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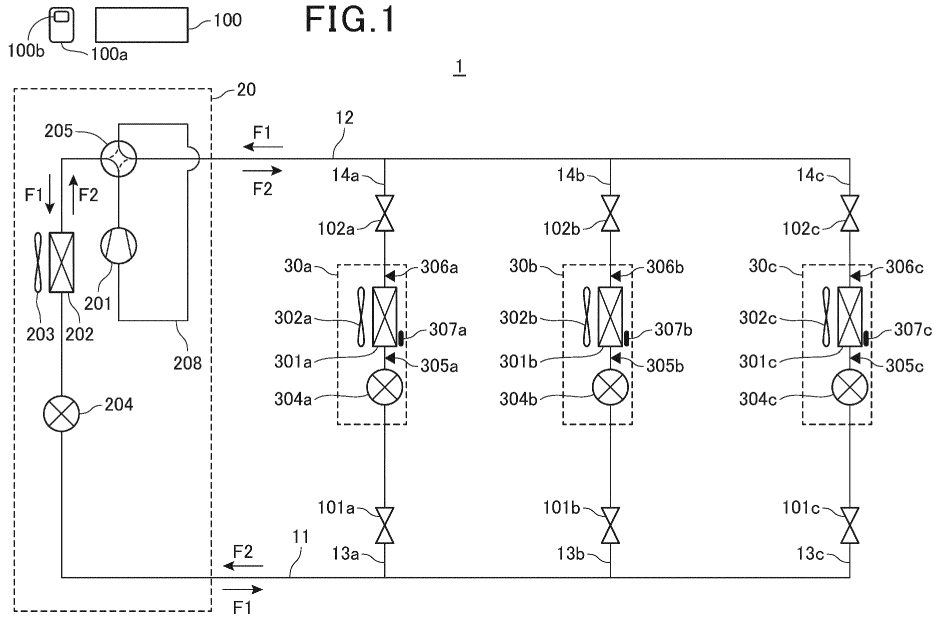
(54) AIR CONDITIONING APPARATUS

(57) An air conditioning apparatus suppresses sticking of an opening and closing device and suppresses an amount of refrigerant leakage from an indoor unit. In an air conditioning apparatus 1 including an outdoor unit 20 having a compressor 201, an indoor unit 30 having a use side heat exchanger 301, a refrigerant pipes 11, 12, 13, and 14 connecting the outdoor unit 20 and the indoor unit 30, opening and closing devices 101 and 102 disposed in the refrigerant pipes 13 and 14, and a controller 100, the controller 100 executes a sticking prevention operation in which the opening and closing devices 101 and 102 are opened and closed when a refrigerant is not leaking.

FIG.1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an air conditioning apparatus.

Description of the Related Art

[0002] In a conventional air conditioning apparatus, a configuration has been known in which an opening and closing device is provided in a refrigerant pipe, and in which when refrigerant leakage occurs, the amount of refrigerant leakage is suppressed (see, for example, International Publication No. WO 2017/203606). In International Publication No. WO 2017/203606, during a cooling operation, when a refrigerant flowing through a liquid side pipe is brought into a gas-liquid two-phase state by controlling an expansion device of an outdoor unit, and refrigerant leakage is detected, an upstream opening and closing device and a downstream opening and closing device of an indoor heat exchanger are closed to further reduce the amount of refrigerant leakage.

[0003] However, in such a conventional air conditioning apparatus, the opening and closing device is not closed unless refrigerant leakage occurs. This may cause sticking due to not closing the opening and closing device for a long time. If the sticking of the opening and closing device occurs, the opening and closing device cannot be closed when refrigerant leakage occurs, and the amount of refrigerant leakage from an indoor unit may increase.

[0004] The present invention has been made in view of the above-described circumstances and has an object to provide an air conditioning apparatus which suppresses sticking of an opening and closing device and suppresses the amount of refrigerant leakage from an indoor unit.

SUMMARY OF THE INVENTION

[0005] In order to solve the problem, the present invention is an air conditioning apparatus including an outdoor unit having a compressor, an indoor unit having a use side heat exchanger, a refrigerant pipe connecting the outdoor unit and the indoor unit, an opening and closing device disposed in the refrigerant pipe, and a controller, wherein the controller executes a sticking prevention operation in which the opening and closing device is opened and closed when a refrigerant is not leaking.

[0006] According to this, even when the refrigerant is not leaking, the opening and closing device is opened and closed, so that sticking of the opening and closing device can be suppressed.

[Advantageous Effect of Invention]

[0007] According to the present invention, sticking of the opening and closing device can be suppressed, so that it becomes easier to appropriately operate the opening and closing device when refrigerant leakage occurs, thereby effectively suppressing the refrigerant amount leaking from the indoor unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a view illustrating a configuration of an air conditioning apparatus according to a first embodiment;
Fig. 2 is a block diagram of a controller of the air conditioning apparatus according to the first embodiment;
Fig. 3 is a flowchart illustrating a sticking prevention shifting determination action of the air conditioning apparatus of the first embodiment;
Fig. 4 is a flowchart illustrating a sticking prevention action of the air conditioning apparatus;
Fig. 5 is a flowchart illustrating an abnormality detection shifting determination action of the air conditioning apparatus of the first embodiment;
Fig. 6 is a flowchart illustrating an abnormality detection action of an opening and closing device of the air conditioning apparatus;
Fig. 7 is a flowchart illustrating the remainder of Fig. 6;
Fig. 8 is a flowchart illustrating a refrigerant leakage detection action of the air conditioning apparatus of the first embodiment;
Fig. 9 is a flowchart illustrating a sticking prevention shifting determination action of an air conditioning apparatus of a second embodiment;
Fig. 10 is a flowchart illustrating a sticking prevention shifting determination action of an air conditioning apparatus of a third embodiment; and
Fig. 11 is a flowchart illustrating an abnormality detection shifting determination action of an air conditioning apparatus of a fourth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] A first invention is an air conditioning apparatus including an outdoor unit having a compressor, an indoor unit having a use side heat exchanger, a refrigerant pipe connecting the outdoor unit and the indoor unit, an opening and closing device disposed in the refrigerant pipe, and a controller, wherein the controller executes a sticking prevention operation in which the opening and closing device is opened and closed when a refrigerant is not leaking.

[0010] This can prevent a case where the opening and

closing device does not open and close for a long time, thereby suppressing sticking of the opening and closing device. Thus, it becomes easier to appropriately operate the opening and closing device when refrigerant leakage occurs, and the refrigerant amount leaking from the indoor unit can be suppressed effectively.

[0011] In a second invention, the refrigerant pipe has a liquid side pipe and a gas side pipe, and the opening and closing device has a first opening and closing device that opens and closes the liquid side pipe connected to the indoor unit, and a second opening and closing device that opens and closes the gas side pipe connected to the indoor unit.

[0012] This enables to open and close each of the liquid side pipe and the gas side pipe which are connected to the indoor unit, thereby effectively suppressing the refrigerant amount leaking from the indoor unit when refrigerant leakage occurs.

[0013] In a third invention, the controller executes the sticking prevention operation in which the first opening and closing device and the second opening and closing device are opened and closed.

[0014] This can prevent a case where the first opening and closing device and the second opening and closing device do not open and close for a long time, thereby suppressing sticking of the first opening and closing device and the second opening and closing device. Thus, when refrigerant leakage occurs, the liquid side pipe and the gas side pipe which are connected to the indoor unit can be opened and closed appropriately.

[0015] In a fourth invention, the liquid side pipe is provided with an expansion device that controls a refrigerant flow rate between the first opening and closing device and the use side heat exchanger.

[0016] Thus, the refrigerant flow rate flowing through the use side heat exchanger can be controlled by the expansion device.

[0017] In a fifth invention, provided is a plurality of the indoor units disposed in parallel, wherein the first opening and closing device and the second opening and closing device are provided in each of the indoor units, and the expansion device is provided in each of the indoor units.

[0018] Thus, the air conditioning apparatus including the plurality of indoor units disposed in parallel can effectively suppress the refrigerant amount leaking from each of the indoor units.

[0019] In a sixth invention, the controller, when executing the sticking prevention operation, if the compressor is stopped, executes the sticking prevention operation of the opening and closing devices of all of the indoor units.

[0020] Thus, in all of the indoor units, while an impact received from the refrigerant flow is suppressed, the sticking prevention operation of the opening and closing devices can be executed.

[0021] In a seventh invention, the controller, when executing the sticking prevention operation, if the compressor is in operation and the indoor unit out of operation is present, controls opening of the expansion device of the indoor unit out of operation, controls closing of the expansion device of the indoor unit in operation, and executes the sticking prevention operation of the opening and closing device of the indoor unit in operation.

[0022] This makes it easier to increase the refrigerant flow rate in the indoor unit out of operation and reduce the refrigerant flow rate in the indoor unit in operation. Thus, the opening and closing device corresponding to the indoor unit in operation can be opened and closed so as to be less likely to receive an impact from the refrigerant flow. Furthermore, the refrigerant can flow by using the indoor unit out of operation, so that an excessive pressure rise of a refrigerant circuit can be suppressed even when the opening and closing device is opened and closed.

[0023] In an eighth invention, the controller, when executing the sticking prevention operation, if the compressor is in operation and there is a plurality of the indoor units in operation, controls closing of the expansion device of a first indoor unit in operation and executes the sticking prevention operation of the opening and closing device of the first indoor unit in operation, then the controller controls closing of the expansion device of a second indoor unit in operation and executes the sticking prevention operation of the opening and closing device of the second indoor unit in operation.

[0024] Thus, when the sticking prevention operation is executed, if the compressor is in operation and there is the plurality of indoor units in operation, the indoor units are divided into the first indoor unit in operation and the second indoor unit in operation, and the sticking prevention operation is executed. Thus, when the sticking prevention operation of the opening and closing device of one of the first and second indoor units in operation is executed, the refrigerant can flow by using the other of the first and second indoor units in operation, so that an excessive pressure rise of the refrigerant circuit can be suppressed.

[0025] In a ninth invention, the controller, when executing the sticking prevention operation, executes the sticking prevention operation of the opening and closing device of the indoor unit out of operation.

[0026] Thus, when the compressor is in operation, the sticking prevention operation of the opening and closing device of the indoor unit out of operation can be executed.

[0027] In a tenth invention, the controller, after elapse of a first predetermined time from execution of the sticking prevention operation, executes the sticking prevention operation again.

[0028] Thus, the sticking prevention operation can be executed at an interval of the first predetermined time, and the sticking prevention operation can be executed at a necessary and sufficient frequency.

[0029] In an eleventh invention, the controller, when an operation frequency of the compressor is equal to or less than a predetermined value, executes the sticking prevention operation.

[0030] Thus, the opening and closing device is easily opened and closed in a state where the refrigerant flow rate is small, and the opening and closing device is less likely to receive an impact from the refrigerant flow.

[0031] In a twelfth invention, provided is an input unit that inputs permission to shift to the sticking prevention operation, wherein the controller, when detecting an input of the input unit, executes the sticking prevention operation.

[0032] Thus, the permission to shift to the sticking prevention operation can be input to the controller. This can permit the controller to shift to the sticking prevention operation, at any timing.

[0033] In a thirteenth invention, the controller executes abnormality determination control in which closing of at least one of the first opening and closing device and the second opening and closing device is controlled in a state where the expansion device is opened and in which an abnormal state of an opening and closing device controlled to close out of the first opening and closing device and the second opening and closing device is determined.

[0034] Thus, the abnormal states of the first opening and closing device and the second opening and closing device can be determined by whether the refrigerant flowing through the indoor unit is blocked by the opening and closing device controlled to close.

[0035] In a fourteenth invention, provided are a first temperature sensor which is disposed in the liquid side pipe between the first opening and closing device and the use side heat exchanger and detects a refrigerant temperature, and a second temperature sensor which is disposed in the gas side pipe between the second opening and closing device and the use side heat exchanger and detects a refrigerant temperature, wherein in the abnormality determination control, the controller controls opening of one of the first opening and closing device and the second opening and closing device, controls closing of the other opening and closing device, and determines that, when a differential value between the temperatures detected by the first temperature sensor and the second temperature sensor is higher than a predetermined temperature, the other opening and closing device is in the abnormal state.

[0036] This enables to detect the refrigerant temperature between the first opening and closing device and the use side heat exchanger and the refrigerant temperature between the second opening and closing device and the use side heat exchanger. Thus, whether the refrigerant is blocked is determined based on the temperature difference between the liquid side and gas side of the use side heat exchanger, so that the abnormal state of the opening and closing device can be determined.

[0037] In a fifteenth invention, in the abnormality determination control, the controller throttles the expansion device, controls opening of an opening and closing device on an upstream side of a refrigerant flow direction between the first opening and closing device and the second opening and closing device, controls closing of an opening and closing device on a downstream side of the refrigerant flow direction between the first opening and closing device and the second opening and closing device, and determines whether the opening and closing device on the downstream side is in the abnormal state.

[0038] Thus, the closing of the opening and closing device on the downstream side of the refrigerant flow direction is controlled in a state where the refrigerant flow rate flowing to the opening and closing device on the downstream side is reduced by the expansion device, so that an impact which the opening and closing device receives from the refrigerant can be suppressed.

[0039] In a sixteenth invention, in the abnormality determination control, the controller, after determining whether the opening and closing device on the downstream side is in the abnormal state, controls opening of the opening and closing device on the downstream side, controls closing of the opening and closing device on the upstream side, and determines whether the opening and closing device on the upstream side is in the abnormal state.

[0040] This also enables to determine the abnormal state of the opening and closing device on the upstream side of the refrigerant flow direction.

[0041] In a seventeenth invention, in the abnormality determination control, the controller, when determining that the opening and closing device is in the abnormal state, notifies that the opening and closing device is in the abnormal state.

[0042] This can make it easier to recognize that the opening and closing device is in the abnormal state.

[0043] In an eighteenth invention, the controller, when an operation frequency of the compressor is equal to or less than a predetermined value, if a second predetermined time has elapsed from execution of the abnormality determination control, executes the abnormality determination control again.

[0044] Thus, when an impact received from the refrigerant flow is small, the opening and closing device is opened and closed, so that the abnormality determination control can be executed. Furthermore, excessive execution of the abnormality determination control can be suppressed.

[0045] In a nineteenth invention, provided is a second input unit that inputs permission to shift to the abnormality determination control, wherein the controller, when detecting an input of the second input unit, executes the abnormality determination control.

[0046] This can permit the controller to shift to the abnormality determination control, at any timing.

[0047] In a twentieth invention, in the abnormality determination control, the controller, when determining that at least one of the first opening and closing device and the second opening and closing device is in the abnormal state, controls closing of the expansion device.

[0048] Thus, when the opening and closing device is in the abnormal state, the closing of the expansion device

is controlled, so that the refrigerant flow can be regulated.

[0049] In a twenty-first invention, the indoor unit includes a refrigerant leakage sensor that detects a refrigerant concentration, and the controller, when the concentration detected by the refrigerant leakage sensor is equal to or more than a predetermined value, controls an operation frequency of the compressor so as to be equal to or less than a predetermined value and then closes the opening and closing device.

[0050] Thus, after the detection of refrigerant leakage, the closing of the opening and closing device is controlled in a state where the operation frequency of the compressor is lowered and the refrigerant flow rate flowing through the refrigerant circuit is small, so that an impact of the refrigerant which is transmitted to the opening and closing device is suppressed. Thus, a risk of damage to the opening and closing device can be reduced, and action reliability of the opening and closing device can be enhanced.

[0051] In a twenty-second invention, the controller, when the concentration detected by the refrigerant leakage sensor is equal to or more than a predetermined value, controls closing of the expansion device and then closes the opening and closing device.

[0052] Thus, after the detection of refrigerant leakage, the closing of the opening and closing device is controlled in a state where the closing of the expansion device is controlled and the refrigerant flow rate flowing through the refrigerant circuit is small, so that an impact of the refrigerant which is transmitted to the opening and closing device is suppressed. Thus, the risk of damage to the opening and closing device can be reduced, and the action reliability of the opening and closing device can be enhanced.

[0053] Hereinafter, an embodiment of the present invention will be described with reference to the drawings.

[1. First Embodiment]

[0054] Fig. 1 is a view illustrating a configuration of an air conditioning apparatus 1 according to a first embodiment.

[0055] The air conditioning apparatus 1 includes an outdoor unit 20 and a plurality of indoor units 30a, 30b, and 30c. The indoor units 30a, 30b, and 30c are each connected to the outdoor unit 20 in parallel by a liquid side pipe 11 and a gas side pipe 12. The liquid side pipe 11 includes liquid side pipes 13a, 13b, and 13c which branch therefrom and are connected to the respective indoor units 30a, 30b, and 30c. The gas side pipe 12 includes gas side pipes 14a, 14b, and 14c which branch therefrom and are connected to the respective indoor units 30a, 30b, and 30c. The air conditioning apparatus 1 causes a refrigerant compressed in the outdoor unit 20 to flow between the outdoor unit 20 and the indoor units 30a, 30b, and 30c and air-conditions a conditioning target space in which the indoor units 30a, 30b, and 30c are installed.

[0056] Since the indoor units 30a, 30b, and 30c are configured similarly, in the following description, corresponding elements in the indoor units 30a, 30b, and 30c are denoted by the same numeral signs and distinguished from each other by being denoted by subscripts a, b, and c. Furthermore, when there is no need to specifically distinguish such corresponding elements, only the numeral signs are used, and the subscripts a, b, and c may be omitted.

[0057] The outdoor unit 20 includes a compressor 201 that compresses a refrigerant, an outdoor heat exchanger 202 that exchanges heat of the refrigerant, an outdoor fan 203, an expansion valve 204, and a switching valve 205.

[0058] The compressor 201 draws the refrigerant from a suction pipe 208 and compresses and discharges the refrigerant.

[0059] The outdoor heat exchanger 202 exchanges heat between the refrigerant and outdoor air in the outdoor unit 20.

[0060] The outdoor fan 203 sends air to the outdoor heat exchanger 202.

[0061] The expansion valve 204 decompresses and expands a high-pressure refrigerant. The expansion valve 204 is configured so that an opening degree thereof is adjustable. The opening degree of the expansion valve 204 is controlled by a controller 100. The expansion valve 204 may be a valve whose opening degree is adjustable and which can block the refrigerant.

[0062] The switching valve 205 is configured by, for example, a four-way valve. The switching valve 205 switches flows of the discharged refrigerant of the compressor 201 and a refrigerant returning to the compressor 201. The switching valve 205 switches a cooling operation mode and a heating operation mode of the air conditioning apparatus 1.

[0063] The indoor unit 30 includes an indoor heat exchanger 301, an indoor fan 302, an indoor expansion valve 304, a first temperature sensor 305, a second temperature sensor 306, and a refrigerant leakage sensor 307.

[0064] The indoor heat exchanger 301 exchanges heat between a refrigerant supplied through the liquid side pipe 11 or the gas side pipe 12 from the outdoor unit 20 and indoor air. The indoor heat exchanger 301 corresponds to an example of a use side heat exchanger.

[0065] The indoor fan 302 sends air to the indoor heat exchanger 301.

[0066] The indoor expansion valve 304 is an expansion valve disposed in the liquid side pipe 11 between the expansion valve 204 and the indoor heat exchanger 301. In the present embodiment, the indoor expansion valve 304 is disposed in the liquid side pipe 13 connected to the indoor heat exchanger 301. The indoor expansion valve 304 is configured similarly to the expansion valve 204. The indoor expansion valve 304 corresponds to an example of an expansion device.

[0067] The liquid side pipe 13 of the indoor heat ex-

changer 301 is provided with the first temperature sensor 305. In the present embodiment, the first temperature sensor 305 is provided in a connection unit by which the liquid side pipe 13 is connected to the indoor heat exchanger 301. The first temperature sensor 305 detects a refrigerant temperature and inputs a detection signal to the controller 100.

[0068] The gas side pipe 14 of the indoor heat exchanger 301 is provided with the second temperature sensor 306. In the present embodiment, the second temperature sensor 306 is provided in a connection unit by which the gas side pipe 14 is connected to the indoor heat exchanger 301. The second temperature sensor 306 detects a refrigerant temperature and inputs a detection signal to the controller 100.

[0069] The refrigerant leakage sensor 307 is disposed in the vicinity of the indoor heat exchanger 301. The refrigerant leakage sensor 307 detects a refrigerant concentration and inputs a detection signal to the controller 100. When the refrigerant concentration is equal to or more than a predetermined value, refrigerant leakage is detected.

[0070] Both sides of the indoor heat exchanger 301 of the indoor unit 30 are provided with a first opening and closing device 101 and a second opening and closing device 102 which adjust the refrigerant flow rate to the indoor unit 30.

[0071] The first opening and closing device 101 is provided in the liquid side pipe 13 connected to the indoor heat exchanger 301. The first opening and closing device 101 of the present embodiment is configured by an opening and closing valve such as an electric valve or an electromagnetic valve. The first opening and closing device 101 is switchable between an opened state in which the refrigerant flows and a closed state in which the refrigerant flow is blocked. The first opening and closing device 101 is configured so that the opening and closing can be controlled by the controller 100. Furthermore, the first opening and closing device 101 is configured to be closed during a power failure.

[0072] Note that the first opening and closing device 101 may be a valve which can set a state between the opened state and the closed state or may be configured so that an opening degree of the first opening and closing device 101 is controlled by the controller 100.

[0073] The second opening and closing device 102 is provided in the gas side pipe 14 connected to the indoor heat exchanger 301. The second opening and closing device 102 is configured similarly to the first opening and closing device 101.

[0074] In the cooling operation mode of the air conditioning apparatus 1, the refrigerant flows in a flow direction F1, and the refrigerant flows through the compressor 201, the switching valve 205, the outdoor heat exchanger 202, the expansion valve 204, the indoor expansion valve 304, the indoor heat exchanger 301, and the switching valve 205 in this order and returns to the suction pipe 208 from the switching valve 205.

[0075] Furthermore, in the heating operation mode of the air conditioning apparatus 1, the refrigerant flows in a flow direction F2, and the refrigerant flows through the compressor 201, the switching valve 205, the indoor heat exchanger 301, the indoor expansion valve 304, the expansion valve 204, the outdoor heat exchanger 202, and the switching valve 205 in this order and returns to the suction pipe 208 from the switching valve 205.

[0076] Fig. 2 is a block diagram of the controller 100 of the air conditioning apparatus 1 according to the first embodiment.

[0077] As illustrated in Figs. 1 and 2, the air conditioning apparatus 1 includes the controller 100. The controller 100 is wiredly or wirelessly connected to an operation unit 100a configured by a remote control, an operation panel, or the like. The operation unit 100a is provided with a display unit 100b. The display unit 100b is configured to display an operation state of the operation unit 100a and an operation state of the air conditioning apparatus 1. The operation unit 100a corresponds to an example of an input unit. The display unit 100b corresponds to an example of notification means.

[0078] The controller 100 executes operation control of the compressor 201, control of opening degrees and opening and closing of the expansion valve 204 and the indoor expansion valve 304, control of switching of a flow path of the switching valve 205, and control of operations and stop of the outdoor fan 203 and the indoor fan 302. Furthermore, the controller 100 executes control of opening and closing of the first opening and closing device 101 and the second opening and closing device 102.

[0079] The controller 100 operates the expansion valve 204, the indoor expansion valve 304, and the switching valve 205 to switch the cooling operation mode and the heating operation mode of the air conditioning apparatus 1. Furthermore, the controller 100, in accordance with a target temperature set by an operation on the operation unit 100a, executes control of an operation frequency, an operation, and stop of the compressor 201 and control of the outdoor fan 203 and the indoor fan 302 to air-condition the conditioning target space in accordance with the target temperature.

[0080] The controller 100 executes processing of a sticking prevention action. The controller 100, in order to execute the processing of the sticking prevention action, executes processing of a sticking prevention shifting determination action of the air conditioning apparatus 1.

[0081] Furthermore, the controller 100 executes processing of an abnormality detection action of the opening and closing device. The controller 100, in order to execute the processing of the abnormality detection action of the opening and closing device, executes processing of an abnormality detection shifting determination action of the air conditioning apparatus 1.

[0082] Furthermore, the controller 100 executes processing of a refrigerant leakage detection action of the air conditioning apparatus 1.

[0083] Examples of the refrigerant used in the air con-

ditioning apparatus 1 include various types. As so-called alternatives for chlorofluorocarbon, refrigerants such as hydrocarbon, ammonia, and R32 have been recently used in air conditioning apparatuses. These alternatives for chlorofluorocarbon are low flammable or flammable. When a low flammable or flammable refrigerant leaks, suppression of the amount of refrigerant leakage is required so that a refrigerant concentration of the conditioning target space of the indoor unit 30 does not reach a lower flammability limit (LFL). In particular, it is desirable to suppress the amount of refrigerant leakage from the indoor unit 30 installed in the conditioning target space or in the vicinity thereof.

[0084] Fig. 3 is a flowchart illustrating the sticking prevention shifting determination action of the air conditioning apparatus 1 of the first embodiment. Fig. 4 is a flowchart illustrating the sticking prevention action of the air conditioning apparatus 1. The actions of Figs. 3 and 4 are executed by the controller 100 controlling each unit of the air conditioning apparatus 1.

[0085] As illustrated in Fig. 3, upon starting the processing of the sticking prevention shifting determination action, the controller 100 starts measurement of a first predetermined time (step ST11). The first predetermined time is a time for setting an interval for executing the sticking prevention action. The first predetermined time allows the first opening and closing device 101 and the second opening and closing device 102 to open and close at a necessary and sufficient frequency and can suppress wear of the opening and closing devices 101 and 102 due to excessive opening and closing. In the present embodiment, as an example, the first predetermined time is set to one week.

[0086] Upon starting the measurement of the first predetermined time, the controller 100 determines whether the first predetermined time has elapsed (step ST12).

[0087] When determining that the first predetermined time has not elapsed (NO in step ST12), the controller 100 executes the processing of step ST12.

[0088] When determining that the first predetermined time has elapsed (YES in step ST12), the controller 100 executes the sticking prevention action illustrated in Fig. 4 (step ST13).

[0089] Upon executing the sticking prevention action, a return is made to step ST11, and the controller 100 starts the measurement of the first predetermined time (step ST11). Namely, the controller 100 executes the sticking prevention action at an interval of the first predetermined time.

[0090] As illustrated in Fig. 4, upon starting the sticking prevention action, the controller 100 determines whether the compressor 201 is in operation (ON) (step ST21).

[0091] When the compressor 201 is in operation (YES in step ST21), the controller 100 determines whether the number of the indoor units 30 in operation is one (step ST22).

[0092] When the number of the indoor units 30 in operation is one (YES in step ST22), the controller 100 fully opens the indoor expansion valve 304 of the indoor unit 30 out of operation, as an example of opening control (step ST23). In the present embodiment, the indoor expansion valves 304 of all of the indoor units 30 out of operation are fully opened. This allows the refrigerant to flow through the indoor unit 30 out of operation. Since the refrigerant can flow through the indoor unit 30 out of operation, if the refrigerant flow is blocked in the indoor unit 30 in operation, an excessive pressure rise of a refrigerant circuit is suppressed.

[0093] Here, instead of the configuration in which the indoor expansion valves 304 of all of the indoor units 30 out of operation are fully opened, a configuration may be employed in which the indoor expansion valves 304 of some of the indoor units 30 out of operation are fully opened. In this case, for example, the indoor units 30a and 30b on the outdoor unit 20 side may be fully opened.

[0094] The controller 100 controls closing of the indoor expansion valve 304 of the indoor unit 30 in operation (step ST24). The closing control of step ST24 controls the opening degree of the indoor expansion valve 304 so that the opening degree of the indoor expansion valve 304 is brought into a more fully closed side than the current one. This suppresses the refrigerant flow rate flowing through the indoor unit 30 in operation and suppresses an impact which the opening and closing devices 101 and 102 receive from the refrigerant flow during opening and closing.

[0095] The controller 100 closes the first opening and closing device 101 corresponding to the indoor unit 30 in operation (step ST25).

[0096] The controller 100 opens the first opening and closing device 101 corresponding to the indoor unit 30 in operation (step ST26).

[0097] The controller 100 closes the second opening and closing device 102 corresponding to the indoor unit 30 in operation (step ST27).

[0098] The controller 100 opens the second opening and closing device 102 corresponding to the indoor unit 30 in operation (step ST28).

[0099] The first opening and closing device 101 and the second opening and closing device 102 of the indoor unit 30 which has been in operation are opened and closed by steps ST25 to ST28, thus preventing sticking of the first opening and closing device 101 and the second opening and closing device 102.

[0100] The controller 100 controls opening of the indoor expansion valve 304 of the indoor unit 30 in operation (step ST29). The opening control of step ST29 controls the opening degree of the indoor expansion valve 304 so as to obtain an opening degree before the closing of the indoor expansion valve 304 is controlled in step ST24. This allows the same refrigerant flow rate as in the indoor unit 30 in operation to flow.

[0101] The controller 100 fully closes the indoor expansion valve 304 of the indoor unit 30 out of operation which is fully opened in step ST23 (step ST30). This blocks the refrigerant flow of the indoor unit 30 out of

operation.

[0102] The controller 100 closes the first opening and closing device 101 corresponding to the indoor unit 30 out of operation (step ST31).

[0103] The controller 100 opens the first opening and closing device 101 corresponding to the indoor unit 30 out of operation (step ST32).

[0104] The controller 100 closes the second opening and closing device 102 corresponding to the indoor unit 30 out of operation (step ST33).

[0105] The controller 100 opens the second opening and closing device 102 corresponding to the indoor unit 30 out of operation (step ST34).

[0106] The first opening and closing device 101 and the second opening and closing device 102 corresponding to the indoor unit 30 which has been out of operation are opened and closed by steps ST31 to ST34, thus preventing sticking of the first opening and closing device 101 and the second opening and closing device 102.

[0107] Then, the controller 100 ends the sticking prevention action when the number of the indoor units 30 in operation is one.

[0108] When the number of the indoor units 30 in operation is not one, namely, when the number of the indoor units 30 in the operation is plural (NO in step ST22), the controller 100 performs setting to group the indoor units 30 in operation into "preceding" and "subsequent" (step ST41). At least one or more indoor units 30 in operation may be set to each of the "preceding" and "subsequent" groups. As long as one or more are set, any method may be employed for the setting of the "preceding" and "subsequent" groups. In the present embodiment, when the indoor unit 30a is in operation, the indoor unit 30a is configured to be set to "preceding," and the remaining indoor units 30b and 30c in operation are configured to be set to "subsequent." Furthermore, when the indoor unit 30a is out of operation, the indoor unit 30b is configured to be set to "preceding," and the indoor unit 30c is configured to be set to "subsequent." The "preceding" indoor unit 30 in operation corresponds to an example of a first indoor unit 30 in operation. Furthermore, the "subsequent" indoor unit 30 in operation corresponds to an example of a second indoor unit 30 in operation.

[0109] The controller 100 controls closing of the indoor expansion valve 304 of the "preceding" indoor unit 30 in operation (step ST42). The closing control of step ST42 is the same as that of step ST24.

[0110] The controller 100 closes the opening and closing devices 101 and 102 corresponding to the "preceding" indoor unit 30 in operation (step ST43).

[0111] The controller 100 opens the opening and closing devices 101 and 102 corresponding to the "preceding" indoor unit 30 in operation (step ST44).

[0112] The first opening and closing device 101 and the second opening and closing device 102 corresponding to the "preceding" indoor unit 30 in operation are opened and closed by steps ST43 to ST44, thus preventing sticking of the first opening and closing device 101 and the second opening and closing device 102. At this time, since the refrigerant can flow through the "subsequent" indoor unit 30 in operation, an excessive pressure rise of the refrigerant circuit is suppressed.

[0113] The controller 100 controls opening of the indoor expansion valve 304 corresponding to the "preceding" indoor unit 30 in operation (step ST45). The opening control of step ST45 is the same as that of step ST29.

[0114] The controller 100 controls closing of the indoor expansion valve 304 corresponding to the "subsequent" indoor unit 30 in operation (step ST46). The closing control of step ST46 is the same as that of step ST24.

[0115] The controller 100 closes the opening and closing devices 101 and 102 corresponding to the "subsequent" indoor unit 30 in operation (step ST47).

[0116] The controller 100 opens the opening and closing devices 101 and 102 corresponding to the "subsequent" indoor unit 30 in operation (step ST48).

[0117] The first opening and closing device 101 and the second opening and closing device 102 corresponding to the "subsequent" indoor unit 30 in operation are opened and closed by steps ST47 to ST48, thus preventing sticking of the first opening and closing device 101 and the second opening and closing device 102. At this time, since the refrigerant can flow through the "preceding" indoor unit 30 in operation, an excessive pressure rise of the refrigerant circuit is suppressed.

[0118] The controller 100 controls opening of the indoor expansion valve 304 corresponding to the "subsequent" indoor unit 30 in operation (step ST49). The opening control of step ST49 is the same as that of step ST29.

[0119] The controller 100 determines whether the indoor unit 30 out of operation is absent (step ST50).

[0120] When determining that the indoor unit 30 out of operation is absent (YES in step ST50), the controller 100 ends the sticking prevention action when there is a plurality of the indoor units 30 in operation.

[0121] When the indoor unit 30 out of operation is present (NO in step ST50), the controller 100 executes the processing of steps ST31 to ST34 in the indoor unit 30 out of operation. Then, the controller 100 ends the sticking prevention action when there is a plurality of the indoor units 30 in operation.

[0122] When determining that the compressor 201 is stopped (NO in step ST21), the controller 100 closes the first opening and closing devices 101 corresponding to all of the indoor units 30 (step ST51).

[0123] The controller 100 opens the first opening and closing devices 101 corresponding to all of the indoor units 30 (step ST52).

[0124] The controller 100 closes the second opening and closing devices 102 corresponding to all of the indoor units 30 (step ST53).

[0125] The controller 100 opens the second opening and closing devices 102 corresponding to all of the indoor units 30 (step ST54).

[0126] The first opening and closing device 101 and the second opening and closing device 102 correspond-

ing to the indoor unit 30 out of operation are opened and closed by steps ST51 to ST54, thus preventing sticking of the first opening and closing device 101 and the second opening and closing device 102. At this time, since the compressor 201 is stopped and the refrigerant does not flow, the control of the indoor expansion valve 304 is omitted.

[0127] Then, the controller 100 ends the sticking prevention action when the compressor 201 is stopped.

[0128] Here, in the conventional configuration disclosed in International Publication No. WO 2017/203606, the opening and closing device is not closed unless refrigerant leakage occurs. This may cause sticking due to not closing the opening and closing device for a long time. Accordingly, there is a problem in which when refrigerant leakage actually occurs, the opening and closing device does not normally function, and the refrigerant circuit cannot be blocked, increasing the amount of refrigerant leakage.

[0129] In contrast, in the present embodiment, even when the refrigerant is not leaking, the opening and closing devices 101 and 102 are opened and closed by the processing of steps ST25 to ST28, steps ST31 to ST34, steps ST43 to ST44, steps ST47 to ST48, and steps ST51 to ST54. This allows the opening and closing devices 101 and 102 to move between the closed state (fully closed) and the opened state (fully opened), thereby suppressing sticking of the opening and closing device. Thus, it becomes easier to appropriately operate the opening and closing devices 101 and 102 when refrigerant leakage occurs, and the refrigerant amount leaking from the indoor unit 30 can be suppressed effectively.

[0130] In the present embodiment, in the above-described steps ST25 to ST28, after the first opening and closing device 101 is opened and closed, the second opening and closing device 102 is opened and closed. However, instead of this, after the second opening and closing device 102 is opened and closed, the first opening and closing device 101 may be opened and closed. Furthermore, the first opening and closing device 101 and the second opening and closing device 102 may be opened and closed simultaneously.

[0131] Similarly, in the present embodiment, in the above-described steps ST31 to ST34, after the first opening and closing device 101 is opened and closed, the second opening and closing device 102 is opened and closed; however, instead of this, after the second opening and closing device 102 is opened and closed, the first opening and closing device 101 may be opened and closed, or the first opening and closing device 101 and the second opening and closing device 102 may be opened and closed simultaneously.

[0132] Furthermore, in the present embodiment, in the above-described steps ST31 to ST34, all of the opening and closing devices 101 and 102 of the indoor units 30 out of operation are opened and closed simultaneously. However, instead of this, steps ST31 to ST34 may be executed in each of the indoor units 30 out of operation, and the opening and closing devices 101 and 102 may be opened and closed in the order of the indoor units 30 out of operation, so that all of the opening and closing devices 101 and 102 of the indoor units 30 out of operation may be opened and closed.

[0133] As described above, the air conditioning apparatus 1 of the present embodiment includes the outdoor unit 20 having the compressor 201, the indoor unit 30 having the indoor heat exchanger 301, the liquid side pipes 11 and 13 and the gas side pipes 12 and 14 which connect the outdoor unit 20 and the indoor unit 30, the opening and closing devices 101 and 102 disposed in the liquid side pipe 13 and the gas side pipe 14, and the controller 100. In this air conditioning apparatus 1, the controller 100 executes a sticking prevention operation in which the opening and closing devices 101 and 102 are opened and closed when the refrigerant is not leaking.

[0134] This can prevent a case where the opening and closing devices 101 and 102 do not open and close for a long time, thereby suppressing sticking of the opening and closing devices 101 and 102. Thus, it becomes easier to appropriately operate the opening and closing devices 101 and 102 when refrigerant leakage occurs, and the refrigerant amount leaking from the indoor unit 30 can be suppressed effectively.

[0135] In the present embodiment, a refrigerant pipe has the liquid side pipes 11 and 13 and the gas side pipes 12 and 14. The opening and closing device has the first opening and closing device 101 that opens and closes the liquid side pipe 13 connected to the indoor unit 30, and the second opening and closing device 102 that opens and closes the gas side pipe 14 connected to the indoor unit 30.

[0136] This enables to open and close each of the liquid side pipe 13 and the gas side pipe 14 which are connected to the indoor unit 30, thereby effectively suppressing the refrigerant amount leaking from the indoor unit 30 when refrigerant leakage occurs.

[0137] Furthermore, in the present embodiment, the controller 100 executes the sticking prevention operation in which the first opening and closing device 101 and the second opening and closing device 102 are opened and closed.

[0138] This can prevent a case where the first opening and closing device 101 and the second opening and closing device 102 do not open and close for a long time, thereby suppressing sticking of the first opening and closing device 101 and the second opening and closing device 102. Thus, when refrigerant leakage occurs, the liquid side pipe 11 and the gas side pipe 12 which are connected to the indoor unit 30 can be opened and closed appropriately.

[0139] Furthermore, in the present embodiment, the liquid side pipe 11 is provided with the indoor expansion valve 304 that controls the refrigerant flow rate between the first opening and closing device 101 and the indoor heat exchanger 301.

[0140] Thus, the refrigerant flow rate flowing through the indoor heat exchanger 301 can be controlled by the indoor expansion valve 304.

[0141] Furthermore, in the present embodiment, provided is the plurality of indoor units 30a, 30b, and 30c disposed in parallel; the first opening and closing devices 101a, 101b, and 101c and the second opening and closing devices 102a, 102b, and 102c are provided in the respective indoor units 30a, 30b, and 30c; and the indoor expansion valves 304a, 304b, and 304c are provided in the respective indoor units 30a, 30b, and 30c.

[0142] Thus, the air conditioning apparatus 1 including the plurality of indoor units 30a, 30b, and 30c disposed in parallel can effectively suppress the refrigerant amount leaking from each of the indoor units 30a, 30b, and 30c.

[0143] Furthermore, in the present embodiment, the controller 100, when executing the sticking prevention operation, if the compressor 201 is stopped, executes the sticking prevention operation of the opening and closing devices 101 and 102 of all of the indoor units 30.

[0144] Thus, in all of the indoor units 30, while an impact received from the refrigerant flow is suppressed, the sticking prevention operation of the opening and closing devices 101 and 102 can be executed.

[0145] Furthermore, in the present embodiment, the controller 100, when executing the sticking prevention operation, if the compressor 201 is in operation and the indoor unit 30 out of operation is present, controls the opening of the indoor expansion valve 304 of the indoor unit 30 out of operation, controls the closing of the indoor expansion valve 304 of the indoor unit 30 in operation, and executes the sticking prevention operation of the opening and closing devices 101 and 102 of the indoor unit 30 in operation.

[0146] This makes it easier to increase the refrigerant flow rate in the indoor unit 30 out of operation and reduce the refrigerant flow rate in the indoor unit 30 in operation. Thus, the opening and closing devices 101 and 102 corresponding to the indoor unit 30 in operation can be opened and closed so as to be less likely to receive an impact from the refrigerant flow. Furthermore, the refrigerant can flow by using the indoor unit 30 out of operation, so that an excessive pressure rise of the refrigerant circuit can be suppressed even when the opening and closing devices 101 and 102 are opened and closed.

[0147] Furthermore, in the present embodiment, the controller 100, when executing the sticking prevention operation, if the compressor 201 is in operation and there is a plurality of the indoor units 30 in operation, controls the closing of the indoor expansion valve 304 of the "preceding" indoor unit 30 in operation, and executes the sticking prevention operation of the opening and closing devices 101 and 102 of the "preceding" indoor unit 30 in operation. Thereafter, the controller 100 controls the closing of the indoor expansion valve 304 of the "subsequent" indoor unit 30 in operation and executes the sticking prevention operation of the opening and closing devices 101 and 102 of the "subsequent" indoor unit 30 in operation.

[0148] Thus, when the sticking prevention operation is executed, if the compressor 201 is in operation and there is a plurality of the indoor units 30 in operation, the indoor units 30 are divided into the "preceding" indoor unit 30 in operation and the "subsequent" indoor unit 30 in operation, and the sticking prevention operation is executed. Thus, when the sticking prevention operation of the opening and closing devices 101 and 102 of one of the "preceding" and the "subsequent" indoor units 30 in operation is executed, the refrigerant can flow by using the indoor unit 30 in the other of the "preceding" and the "subsequent" indoor units 30, so that an excessive pressure rise of the refrigerant circuit can be suppressed.

[0149] Furthermore, in the present embodiment, the controller 100, when executing the sticking prevention operation, executes the sticking prevention operation of the opening and closing devices 101 and 102 of the indoor unit 30 out of operation.

[0150] Thus, when the compressor 201 is in operation, the sticking prevention operation of the opening and closing devices 101 and 102 of the indoor unit out of operation can be executed.

[0151] Furthermore, in the present embodiment, the controller 100, after elapse of the first predetermined time from execution of the sticking prevention operation, executes the sticking prevention operation again.

[0152] Thus, the sticking prevention operation can be executed at an interval of the first predetermined time, and the sticking prevention operation can be executed at a necessary and sufficient frequency.

[0153] Fig. 5 is a flowchart illustrating the abnormality detection shifting determination action of the air conditioning apparatus 1 of the first embodiment. Fig. 6 is a flowchart illustrating the abnormality detection action of the opening and closing device of the air conditioning apparatus 1. Fig. 7 is a flowchart illustrating the remainder of Fig. 6. The actions of Figs. 5 to 7 are executed by the controller 100 controlling each unit of the air conditioning apparatus 1.

[0154] As illustrated in Fig. 5, upon starting the processing of the abnormality detection shifting determination action, the controller 100 starts measurement of a second predetermined time (step ST101). The second predetermined time is the shortest time interval for executing the abnormality detection action. This can suppress a case where the abnormality detection action of the opening and closing device is excessively performed. Namely, it is possible to suppress wear of the opening and closing devices 101 and 102 due to excessive opening and closing of the first opening and closing device 101 and the second opening and closing device 102. In the present embodiment, as an example, the second predetermined time is set to one month.

[0155] The controller 100 determines whether an instruction for controlling lowering of the operation frequency of the compressor 201 is present (step ST102).

[0156] When the instruction for controlling lowering of

the operation frequency of the compressor 201 is absent (NO in step ST102), the controller 100 executes the processing of step ST102.

[0157] When the instruction for controlling lowering of the operation frequency of the compressor 201 is present (YES in step ST102), the controller 100 determines whether the operation frequency of the compressor 201 is equal to or less than a predetermined value (step ST103). The predetermined value of step ST103 is set to an operation frequency in which the refrigerant flow rate is small and the opening and closing devices 101 and 102 are less likely to receive an impact from the refrigerant flow during opening and closing of the opening and closing devices 101 and 102.

[0158] When determining that the operation frequency of the compressor 201 is not equal to or less than the predetermined value (NO in step ST103), the controller 100 executes the processing of step ST102.

[0159] When determining that the operation frequency of the compressor 201 is equal to or less than the predetermined value (YES in step ST103), the controller 100 determines whether the operation frequency is not 0 (step ST103).

[0160] When determining that the operation frequency of the compressor 201 is 0 (NO in step ST104), the controller 100 stops the operation of the air conditioning apparatus 1 (step ST107) and executes the processing of step ST102.

[0161] When determining that the operation frequency of the compressor 201 is not 0 (YES in step ST104), the controller 100 determines whether the second predetermined time has elapsed (step ST105). Thus, whether the second predetermined time has elapsed in a state where the refrigerant flow rate is small is determined.

[0162] When determining that the second predetermined time has not elapsed (NO in step ST105), the controller 100 executes the processing of step ST102.

[0163] When determining that the second predetermined time has elapsed (YES in step ST105), the controller 100 executes the abnormality detection action of the opening and closing device which is illustrated in Figs. 6 and 7 (step ST106).

[0164] Upon end of the abnormality detection action of the opening and closing device, a return is made to step ST101, and the controller 100 executes the processing of step ST101.

[0165] In Figs. 6 and 7, the abnormality detection action of the opening and closing device is executed in each of the indoor units 30a, 30b, and 30c. In the present embodiment, the flowchart of the abnormality detection action of the opening and closing device which is illustrated in Figs. 6 and 7 is repeated in the order of the indoor unit 30a, the indoor unit 30b, and the indoor unit 30c. The abnormality detection action of the opening and closing device corresponds to an example of abnormality determination control of the opening and closing device.

[0166] As illustrated in Fig. 6, upon starting the processing of the abnormality detection action of the opening and closing device, the controller 100 determines whether the cooling operation mode is set (step ST110). Thus, the refrigerant flow directions F1 and F2 are determined, and which of the first opening and closing device 101 and the second opening and closing device 102 is upstream of the refrigerant flow direction is determined.

[0167] When determining that the cooling operation mode is set (YES in step ST110), the controller 100 controls closing of the indoor expansion valve 304 so that the indoor expansion valve 304 is throttled (step ST111). Throttling the indoor expansion valve 304 reduces the refrigerant flow rate, and thereafter the second opening and closing device 102 on the downstream side is closed, so that an impact on the second opening and closing device 102 in the closed state can be suppressed.

[0168] The controller 100 opens the first opening and closing device 101 corresponding to the upstream side and closes the second opening and closing device 102 corresponding to the downstream side (step ST112). Thus, when the second opening and closing device 102 functions normally, the second opening and closing device 102 is in the closed state, so that the refrigerant is blocked. Due to this, the refrigerant remains in the indoor heat exchanger 301, and the indoor heat exchanger 301 no longer exchanges heat. This reduces a temperature difference between the refrigerant of the liquid side pipe 13 on the upstream side of the indoor heat exchanger 301 and the refrigerant of the gas side pipe 14 on the downstream side of the indoor heat exchanger 301.

[0169] The controller 100 fully opens the indoor expansion valve 304 (step ST113). Thus, when the second opening and closing device 102 is abnormal, the refrigerant easily flows through the indoor heat exchanger 301.

[0170] The controller 100 determines whether a third predetermined time has elapsed (step ST114). The third predetermined time of step ST114 is set to a time in which the refrigerant remaining in the indoor heat exchanger 301 no longer exchanges heat with indoor air. In the present embodiment, as an example of the third predetermined time, four minutes is set.

[0171] The controller 100 determines whether each of a refrigerant temperature of the liquid side pipe 13 of the indoor heat exchanger 301 and a refrigerant temperature of the gas side pipe 14 of the indoor heat exchanger 301 is equal to or less than a predetermined value (step ST115). In the present embodiment, a differential value between the temperature detected by the first temperature sensor 305 provided in the liquid side pipe 13 and the temperature detected by the second temperature sensor 306 provided in the gas side pipe 14 is calculated. Then, whether the differential value between the detected temperatures is equal to or less than a minute predetermined value is determined.

[0172] Here, when the second opening and closing device 102 operates normally, the refrigerant flow is blocked, and the refrigerant remains in the indoor heat exchanger 301. Due to this, the indoor heat exchanger

301 no longer exchanges heat between the refrigerant and indoor air, reducing the refrigerant temperature difference between the liquid side pipe 13 and the gas side pipe 14. On the other hand, when the second opening and closing device 102 is abnormal, the refrigerant continues to flow through the indoor heat exchanger 301, and the indoor heat exchanger 301 continues to exchange heat between the refrigerant and indoor air. This causes a refrigerant temperature difference between the liquid side pipe 13 and the gas side pipe 14. Accordingly, in step ST115, in order to determine whether the second opening and closing device 102 is abnormal, each of the refrigerant temperature of the liquid side pipe 11 of the indoor heat exchanger 301 and the refrigerant temperature of the gas side pipe 12 of the indoor heat exchanger 301 is equal to or less than the predetermined value.

[0173] When determining that each of the refrigerant temperature of the liquid side pipe 13 of the indoor heat exchanger 301 and the refrigerant temperature of the gas side pipe 14 of the indoor heat exchanger 301 is equal to or less than the predetermined value (YES in step ST115), the controller 100 closes the first opening and closing device 101 corresponding to the upstream side and opens the second opening and closing device 102 corresponding to the downstream side (step ST116).

[0174] The controller 100 determines whether the third predetermined time has elapsed (step ST117). Step ST117 is the same as step ST114.

[0175] The controller 100 determines whether each of the refrigerant temperature of the liquid side pipe 13 of the indoor heat exchanger 301 and the refrigerant temperature of the gas side pipe 14 of the indoor heat exchanger 301 is equal to or less than a predetermined value (step ST118). Step ST118 is the same as step ST115.

[0176] When determining that each of the refrigerant temperature of the liquid side pipe 13 of the indoor heat exchanger 301 and the refrigerant temperature of the gas side pipe 14 of the indoor heat exchanger 301 is equal to or less than the predetermined value (YES in step ST118), the controller 100 opens the first opening and closing device 101 (step ST119). Thus, the first opening and closing device 101 is returned to its original state.

[0177] Then, the controller 100 ends the abnormality detection action of the opening and closing device.

[0178] When determining that each of the refrigerant temperature of the liquid side pipe 13 of the indoor heat exchanger 301 and the refrigerant temperature of the gas side pipe 14 of the indoor heat exchanger 301 is not equal to or less than the predetermined value (NO in step ST115), the controller 100 determines that the second opening and closing device 102 is abnormal, and notifies the abnormality of the second opening and closing device 102 (step ST122). Means for notifying the abnormality of the second opening and closing device 102, for example, may be configured so that the operation screen 100b indicates that the second opening and closing device 102 is abnormal or so that a sound source as an example of notification means, which is not illustrated, is controlled to output a notification sound.

[0179] The controller 100 fully closes the indoor expansion valve 304 (step ST121). This blocks the refrigerant flow.

[0180] Then, the controller 100 ends the abnormality detection action of the opening and closing device.

[0181] When determining that each of the refrigerant temperature of the liquid side pipe 13 of the indoor heat exchanger 301 and the refrigerant temperature of the gas side pipe 14 of the indoor heat exchanger 301 is not equal to or less than the predetermined value (NO in step ST118), the controller 100 determines that the first opening and closing device 101 is abnormal, and notifies the abnormality of the first opening and closing device 101 (step ST120).

[0182] The controller 100 fully closes the indoor expansion valve 304 (step ST121) and ends the abnormality detection action of the opening and closing device.

[0183] When the cooling operation mode is not set, namely, when the heating operation mode is set (NO in step ST110), the controller 100 controls closing of the indoor expansion valve 304 so that the indoor expansion valve 304 is throttled (step ST130 of Fig. 7). Throttling the indoor expansion valve 304 reduces the refrigerant flow rate.

[0184] The controller 100 opens the second opening and closing device 102 corresponding to the upstream side and closes the first opening and closing device 101 corresponding to the downstream side (step ST131).

[0185] Since steps ST131 to ST141 illustrated in Fig. 7 are the same as steps ST112 to ST121 except in that the opening and closing device on the upstream side and the opening and closing device on the downstream side are opposite to the opening and closing devices of steps ST112 to ST121 illustrated in Fig. 6, detailed description thereof will be omitted.

[0186] Here, in the conventional configuration disclosed in International Publication No. WO 2017/203606, the opening and closing device is not closed unless refrigerant leakage occurs, which may cause, for example, sticking of the opening and closing device, and thus there is a problem of lowering reliability of the opening and closing device.

[0187] In contrast, in the present embodiment, when the opening and closing devices 101 and 102 are closed, whether the refrigerant is normally blocked is determined by the processing of steps ST112 to ST115, steps ST116 to ST118, steps ST131 to ST134, and steps ST135 to ST137. Accordingly, when the opening and closing devices 101 and 102 are determined to be abnormal, the opening and closing devices 101 and 102 can be repaired or exchanged, and thus reliability of the opening and closing devices 101 and 102 is enhanced.

[0188] As described above, the air conditioning apparatus 1 of the present embodiment includes the outdoor unit 20 having the compressor 201, the indoor unit 30 having the indoor heat exchanger 301, the liquid side

pipes 11 and 13 and the gas side pipes 12 and 14 which connect the outdoor unit 20 and the indoor unit 30, the first opening and closing device 101 that opens and closes the liquid side pipe 13 connected to the indoor unit 30, the second opening and closing device 102 that opens and closes the gas side pipe 14 connected to the indoor unit 30, the indoor expansion valve 304 which is provided between the first opening and closing device 101 and the indoor heat exchanger 301 and controls the refrigerant flow rate, and the controller 100. In this air conditioning apparatus 1, the controller 100 executes the abnormality detection action in which the closing of at least one of the first opening and closing device 101 and the second opening and closing device 102 is controlled in a state where the indoor expansion valve 304 is opened and in which the abnormal state of the opening and closing device 101 and/or 102 controlled to close between the first opening and closing device 101 and the second opening and closing device 102 is determined.

[0189] Thus, the abnormal states of the first opening and closing device 101 and the second opening and closing device 102 can be determined by whether the refrigerant flowing through the indoor unit 30 is blocked by the opening and closing device 101 and/or 102 controlled to close.

[0190] In the present embodiment, the air conditioning apparatus 1 includes the first temperature sensor 305 which is disposed in the liquid side pipe 13 between the first opening and closing device 101 and the indoor heat exchanger 301 and detects the refrigerant temperature, and the second temperature sensor 306 which is disposed in the gas side pipe 14 between the second opening and closing device 102 and the indoor heat exchanger 301 and detects the refrigerant temperature. In the abnormality detection action, the controller 100 of the air conditioning apparatus 1 controls the opening of one of the first opening and closing device 101 and the second opening and closing device 102, controls the closing of the other of the opening and closing devices 102 and 101, and determines that, when the differential value between the temperatures detected by the first temperature sensor 305 and the second temperature sensor 306 is higher than a predetermined temperature, the other of the opening and closing devices 102 and 101 is in the abnormal state.

[0191] This enables to detect the refrigerant temperature between the first opening and closing device 101 and the indoor heat exchanger 301 and the refrigerant temperature between the second opening and closing device 102 and the indoor heat exchanger 301. Thus, whether the refrigerant is blocked is determined based on the temperature difference between the liquid side and the gas side of the indoor heat exchanger 301, so that the abnormal states of the opening and closing devices 101 and 102 can be determined.

[0192] Furthermore, in the present embodiment, in the abnormality detection action, the controller 100 throttles the indoor expansion valve 304, controls the opening of the opening and closing device 101 or 102 on the upstream side of the refrigerant flow direction between the first opening and closing device 101 and the second opening and closing device 102, controls the closing of the opening and closing device 102 or 101 on the downstream side of the refrigerant flow direction between the first opening and closing device 101 and the second opening and closing device 102, and determines whether the opening and closing device 102 or 101 on the downstream side is in the abnormal state.

[0193] Thus, the closing of the opening and closing device 102 or 101 on the downstream side of the refrigerant flow direction is controlled in a state where the refrigerant flow rate flowing to the opening and closing device 102 or 101 on the downstream side of the refrigerant flow direction is reduced by the indoor expansion valve 304, so that an impact which the opening and closing device 102 or 101 receives from the refrigerant can be suppressed.

[0194] Furthermore, in the present embodiment, in the abnormality detection action, the controller 100, after determining whether the opening and closing device 102 or 101 on the downstream side is in the abnormal state, controls the opening of the opening and closing device 102 or 101 on the downstream side, controls the closing of the opening and closing device 101 or 102 on the upstream side, and determines whether the opening and closing device 101 or 102 on the upstream side is in the abnormal state.

[0195] This also enables abnormality determination of the opening and closing device 102 or 101 on the upstream side of the refrigerant flow direction.

[0196] Furthermore, in the present embodiment, in the abnormality detection action, the controller 100, when determining that the opening and closing devices 101 and 102 are in the abnormal states, notifies that the opening and closing devices 101 and 102 are in the abnormal states.

[0197] This can make it easier to recognize that the opening and closing devices 101 and 102 are in the abnormal states.

[0198] Furthermore, in the present embodiment, in the abnormality detection action, the controller 100, when determining that at least one of the first opening and closing device 101 and the second opening and closing device 102 is in the abnormal state, controls the closing of the indoor expansion valve 304.

[0199] Thus, when the opening and closing devices 101 and 102 are in the abnormal states, the closing of the indoor expansion valve 304 is controlled, so that the refrigerant flow can be regulated.

[0200] Furthermore, in the present embodiment, the controller 100, when the operation frequency of the compressor 201 is equal to or less than the predetermined value, if the second predetermined time has elapsed from execution of the abnormality detection action, executes the abnormality detection action again.

[0201] Thus, when an impact received from the refrig-

erant flow is small, the opening and closing devices 101 and 102 are opened and closed, so that the abnormality detection action can be executed. Furthermore, excessive execution of the abnormality detection action can be suppressed.

[0202] Fig. 8 is a flowchart illustrating the refrigerant leakage detection action of the air conditioning apparatus 1 of the first embodiment. The action of Fig. 8 is executed by the controller 100 controlling each unit of the air conditioning apparatus 1.

[0203] As illustrated in Fig. 8, upon starting the processing of the refrigerant leakage detection action, the controller 100 determines whether refrigerant leakage is detected, based on a detection result of the refrigerant leakage sensor 307 (step ST201).

[0204] When not detecting refrigerant leakage (NO in step ST201), the controller 100 executes the processing of step ST201.

[0205] When detecting refrigerant leakage (YES in step ST201), the controller 100 continues the operation of the indoor fan 302 (step ST202). Thus, the refrigerant leaking indoors is conveyed by air sending of the indoor fan 302, and the refrigerant leaking indoors is easily diluted.

[0206] The controller 100 controls lowering of the operation frequency of the compressor 201 (step ST203). The lowering control of the operation frequency is performed, for example, as follows. It is performed so as to obtain a value in which the operation frequency of the compressor 201 before detection is multiplied by a ratio of an operation capacity of the indoor unit 30 in which the leakage is detected to operation capacities of all of the indoor units 30. Specifically, for example, when the operation frequency before detection is 60 Hz, the operation capacity of the indoor unit 30 in which the leakage is detected is 5 HP (horsepower), and the operation capacities of all of the indoor units 30 is 15 HP, the lowering control of the operation frequency is performed so that 60 Hz $\times$ (5 HP/15 HP) = 20 Hz.

[0207] The controller 100 fully closes the indoor expansion valve 304 in the indoor unit 30 in which the leakage is detected (step ST204). This can regulate the refrigerant flow.

[0208] The controller 100 closes the first opening and closing device 101 and the second opening and closing device 102 corresponding to the indoor unit 30 in which the leakage is detected (step ST205).

[0209] The controller 100 determines whether the first opening and closing device 101 and the second opening and closing device 102 corresponding to the indoor unit 30 in which the leakage is not detected are opened (step ST206).

[0210] When the first opening and closing device 101 and the second opening and closing device 102 corresponding to the indoor unit 30 in which the leakage is not detected are opened (YES in step ST206), the controller 100 continues the operation (step ST207) and ends the processing of the refrigerant leakage detection action.

[0211] When the first opening and closing device 101 and the second opening and closing device 102 corresponding to the indoor unit 30 in which the leakage is not detected are not opened (NO in step ST206), the controller 100 stops the operation (step ST208) and ends the processing of the refrigerant leakage detection action.

[0212] Here, in the conventional configuration disclosed in International Publication No. WO 2017/203606, the opening and closing device is closed when refrigerant leakage occurs. However, when refrigerant leakage occurs, simply closing the opening and closing device transmits to the opening and closing device in the closed state an impact of the refrigerant flowing through the refrigerant circuit, which may damage the opening and closing device. Accordingly, the conventional configuration has a problem of lowering action reliability of the opening and closing device.

[0213] In contrast, in the present embodiment, the drive frequency is reduced by step ST203 to lower the refrigerant flow rate, the indoor expansion valve 304 is closed by step ST204 to regulate the refrigerant flow, then the first opening and closing device 101 and the second opening and closing device 102 are closed by step ST205. This prevents the impact of the refrigerant flowing through the refrigerant circuit from being transmitted to the opening and closing devices 101 and 102 in the closed states. Accordingly, a risk of damage to the opening and closing devices 101 and 102 can be reduced, and action reliability of the opening and closing devices 101 and 102 can be enhanced.

[0214] It is desirable to have the above-described step ST204, but it may be omitted. Namely, the controller 100, after executing step ST203, may proceed to step ST205.

[0215] As described above, the air conditioning apparatus 1 of the present embodiment includes the outdoor unit 20 having the compressor 201, the indoor unit 30, the refrigerant pipes 11, 12, 13, and 14 connecting the outdoor unit 20 and the indoor unit 30, the opening and closing devices 101 and 102 that open and close the refrigerant pipes 13 and 14, the refrigerant leakage sensor 307 that detects the refrigerant concentration, and the controller 100. When the concentration detected by the refrigerant leakage sensor 307 is equal to or more than the predetermined value, the controller 100 controls the operation frequency of the compressor 201 so as to be equal to or less than the predetermined value, then the opening and closing devices 101 and 102 are closed.

[0216] Thus, after the detection of refrigerant leakage, the closing of the opening and closing devices 101 and 102 is controlled in a state where the operation frequency of the compressor 201 is lowered and the refrigerant flow rate flowing through the refrigerant circuit is small, so that an impact of the refrigerant which is transmitted to the opening and closing devices 101 and 102 is suppressed. Thus, the risk of damage to the opening and closing devices 101 and 102 can be reduced, and the action reliability of the opening and closing devices 101 and 102 can

be enhanced.

[0217] In the present embodiment, when the concentration detected by the refrigerant leakage sensor 307 is equal to or more than the predetermined value, the controller 100 controls the closing of the indoor expansion valve 304 and then closes the opening and closing devices 101 and 102.

[0218] Thus, after the detection of refrigerant leakage, the closing of the opening and closing devices 101 and 102 is controlled in a state where the closing of the indoor expansion valve 304 is controlled and the refrigerant flow rate flowing through the refrigerant circuit is small, so that an impact of the refrigerant which is transmitted to the opening and closing device is suppressed. Thus, the risk of damage to the opening and closing devices 101 and 102 can be reduced, and the action reliability of the opening and closing devices 101 and 102 can be enhanced.

[2. Second Embodiment]

[0219] Fig. 9 is a flowchart illustrating a sticking prevention shifting determination action of the air conditioning apparatus 1 of a second embodiment. In the second embodiment, component parts common to those of the first embodiment are denoted by the same signs, and description thereof will be omitted.

[0220] The controller 100 of the air conditioning apparatus 1 of the second embodiment differs from that of the first embodiment in performing, instead of the control of the flowchart illustrated in Fig. 3, control of the flowchart illustrated in Fig. 9.

[0221] As illustrated in Fig. 9, upon starting the processing of the sticking prevention shifting determination action, the controller 100 determines whether the operation frequency of the compressor 201 is equal to or less than a predetermined value (step ST61). The predetermined value of step ST61 is set to a frequency in which the refrigerant flow rate is small and the refrigerant flow is less likely to give an impact to the opening and closing devices 101 and 102.

[0222] When determining that the operation frequency of the compressor 201 is not equal to or less than the predetermined value (NO in step ST61), the controller 100 executes the processing of step ST61.

[0223] When determining that the operation frequency of the compressor 201 is equal to or less than the predetermined value (YES in step ST61), in step ST62, the controller 100 executes the sticking prevention action illustrated in Fig. 4, and a return is made to step ST61.

[0224] In the present embodiment, the controller 100, when the operation frequency of the compressor 201 is equal to or less than the predetermined value, executes the sticking prevention operation.

[0225] Thus, the opening and closing devices 101 and 102 are easily opened and closed in a state where the refrigerant flow rate is small, and the opening and closing devices 101 and 102 are less likely to receive an impact from the refrigerant flow.

[3. Third Embodiment]

[0226] Fig. 10 is a flowchart illustrating a sticking prevention shifting determination action of the air conditioning apparatus 1 of a third embodiment. In the third embodiment, component parts common to those of the first and second embodiments are denoted by the same signs, and description thereof will be omitted.

[0227] The operation unit 100a of the air conditioning apparatus 1 of the third embodiment is configured to input to the controller 100 permission to shift to the sticking prevention operation. The operation unit 100a corresponds to an example of an input unit.

[0228] The controller 100 of the air conditioning apparatus 1 of the third embodiment differs from that of the first embodiment in performing, instead of the control of the flowchart illustrated in Fig. 3, control of the flowchart illustrated in Fig. 10.

[0229] As illustrated in Fig. 10, the controller 100 detects a presence or absence of the input of the operation unit 100a and determines whether the sticking prevention operation is input (step ST71).

[0230] When not detecting the input of the sticking prevention operation (NO in step ST71), the controller 100 executes the processing of step ST71.

[0231] When detecting the input of the sticking prevention operation (YES in step ST71), in step ST72, the controller 100 executes the sticking prevention action illustrated in Fig. 4, and a return is made to step ST71.

[0232] In the present embodiment, provided is the operation unit 100a that inputs the permission to shift to the sticking prevention operation, and the controller 100, when detecting the input of the operation unit 100a, executes the sticking prevention operation.

[0233] Thus, the permission to shift to the sticking prevention operation can be input to the controller 100. This can permit the controller 100 to shift to the sticking prevention operation, at any timing.

[4. Fourth Embodiment]

[0234] Fig. 11 is a flowchart illustrating an abnormality detection shifting determination action of the air conditioning apparatus 1 of a fourth embodiment. In the fourth embodiment, component parts common to those of the first to third embodiments are denoted by the same signs, and description thereof will be omitted.

[0235] The operation unit 100a of the air conditioning apparatus 1 of the fourth embodiment is configured to input to the controller 100 permission to shift to the abnormality detection action of the opening and closing device. The operation unit 100a corresponds to an example of a second input unit.

[0236] The controller 100 of the air conditioning apparatus 1 of the fourth embodiment differs from that of the first embodiment in performing, instead of the control of the flowchart illustrated in Fig. 5, control of the flowchart illustrated in Fig. 11.

[0237] As illustrated in Fig. 11, the controller 100 detects a presence or absence of the input of the operation unit 100a and determines whether the permission to shift to the abnormality detection action of the opening and closing device is input (step ST181).

[0238] When not detecting the input of the permission to shift to the abnormality detection action of the opening and closing device (NO in step ST181), the controller 100 executes the processing of step ST181.

[0239] When detecting the input of the permission to shift to the abnormality detection action of the opening and closing device (YES in step ST181), in step ST182, the controller 100 executes the abnormality detection action of the opening and closing device which is illustrated in Figs. 6 and 7, and a return is made to step ST181.

[0240] In the present embodiment, provided is the operation unit 100a that inputs the permission to shift to the abnormality detection action of the opening and closing device, and the controller 100, when detecting the input of the operation unit 100a, executes the abnormality detection action of the opening and closing device.

[0241] This can permit the controller 100 to shift to the abnormality detection action of the opening and closing device, at any timing.

[5. Other Embodiments]

[0242] Although the present invention has been described based on the embodiments, the present invention is not limited to the present embodiments. Since each of the present embodiments is given to merely exemplify an embodiment of the present invention, any changes and applications are possible without departing from the gist of the present invention.

[0243] The description has been made in which the sticking prevention action is configured to be executed based on the first predetermined time in the first embodiment, executed based on the operation frequency of the compressor 201 in the second embodiment, and executed based on the input of the operation unit 100a in the third embodiment. However, for example, the sticking prevention action may be configured to be executed based on the first predetermined time and executed based on the operation frequency of the compressor 201. Furthermore, for example, the sticking prevention action may be configured to be executed based on the operation frequency of the compressor 201 and executed based on the input of the operation unit 100a. Namely, the flowchart illustrated in Fig. 3 of the first embodiment, the flowchart illustrated in Fig. 9 of the second embodiment, and the flowchart illustrated in Fig. 10 of the third embodiment, not limited to a configuration in which they are processed by the controller 100 separately, may be configured to be processed by the controller 100 in parallel.

[0244] The description has been made in which the abnormality detection action of the opening and closing device is configured to be executed based on the second predetermined time and the operation frequency of the compressor 201 in the first to third embodiments, and executed based on the input of the operation unit 100a in the fourth embodiment. However, the abnormality detection action of the opening and closing device may be configured to be executed based on the second predetermined time and the operation frequency of the compressor 201 and executed based on the input of the operation unit 100a. Namely, the flowchart illustrated in Fig. 5 of the first to third embodiments and the flowchart illustrated in Fig. 11 of the fourth embodiment, not limited to a configuration in which they are processed by the controller 100 separately, may be configured to be processed by the controller 100 in parallel.

[0245] Although in the embodiment, an example has been illustrated in which the air conditioning apparatus 1 has a configuration of a packaged air conditioner (PAC) including one outdoor unit 20 and three indoor units 30, the present invention is not limited to this. For example, the present invention may be applied to a configuration of a room air conditioner (RAC) including one outdoor unit 20 and one indoor unit 30, a packaged air conditioner (PAC) in which a plurality of indoor units is connected to a plurality of outdoor units, or a multi-air-conditioner for building (VRF).

[Industrial Applicability]

[0246] As described above, the air conditioning apparatus according to the present invention can be preferably used as an air conditioning apparatus capable of, even when refrigerant leakage occurs, suppressing the leaking refrigerant amount.

[Reference Signs List]

[0247]

1 air conditioning apparatus
11, 13a, 13b, 13c liquid side pipe (refrigerant pipe)
12, 14a, 14b, 14c gas side pipe (refrigerant pipe)
20 outdoor unit
30a, 30b, 30c indoor unit
100 controller
100a operation unit (input unit, second input unit)
101a, 101b, 101c first opening and closing device
102a, 102b, 102c second opening and closing device
201 compressor
301a, 301b, 301c indoor heat exchanger (use side heat exchanger)
302a, 302b, 302c indoor fan
304a, 304b, 304c indoor expansion valve (expansion device)
305a, 305b, 305c first temperature sensor
306a, 306b, 306c second temperature sensor
307a, 307b, 307c refrigerant leakage sensor

Claims

1. An air conditioning apparatus (1) comprising:

   an outdoor unit (20) comprising a compressor (201);
   an indoor unit (30) comprising a use side heat exchanger (301);
   a refrigerant pipe (11, 12, 13, 14) connecting the outdoor unit (20) and the indoor unit (30);
   an opening and closing device (101, 102) disposed in the refrigerant pipe (11, 12, 13, 14); and
   a controller (100),
   characterized in that the controller (100) is configured to execute a sticking prevention operation in which the opening and closing device (101, 102) is opened and closed when a refrigerant is not leaking.

2. The air conditioning apparatus (1) according to claim 1,
   wherein the refrigerant pipe (11, 12, 13, 14) comprises:

   a liquid side pipe (11, 13); and
   a gas side pipe (12, 14), and
   the opening and closing device (101, 102) comprises:

   a first opening and closing device (101) configured to open and close the liquid side pipe (11, 13) connected to the indoor unit (30); and
   a second opening and closing device (102) configured to open and close the gas side pipe (12, 14) connected to the indoor unit (30).

3. The air conditioning apparatus (1) according to claim 2,
   wherein the controller (100) is configured to execute the sticking prevention operation in which the first opening and closing device (101) and the second opening and closing device (102) are opened and closed.

4. The air conditioning apparatus (1) according to claim 3,
   wherein the liquid side pipe (11, 13) is provided with an expansion device (304) configured to control a refrigerant flow rate between the first opening and closing device (101) and the use side heat exchanger (301).

5. The air conditioning apparatus (1) according to claim 4, comprising a plurality of the indoor units (30) disposed in parallel,
   wherein the first opening and closing device (101) and the second opening and closing device (102) are provided in each of the indoor units (30), and
   the expansion device (304) is provided in each of the indoor units (30).

6. The air conditioning apparatus (1) according to claim 5,
   wherein the controller (100) is configured to, when executing the sticking prevention operation, if the compressor (201) is stopped, execute the sticking prevention operation of the opening and closing devices (101, 102) of all of the indoor units (30).

7. The air conditioning apparatus (1) according to claim 5 or 6,
   wherein the controller (100) is configured to, when executing the sticking prevention operation, if the compressor (201) is in operation and the indoor unit (30) out of operation is present, control opening of the expansion device (304) of the indoor unit (30) out of operation, control closing of the expansion device (304) of the indoor unit (30) in operation, and execute the sticking prevention operation of the opening and closing device (101, 102) of the indoor unit (30) in operation.

8. The air conditioning apparatus (1) according to any one of claims 5 to 7,
   wherein the controller (100) is configured to, when executing the sticking prevention operation, if the compressor (201) is in operation and there is a plurality of the indoor units (30) in operation, control closing of the expansion device (304) of a first indoor unit (30) in operation and execute the sticking prevention operation of the opening and closing device (101, 102) of the first indoor unit (30) in operation, then control closing of the expansion device (304) of a second indoor unit (30) in operation and execute the sticking prevention operation of the opening and closing device (101, 102) of the second indoor unit (30) in operation.

9. The air conditioning apparatus (1) according to claim 7 or 8,
   wherein the controller (100) is configured to, when executing the sticking prevention operation, execute the sticking prevention operation of the opening and closing device (101, 102) of the indoor unit (30) out of operation.

10. The air conditioning apparatus (1) according to any one of claims 1 to 9,
    wherein the controller (100) is configured to, after elapse of a first predetermined time from execution of the sticking prevention operation, execute the sticking prevention operation again.

11. The air conditioning apparatus (1) according to any

one of claims 1 to 10,
wherein the controller (100) is configured to, when an operation frequency of the compressor (201) is equal to or less than a predetermined value, execute the sticking prevention operation.

12. The air conditioning apparatus (1) according to any one of claims 1 to 11, comprising an input unit (100a) configured to input permission to shift to the sticking prevention operation,
wherein the controller (100) is configured to, when detecting an input of the input unit (100a), execute the sticking prevention operation.

13. The air conditioning apparatus (1) according to claim 4 or 5,
wherein the controller (100) is configured to execute abnormality determination control in which closing of at least one of the first opening and closing device (101) and the second opening and closing device (102) is controlled in a state where the expansion device (304) is opened and in which an abnormal state of an opening and closing device (101, 102) controlled to close out of the first opening and closing device (101) and the second opening and closing device (102) is determined.

14. The air conditioning apparatus (1) according to claim 13, comprising:

a first temperature sensor (305) disposed in the liquid side pipe (11, 13) between the first opening and closing device (101) and the use side heat exchanger (301), the first temperature sensor (305) being configured to detect a refrigerant temperature; and
a second temperature sensor (306) disposed in the gas side pipe (12, 14) between the second opening and closing device (102) and the use side heat exchanger (301), the second temperature sensor (306) being configured to detect a refrigerant temperature,
wherein in the abnormality determination control, the controller (100) is configured to control opening of one of the first opening and closing device (101) and the second opening and closing device (102), control closing of the other opening and closing device (101, 102), and determine that, when a differential value between the temperatures detected by the first temperature sensor (305) and the second temperature sensor (306) is higher than a predetermined temperature, the other opening and closing device (101, 102) is in the abnormal state.

15. The air conditioning apparatus (1) according to claim 14,
wherein in the abnormality determination control, the controller (100) is configured to throttle the expansion device (304), control opening of an opening and closing device (101, 102) on an upstream side of a refrigerant flow direction between the first opening and closing device (101) and the second opening and closing device (102), control closing of an opening and closing device (101, 102) on a downstream side of the refrigerant flow direction between the first opening and closing device (101) and the second opening and closing device (102), and determine whether the opening and closing device (101, 102) on the downstream side is in the abnormal state.

16. The air conditioning apparatus (1) according to claim 15,
wherein in the abnormality determination control, the controller (100) is configured to, after determining whether the opening and closing device (101, 102) on the downstream side is in the abnormal state, control opening of the opening and closing device (101, 102) on the downstream side, control closing of the opening and closing device (101, 102) on the upstream side, and determine whether the opening and closing device (101, 102) on the upstream side is in the abnormal state.

17. The air conditioning apparatus (1) according to any one of claims 13 to 16,
wherein in the abnormality determination control, the controller (100) is configured to, when determining that the opening and closing device (101, 102) is in the abnormal state, notify that the opening and closing device (101, 102) is in the abnormal state.

18. The air conditioning apparatus (1) according to any one of claims 13 to 17,
wherein the controller (100) is configured to, when an operation frequency of the compressor (201) is equal to or less than a predetermined value, if a second predetermined time has elapsed from execution of the abnormality determination control, execute the abnormality determination control again.

19. The air conditioning apparatus (1) according to any one of claims 13 to 18, comprising a second input unit (100a) configured to input permission to shift to the abnormality determination control,
wherein the controller (100) is configured to, when detecting an input of the second input unit (100a), execute the abnormality determination control.

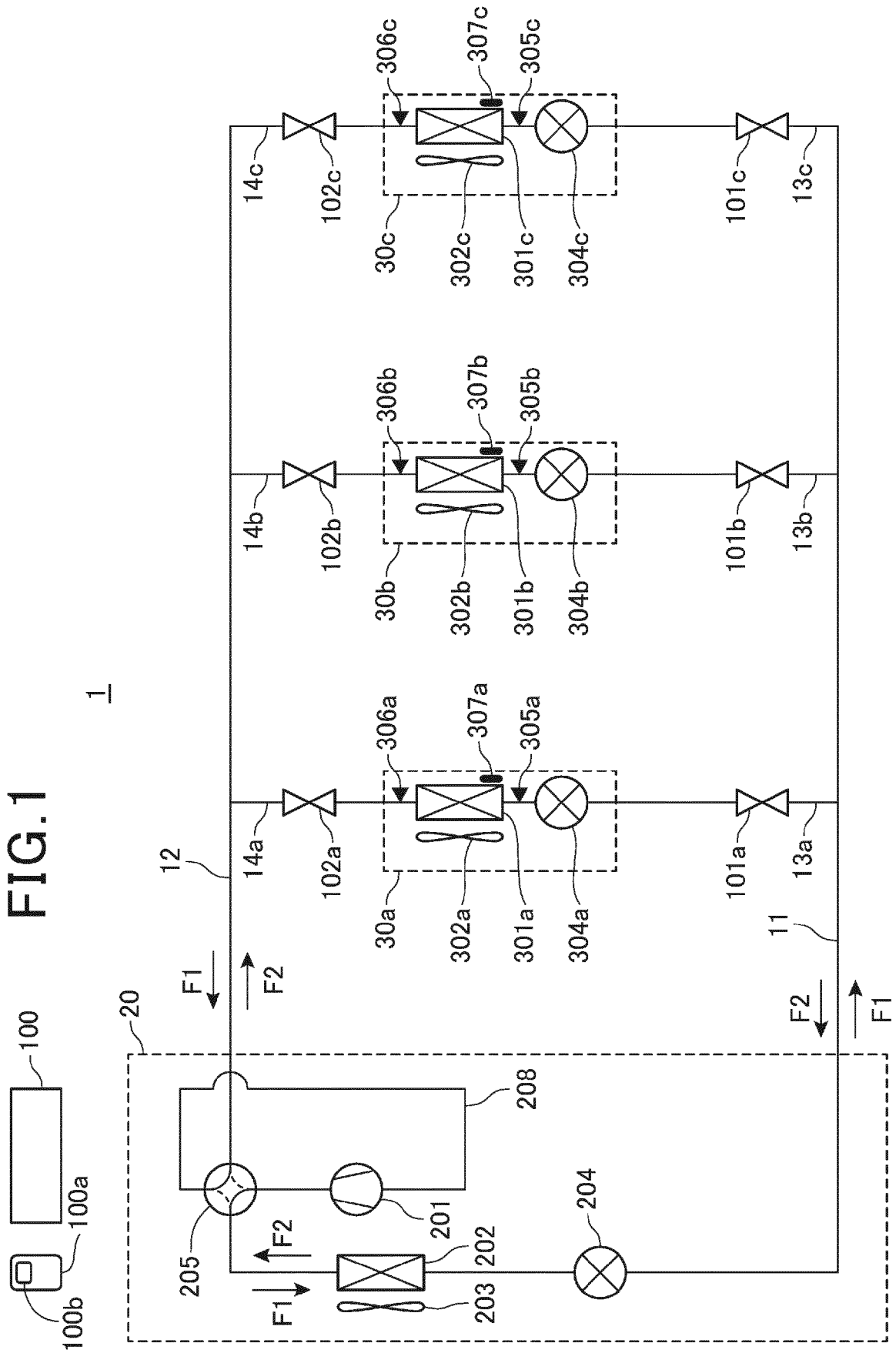
20. The air conditioning apparatus (1) according to any one of claims 13 to 19,
wherein in the abnormality determination control, the controller (100) is configured to, when determining that at least one of the first opening and closing device (101) and the second opening and closing device (102) is in the abnormal state, control closing of

the expansion device (304).

21. The air conditioning apparatus (1) according to claim 4 or 5,
wherein the indoor unit (30) comprises a refrigerant leakage sensor (307) configured to detect a refrigerant concentration, and
the controller (100) is configured to, when the concentration detected by the refrigerant leakage sensor (307) is equal to or more than a predetermined value, control an operation frequency of the compressor (201) so as to be equal to or less than a predetermined value, then close the opening and closing device (101, 102).

22. The air conditioning apparatus (1) according to claim 21,
wherein the controller (100) is configured to, when the concentration detected by the refrigerant leakage sensor (307) is equal to or more than a predetermined value, control closing of the expansion device (304) and then close the opening and closing device (101, 102).

FIG. 1


1
12
11
20
100
100a
100b
F1
F2
14a
102a
306a
307a
305a
30a
302a
301a
304a
101a
13a
14b
102b
306b
307b
305b
30b
302b
301b
304b
101b
13b
14c
102c
306c
307c
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30c
302c
301c
304c
101c
13c
208
201
205
202
203
204

FIG.2

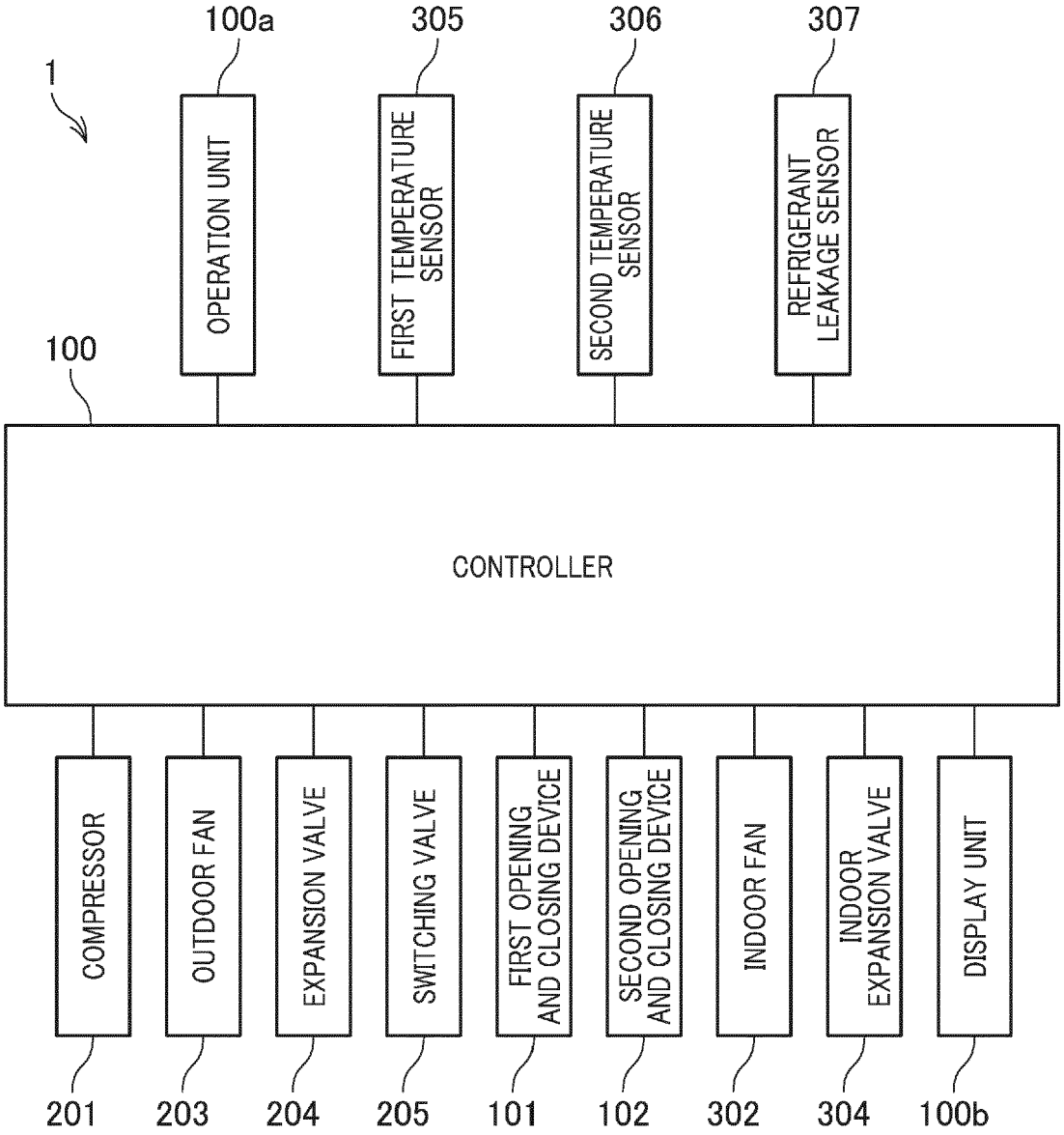

1
100a
305
306
307
OPERATION UNIT
FIRST TEMPERATURE SENSOR
SECOND TEMPERATURE SENSOR
REFRIGERANT LEAKAGE SENSOR
100
CONTROLLER
COMPRESSOR
OUTDOOR FAN
EXPANSION VALVE
SWITCHING VALVE
FIRST OPENING AND CLOSING DEVICE
SECOND OPENING AND CLOSING DEVICE
INDOOR FAN
INDOOR EXPANSION VALVE
DISPLAY UNIT
201
203
204
205
101
102
302
304
100b

FIG.3

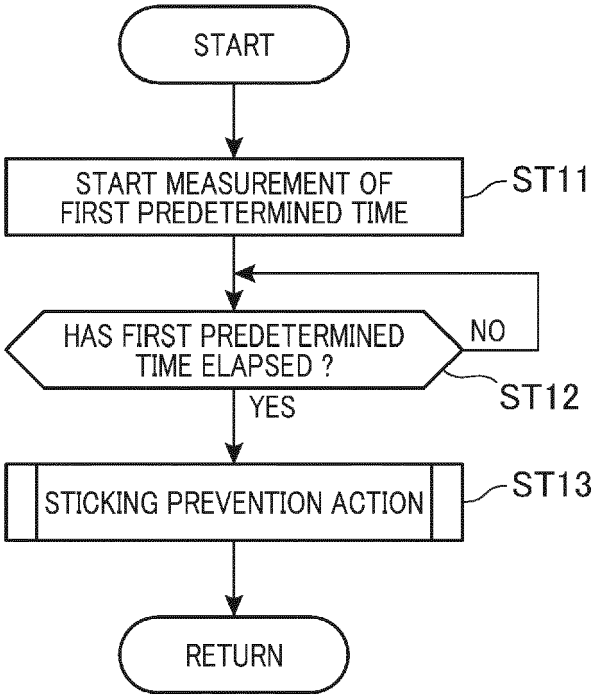

START
START MEASUREMENT OF FIRST PREDETERMINED TIME
ST11
HAS FIRST PREDETERMINED TIME ELAPSED ?
NO
ST12
YES
STICKING PREVENTION ACTION
ST13
RETURN

FIG.4

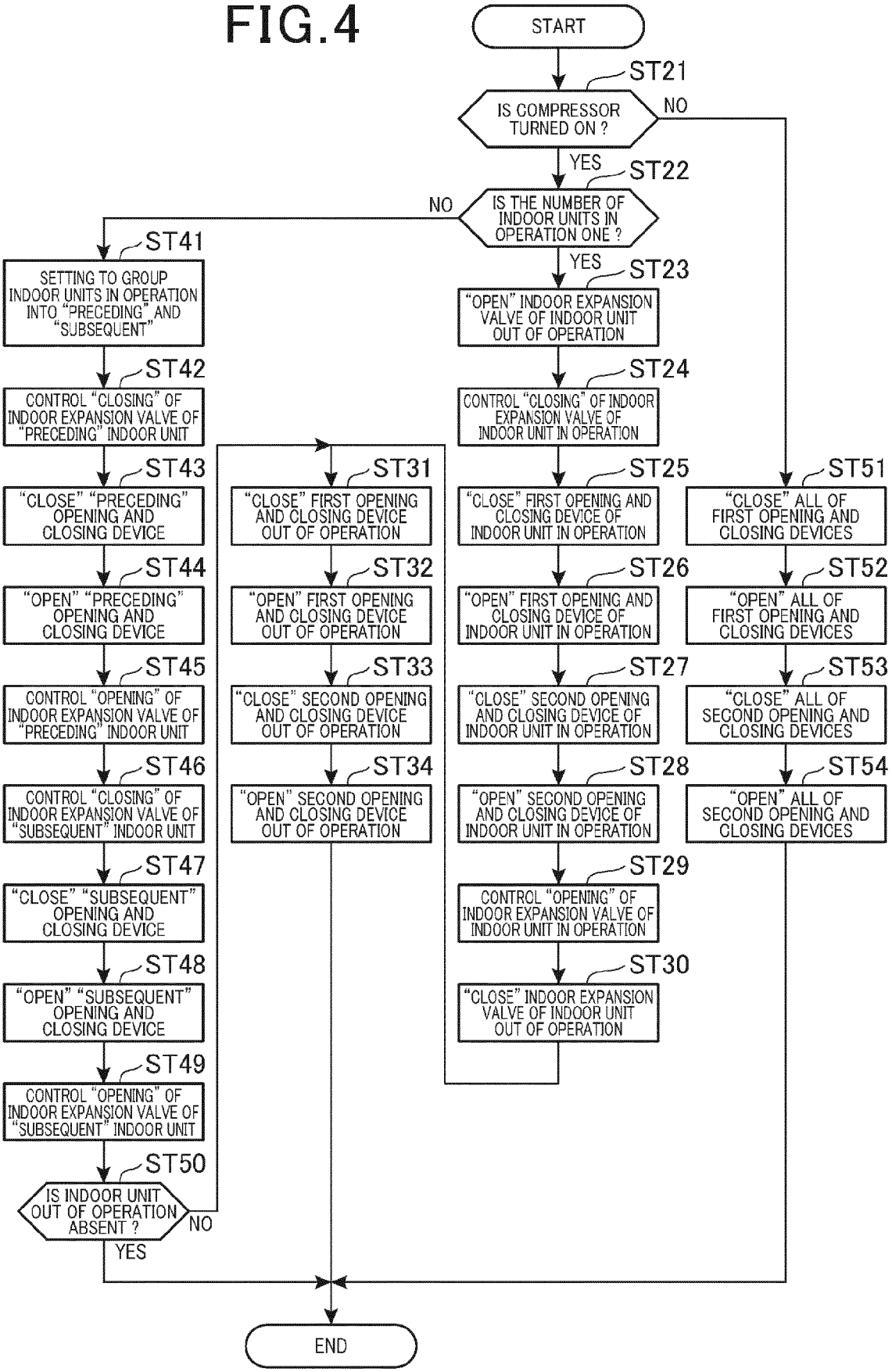

START
ST21
IS COMPRESSOR TURNED ON ?
NO
YES
ST22
IS THE NUMBER OF INDOOR UNITS IN OPERATION ONE ?
NO
YES
ST41
SETTING TO GROUP INDOOR UNITS IN OPERATION INTO "PRECEDING" AND "SUBSEQUENT"
ST23
"OPEN" INDOOR EXPANSION VALVE OF INDOOR UNIT OUT OF OPERATION
ST42
CONTROL "CLOSING" OF INDOOR EXPANSION VALVE OF "PRECEDING" INDOOR UNIT
ST24
CONTROL "CLOSING" OF INDOOR EXPANSION VALVE OF INDOOR UNIT IN OPERATION
ST43
"CLOSE" "PRECEDING" OPENING AND CLOSING DEVICE
ST31
"CLOSE" FIRST OPENING AND CLOSING DEVICE OUT OF OPERATION
ST25
"CLOSE" FIRST OPENING AND CLOSING DEVICE OF INDOOR UNIT IN OPERATION
ST51
"CLOSE" ALL OF FIRST OPENING AND CLOSING DEVICES
ST44
"OPEN" "PRECEDING" OPENING AND CLOSING DEVICE
ST32
"OPEN" FIRST OPENING AND CLOSING DEVICE OUT OF OPERATION
ST26
"OPEN" FIRST OPENING AND CLOSING DEVICE OF INDOOR UNIT IN OPERATION
ST52
"OPEN" ALL OF FIRST OPENING AND CLOSING DEVICES
ST45
CONTROL "OPENING" OF INDOOR EXPANSION VALVE OF "PRECEDING" INDOOR UNIT
ST33
"CLOSE" SECOND OPENING AND CLOSING DEVICE OUT OF OPERATION
ST27
"CLOSE" SECOND OPENING AND CLOSING DEVICE OF INDOOR UNIT IN OPERATION
ST53
"CLOSE" ALL OF SECOND OPENING AND CLOSING DEVICES
ST46
CONTROL "CLOSING" OF INDOOR EXPANSION VALVE OF "SUBSEQUENT" INDOOR UNIT
ST34
"OPEN" SECOND OPENING AND CLOSING DEVICE OUT OF OPERATION
ST28
"OPEN" SECOND OPENING AND CLOSING DEVICE OF INDOOR UNIT IN OPERATION
ST54
"OPEN" ALL OF SECOND OPENING AND CLOSING DEVICES
ST47
"CLOSE" "SUBSEQUENT" OPENING AND CLOSING DEVICE
ST29
CONTROL "OPENING" OF INDOOR EXPANSION VALVE OF INDOOR UNIT IN OPERATION
ST48
"OPEN" "SUBSEQUENT" OPENING AND CLOSING DEVICE
ST30
"CLOSE" INDOOR EXPANSION VALVE OF INDOOR UNIT OUT OF OPERATION
ST49
CONTROL "OPENING" OF INDOOR EXPANSION VALVE OF "SUBSEQUENT" INDOOR UNIT
ST50
IS INDOOR UNIT OUT OF OPERATION ABSENT ?
NO
YES
END

FIG.5

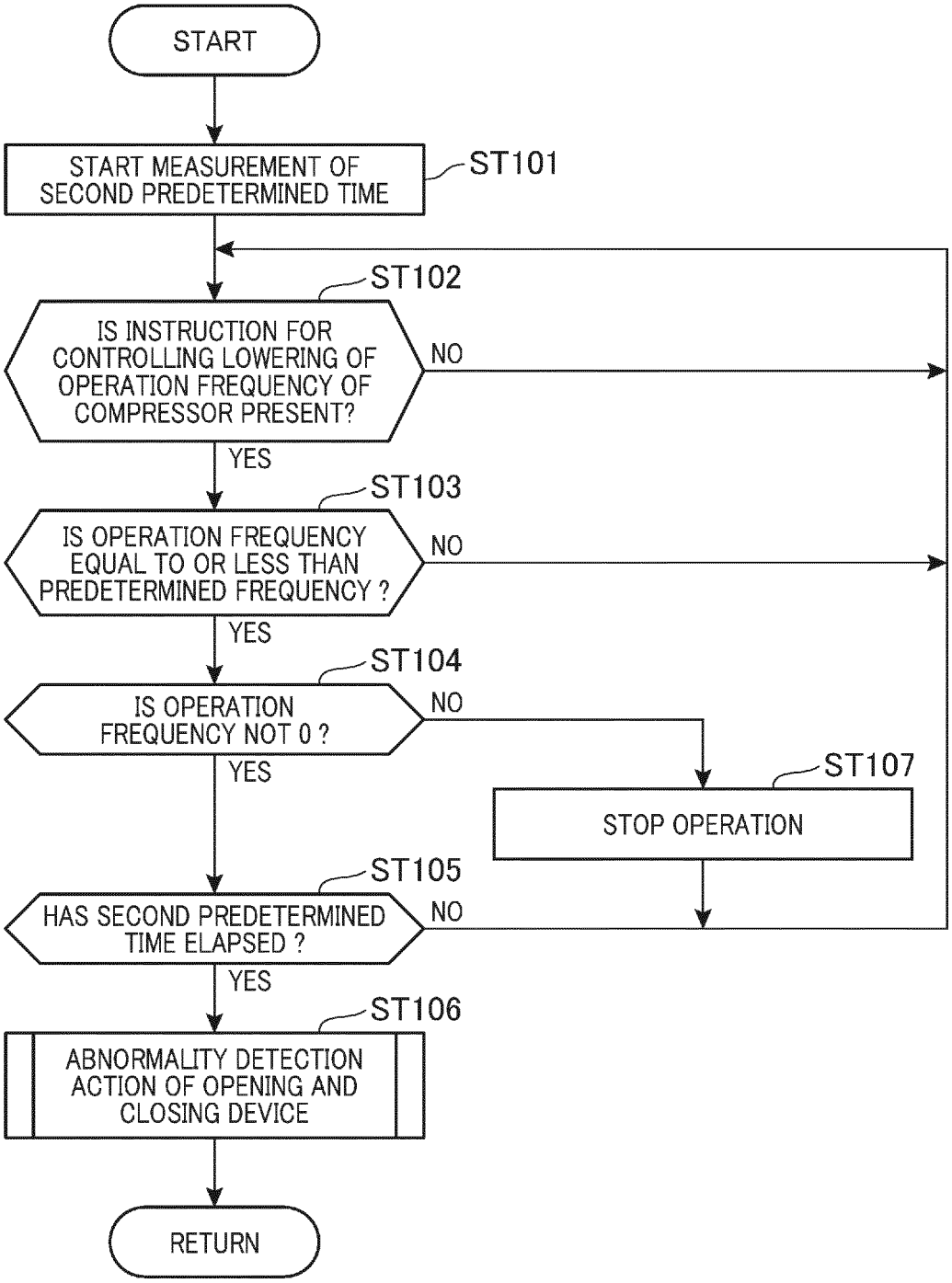

START
START MEASUREMENT OF SECOND PREDETERMINED TIME
ST101
ST102
IS INSTRUCTION FOR CONTROLLING LOWERING OF OPERATION FREQUENCY OF COMPRESSOR PRESENT?
NO
YES
ST103
IS OPERATION FREQUENCY EQUAL TO OR LESS THAN PREDETERMINED FREQUENCY ?
NO
YES
ST104
IS OPERATION FREQUENCY NOT 0 ?
NO
YES
ST107
STOP OPERATION
ST105
HAS SECOND PREDETERMINED TIME ELAPSED ?
NO
YES
ST106
ABNORMALITY DETECTION ACTION OF OPENING AND CLOSING DEVICE
RETURN

FIG.6

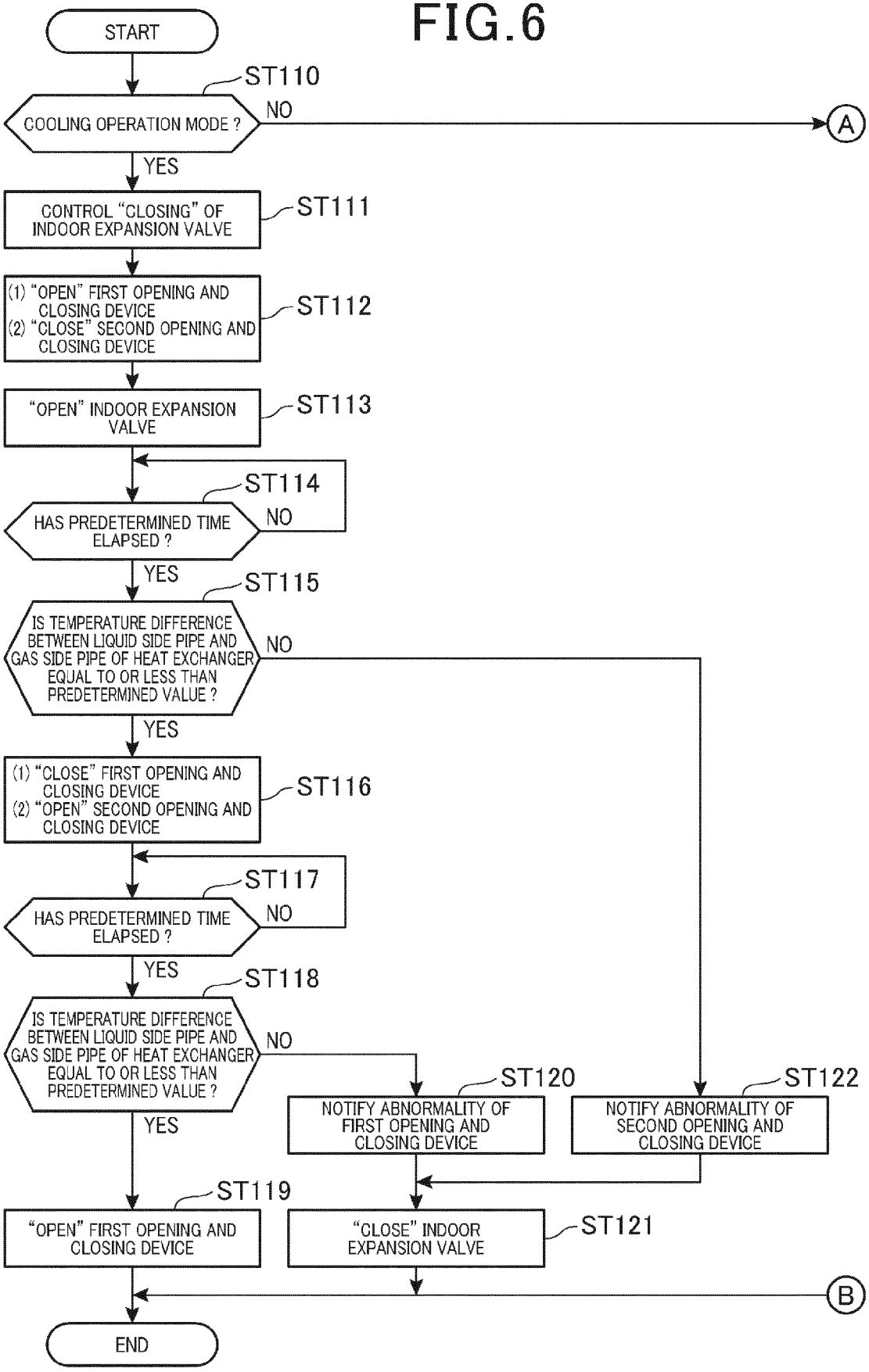

START
ST110
COOLING OPERATION MODE ?
NO
A
YES
CONTROL "CLOSING" OF INDOOR EXPANSION VALVE
ST111
(1) "OPEN" FIRST OPENING AND CLOSING DEVICE
(2) "CLOSE" SECOND OPENING AND CLOSING DEVICE
ST112
"OPEN" INDOOR EXPANSION VALVE
ST113
ST114
HAS PREDETERMINED TIME ELAPSED ?
NO
YES
ST115
IS TEMPERATURE DIFFERENCE BETWEEN LIQUID SIDE PIPE AND GAS SIDE PIPE OF HEAT EXCHANGER EQUAL TO OR LESS THAN PREDETERMINED VALUE ?
NO
YES
(1) "CLOSE" FIRST OPENING AND CLOSING DEVICE
(2) "OPEN" SECOND OPENING AND CLOSING DEVICE
ST116
ST117
HAS PREDETERMINED TIME ELAPSED ?
NO
YES
ST118
IS TEMPERATURE DIFFERENCE BETWEEN LIQUID SIDE PIPE AND GAS SIDE PIPE OF HEAT EXCHANGER EQUAL TO OR LESS THAN PREDETERMINED VALUE ?
NO
YES
ST120
NOTIFY ABNORMALITY OF FIRST OPENING AND CLOSING DEVICE
ST122
NOTIFY ABNORMALITY OF SECOND OPENING AND CLOSING DEVICE
ST119
"OPEN" FIRST OPENING AND CLOSING DEVICE
"CLOSE" INDOOR EXPANSION VALVE
ST121
B
END

FIG. 7

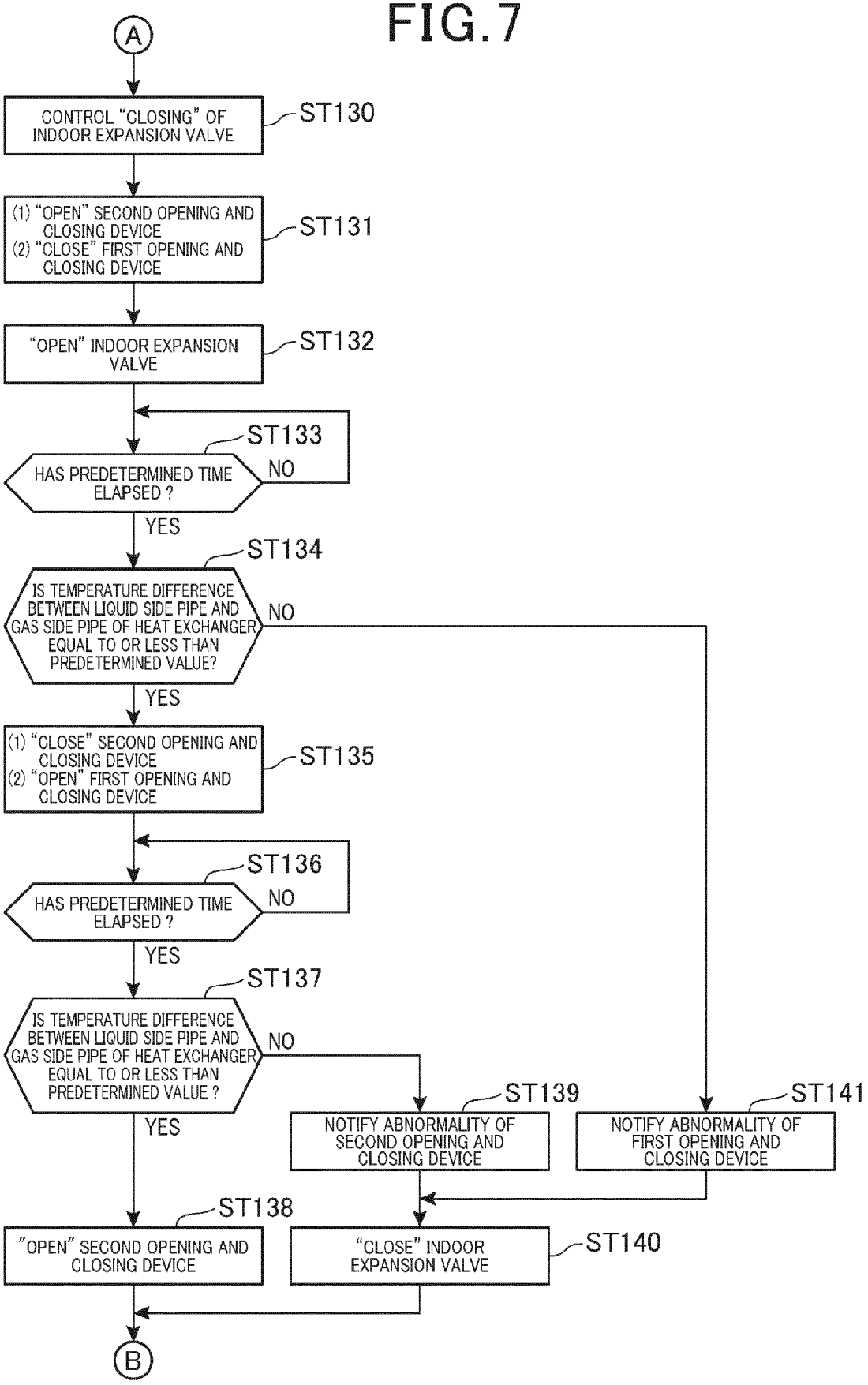

A
CONTROL "CLOSING" OF INDOOR EXPANSION VALVE
ST130
(1) "OPEN" SECOND OPENING AND CLOSING DEVICE
(2) "CLOSE" FIRST OPENING AND CLOSING DEVICE
ST131
"OPEN" INDOOR EXPANSION VALVE
ST132
ST133
HAS PREDETERMINED TIME ELAPSED ?
NO
YES
ST134
IS TEMPERATURE DIFFERENCE BETWEEN LIQUID SIDE PIPE AND GAS SIDE PIPE OF HEAT EXCHANGER EQUAL TO OR LESS THAN PREDETERMINED VALUE?
NO
YES
(1) "CLOSE" SECOND OPENING AND CLOSING DEVICE
(2) "OPEN" FIRST OPENING AND CLOSING DEVICE
ST135
ST136
HAS PREDETERMINED TIME ELAPSED ?
NO
YES
ST137
IS TEMPERATURE DIFFERENCE BETWEEN LIQUID SIDE PIPE AND GAS SIDE PIPE OF HEAT EXCHANGER EQUAL TO OR LESS THAN PREDETERMINED VALUE ?
NO
YES
ST139
NOTIFY ABNORMALITY OF SECOND OPENING AND CLOSING DEVICE
ST141
NOTIFY ABNORMALITY OF FIRST OPENING AND CLOSING DEVICE
ST138
"OPEN" SECOND OPENING AND CLOSING DEVICE
"CLOSE" INDOOR EXPANSION VALVE
ST140
B

FIG.8

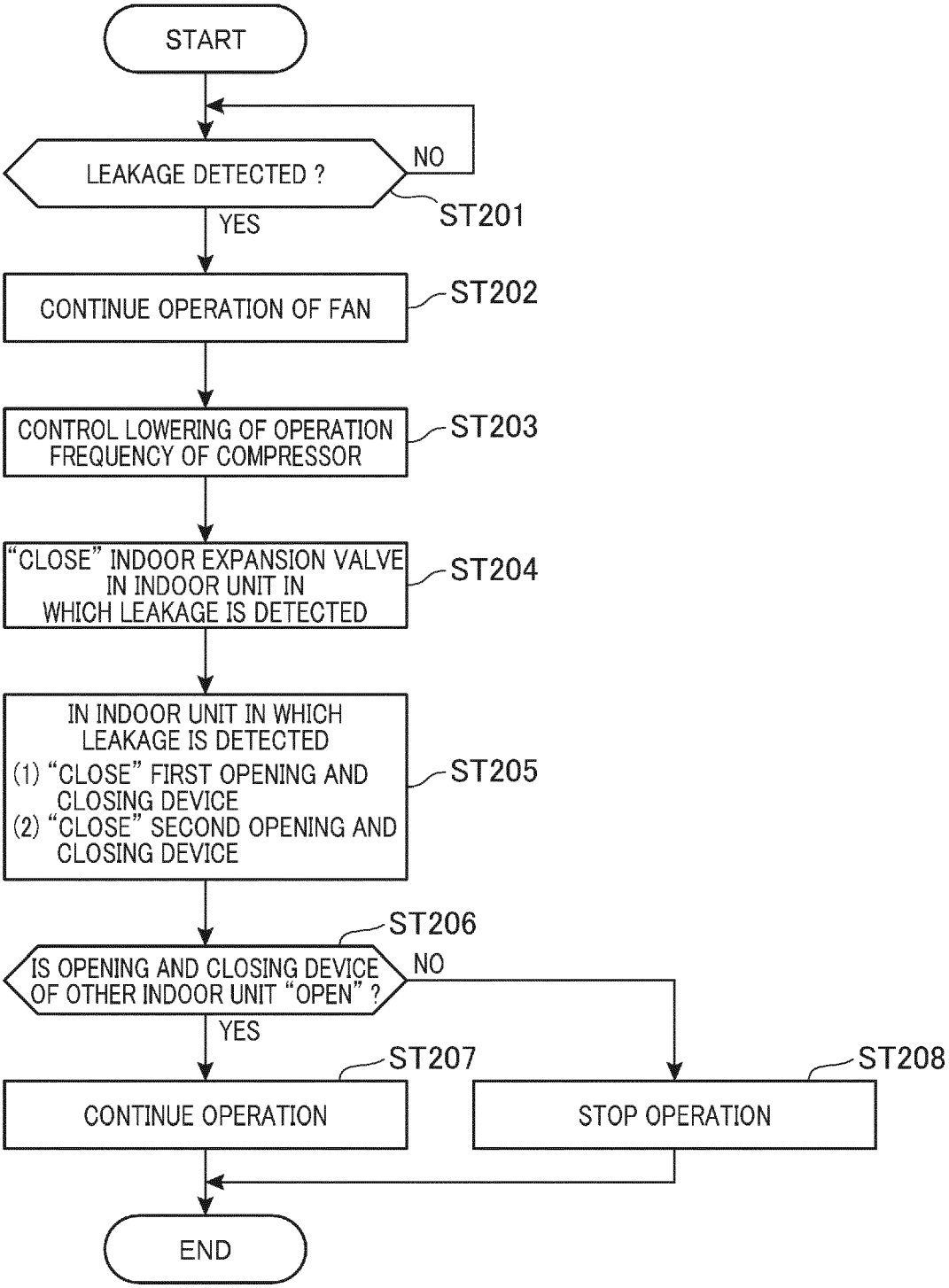

START
LEAKAGE DETECTED ?
NO
YES
ST201
CONTINUE OPERATION OF FAN
ST202
CONTROL LOWERING OF OPERATION FREQUENCY OF COMPRESSOR
ST203
"CLOSE" INDOOR EXPANSION VALVE IN INDOOR UNIT IN WHICH LEAKAGE IS DETECTED
ST204
IN INDOOR UNIT IN WHICH LEAKAGE IS DETECTED
(1) "CLOSE" FIRST OPENING AND CLOSING DEVICE
(2) "CLOSE" SECOND OPENING AND CLOSING DEVICE
ST205
ST206
IS OPENING AND CLOSING DEVICE OF OTHER INDOOR UNIT "OPEN" ?
NO
YES
ST207
CONTINUE OPERATION
ST208
STOP OPERATION
END

FIG.9

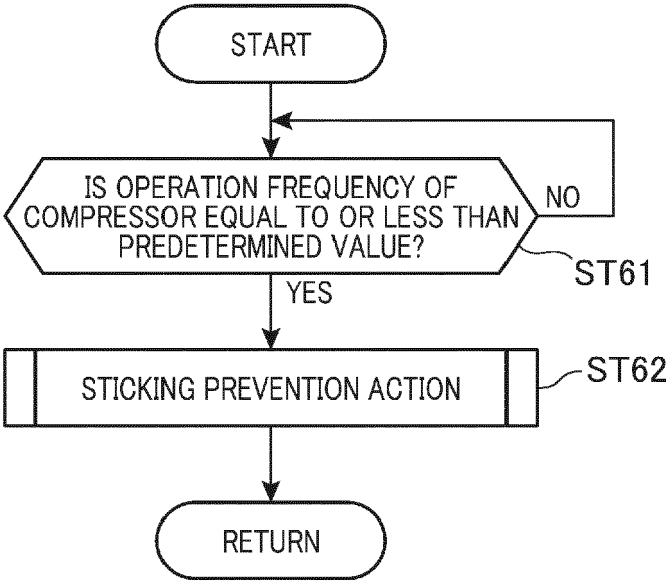

START
IS OPERATION FREQUENCY OF COMPRESSOR EQUAL TO OR LESS THAN PREDETERMINED VALUE?
NO
ST61
YES
STICKING PREVENTION ACTION
ST62
RETURN

FIG.10

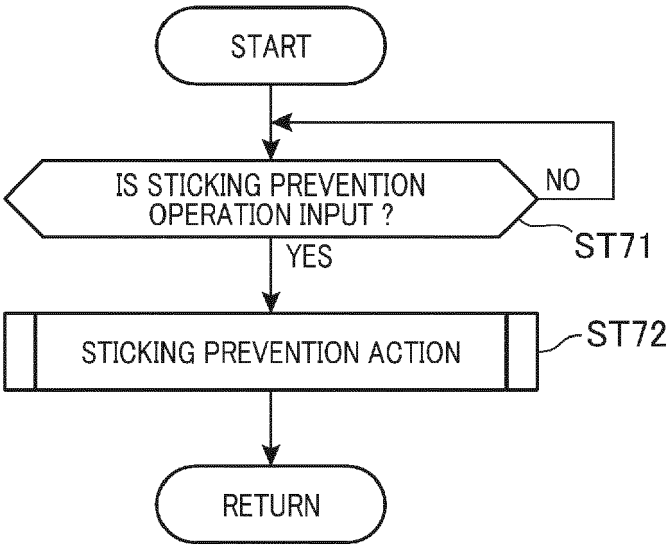
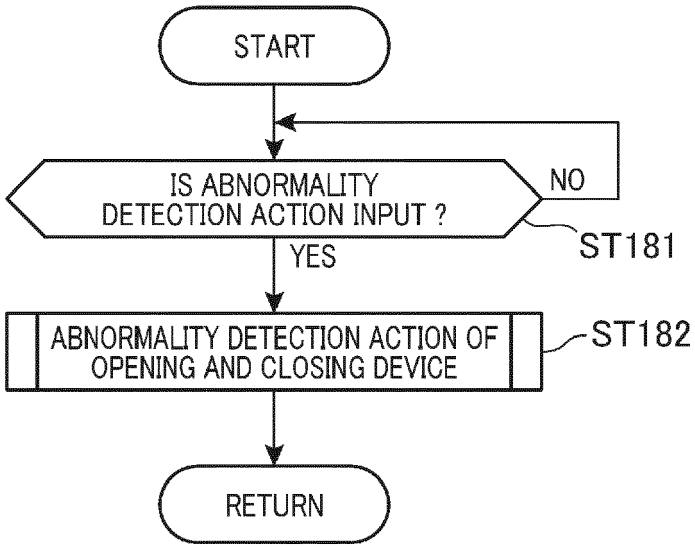

START
IS STICKING PREVENTION OPERATION INPUT ?
NO
ST71
YES
STICKING PREVENTION ACTION
ST72
RETURN

FIG.11


START
IS ABNORMALITY DETECTION ACTION INPUT ?
NO
ST181
YES
ABNORMALITY DETECTION ACTION OF OPENING AND CLOSING DEVICE
ST182
RETURN

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EUROPEAN SEARCH REPORT

Application Number
EP 21 15 7496

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	WO 2018/216127 A1 (MITSUBISHI ELECTRIC CORP [JP]) 29 November 2018 (2018-11-29) * paragraphs [0012] - [0046], [0080]; figures 1, 2, 4, 5 *	1-5,10, 12 6-9,11, 13-22	INV. F25B13/00 F25B41/24 F25B49/00
A	JP 6 120979 B2 (MITSUBISHI ELECTRIC CORP) 26 April 2017 (2017-04-26) * paragraphs [0095], [0096], [0097] *	1-22	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 June 2021	Amous, Moez

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