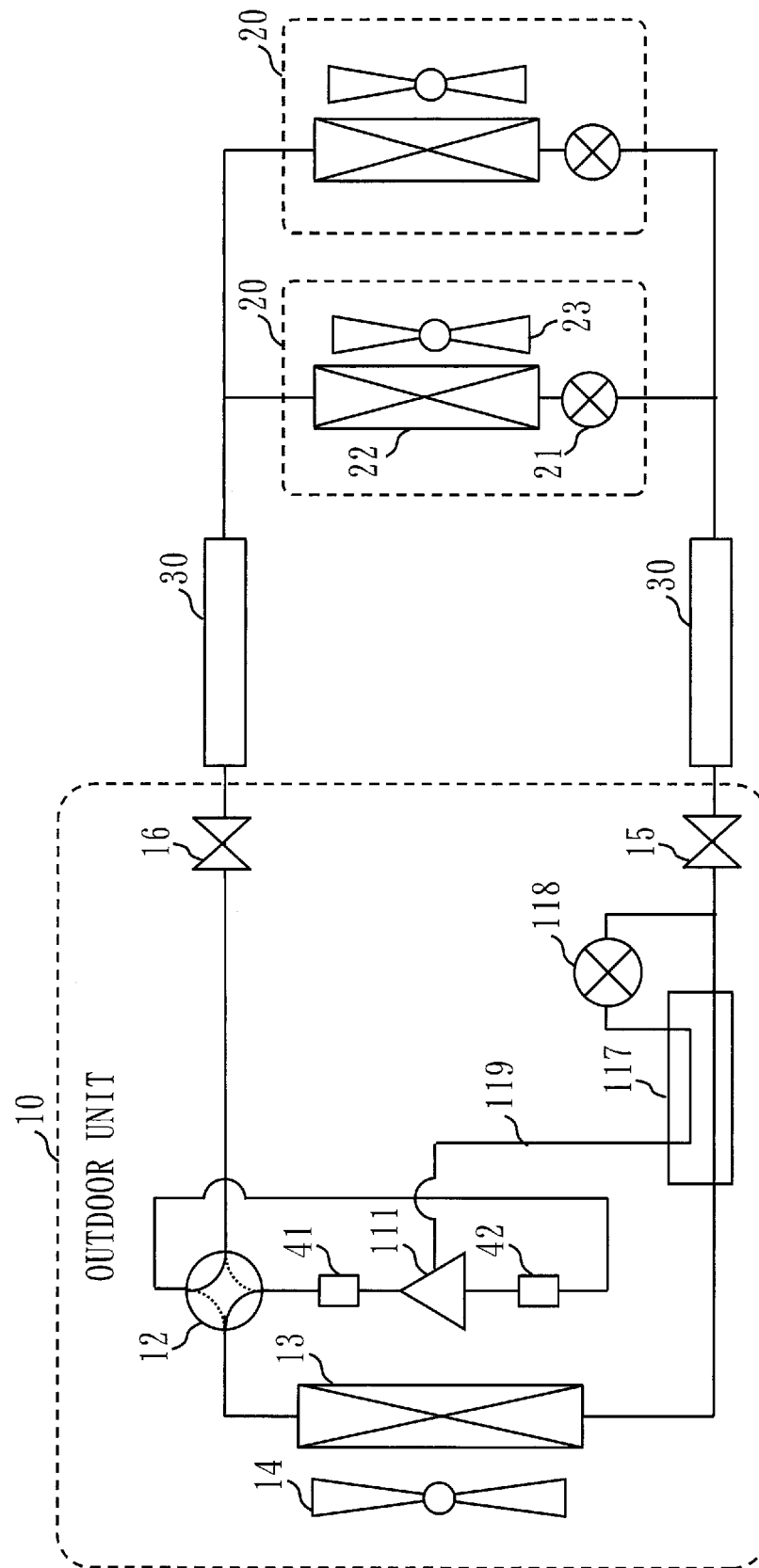


Fig. 7

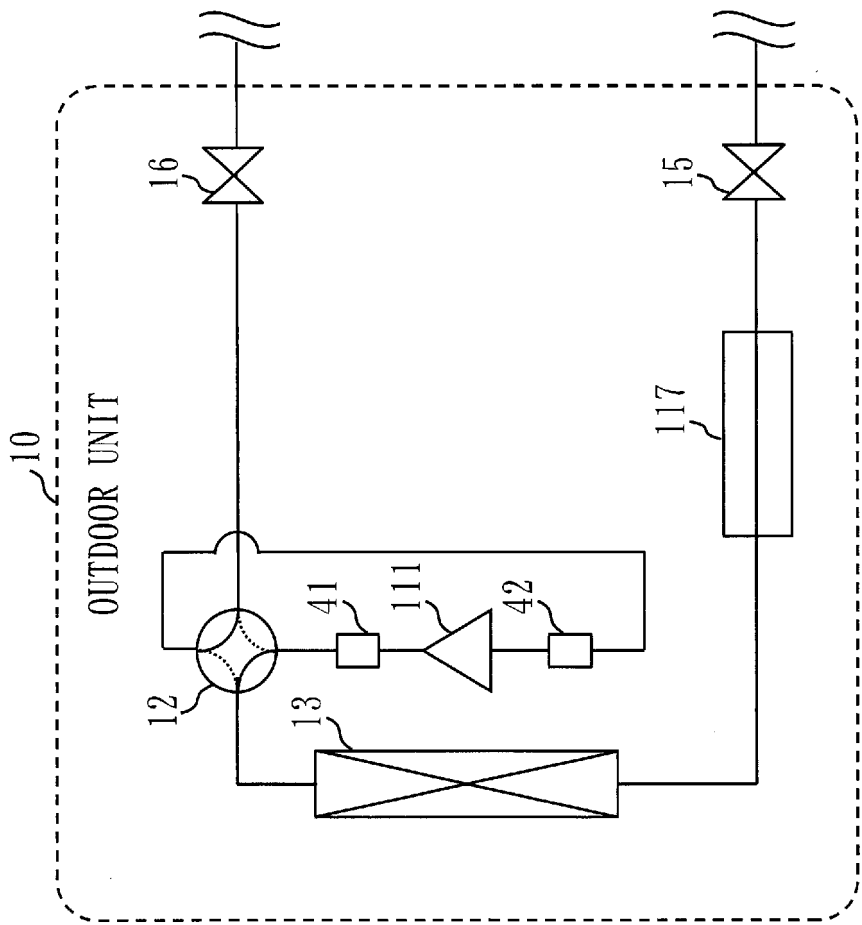


Fig. 8

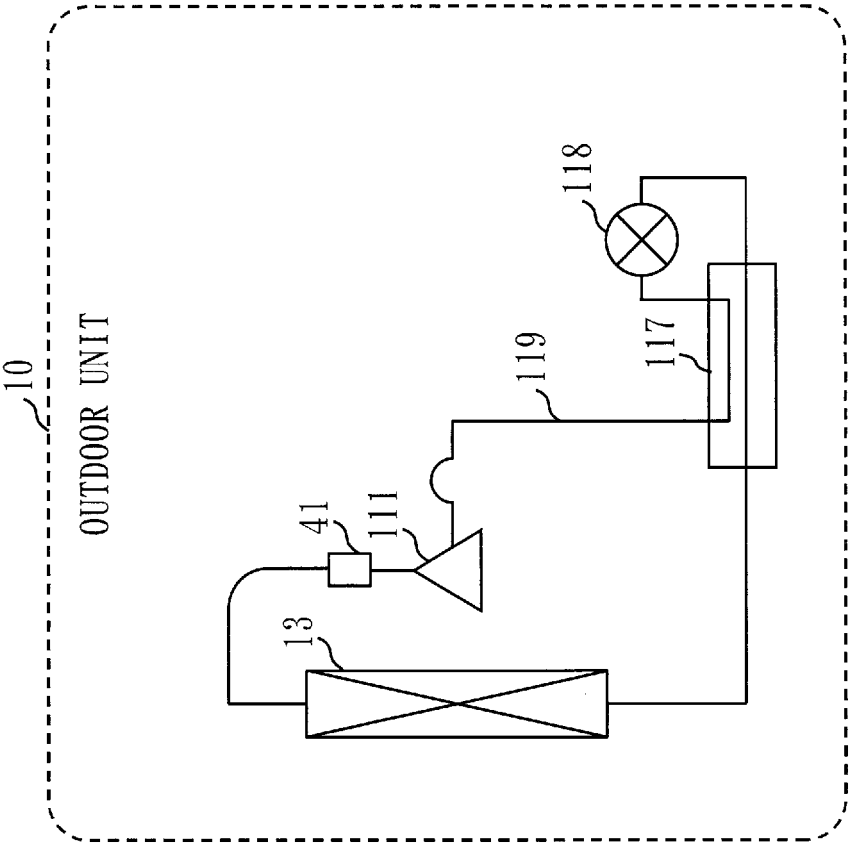


Fig. 9

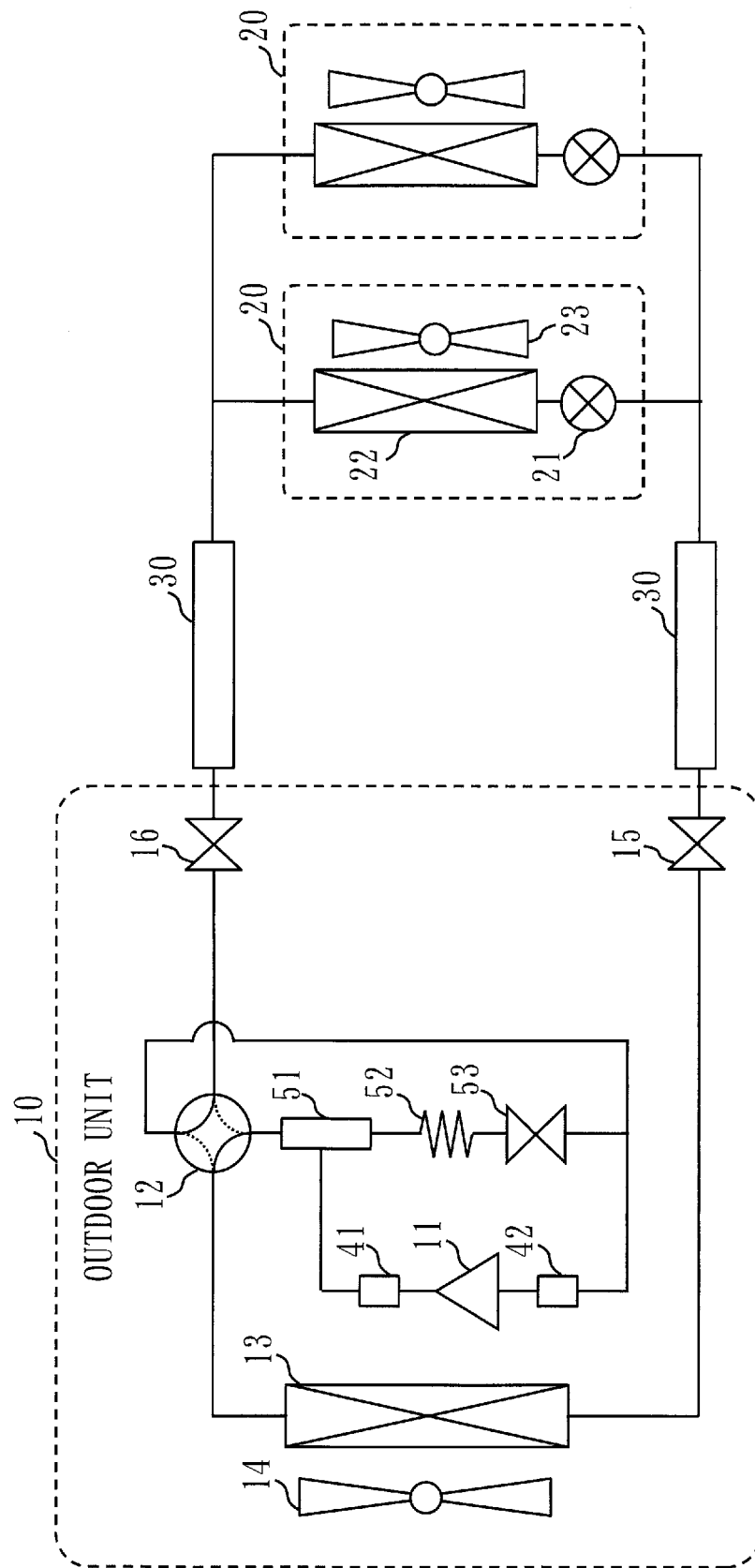


Fig. 10

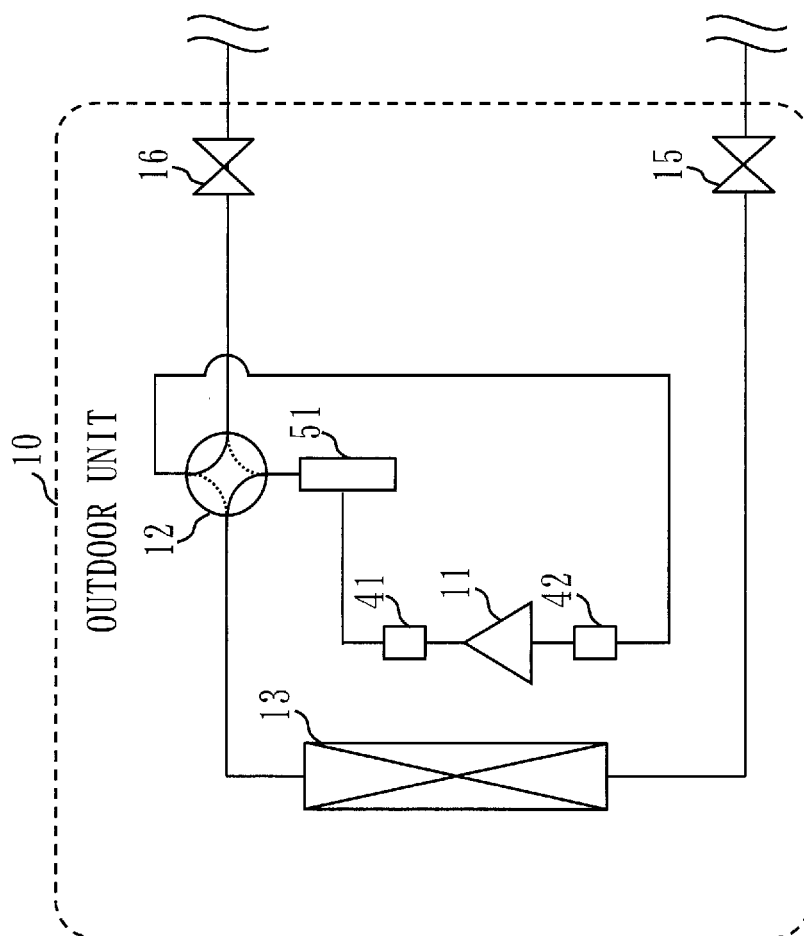
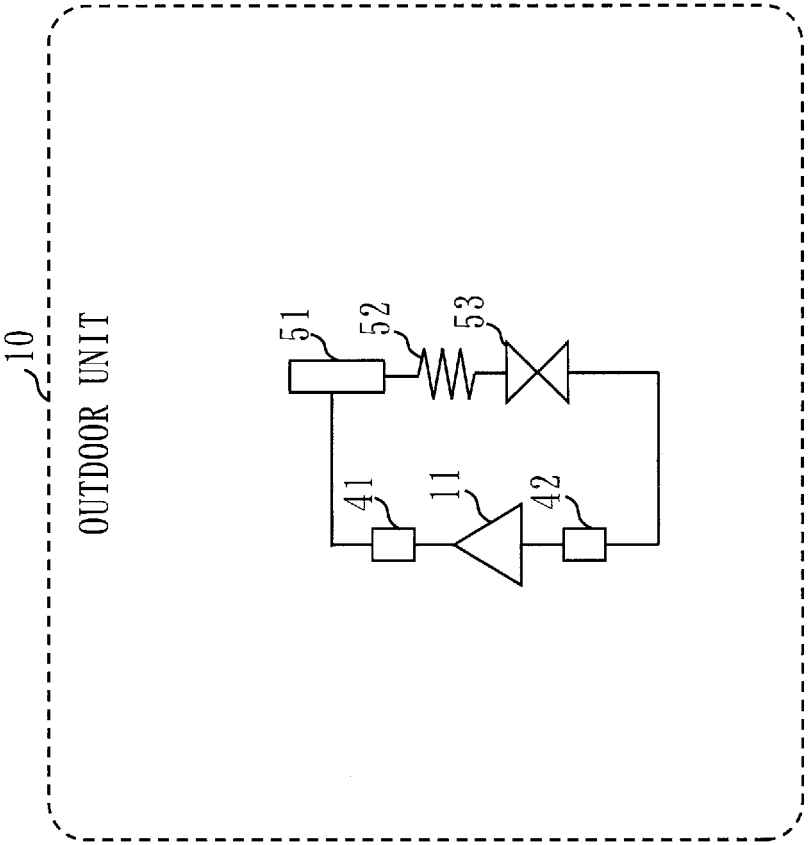


Fig. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/017742

A. CLASSIFICATION OF SUBJECT MATTER F24F 11/86 (2018.01)i FI: F24F11/86 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) F24F11/86 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Published examined utility model applications of Japan 1922-1996 Published unexamined utility model applications of Japan 1971-2021 Registered utility model specifications of Japan 1996-2021 Published registered utility model applications of Japan 1994-2021 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)															
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y</td> <td>JP 2008-175410 A (MITSUBISHI ELECTRIC CORP) 31 July 2008 (2008-07-31) paragraphs [0008]-[0075], fig. 1-6</td> <td>1-8</td> </tr> <tr> <td>Y</td> <td>JP 2001-280716 A (DAIKIN IND LTD) 10 October 2001 (2001-10-10) paragraphs [0006]-[0065], fig. 1-3</td> <td>1-8</td> </tr> <tr> <td>Y</td> <td>JP 2002-107015 A (DAIKIN IND LTD) 10 April 2002 (2002-04-10) paragraphs [0006]-[0060], fig. 1-3</td> <td>1-8</td> </tr> <tr> <td>A</td> <td>WO 2020/245918 A1 (MITSUBISHI ELECTRIC CORP) 10 December 2020 (2020-12-10) paragraphs [0010]-[0111], fig. 1-11</td> <td>1-8</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	JP 2008-175410 A (MITSUBISHI ELECTRIC CORP) 31 July 2008 (2008-07-31) paragraphs [0008]-[0075], fig. 1-6	1-8	Y	JP 2001-280716 A (DAIKIN IND LTD) 10 October 2001 (2001-10-10) paragraphs [0006]-[0065], fig. 1-3	1-8	Y	JP 2002-107015 A (DAIKIN IND LTD) 10 April 2002 (2002-04-10) paragraphs [0006]-[0060], fig. 1-3	1-8	A	WO 2020/245918 A1 (MITSUBISHI ELECTRIC CORP) 10 December 2020 (2020-12-10) paragraphs [0010]-[0111], fig. 1-11	1-8
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.													
Y	JP 2008-175410 A (MITSUBISHI ELECTRIC CORP) 31 July 2008 (2008-07-31) paragraphs [0008]-[0075], fig. 1-6	1-8													
Y	JP 2001-280716 A (DAIKIN IND LTD) 10 October 2001 (2001-10-10) paragraphs [0006]-[0065], fig. 1-3	1-8													
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A	WO 2020/245918 A1 (MITSUBISHI ELECTRIC CORP) 10 December 2020 (2020-12-10) paragraphs [0010]-[0111], fig. 1-11	1-8													
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex. * Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family															
Date of the actual completion of the international search 24 June 2021	Date of mailing of the international search report 06 July 2021														
Name and mailing address of the ISA/JP Japan Patent Office (ISA/JP) 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915 Japan	Authorized officer Telephone No.														

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/JP2021/017742

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REFERENCES CITED IN THE DESCRIPTION

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