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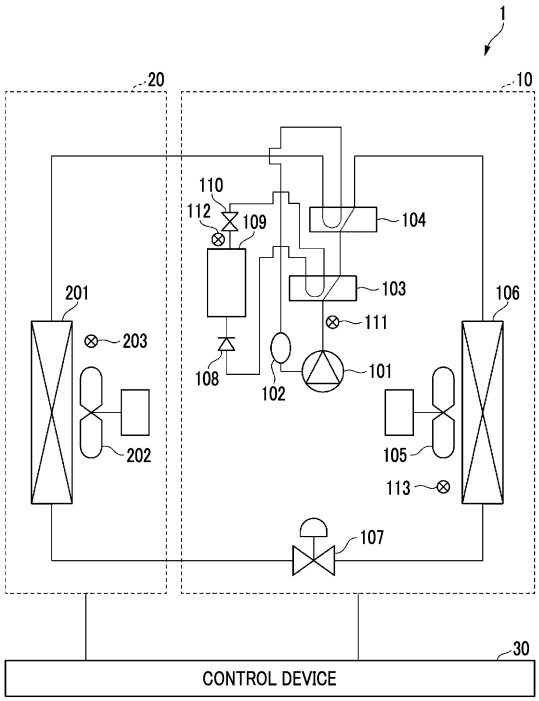
(54) AIR CONDITIONER, CONTROL METHOD, AND PROGRAM

(57) This air conditioner comprises a condenser for condensing a refrigerant, an evaporator for evaporating the condensed refrigerant, a compressor for compressing the evaporated refrigerant, a receiver capable of recovering the compressed refrigerant, and a switching valve that can switch the discharge destination of the compressed refrigerant from the compressor to the receiver.

FIG. 1



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Description

Technical Field

[0001] The present disclosure relates to an air conditioner, a control method, and a program.

[0002] Priority is claimed on Japanese Patent Application No. 2020-066032, filed April 1, 2020, the content of which is incorporated herein by reference.

Background Art

[0003] Various types of refrigerants are used in air conditioners. From the viewpoint of preventing global warming, the use of refrigerants with a low global warming potential (GWP) is being promoted.

[0004] PTL 1 discloses, as a related technique, a technique relating to a refrigerating cycle device for storing a refrigerant such that a pipe having a low design pressure can be used.

Citation List

Patent Literature

[0005] [PTL 1] International Publication No. 2017/175299

Summary of Invention

Technical Problem

[0006] By the way, among the refrigerants having a low GWP, there are refrigerants having higher combustibility than the refrigerants having a high GWP. When such a refrigerant leaks to the outside of the air conditioner, it is necessary to ensure that the refrigerant does not burn.

[0007] Therefore, when a refrigerant leaks in an air conditioner, there is a demand for a technique capable of reducing the leakage.

[0008] An object of the present disclosure is to provide an air conditioner, a control method and a program capable of solving the above-described problems.

Solution to Problem

[0009] In order to solve the above problems, an air conditioner according to the present disclosure includes: a condenser that condenses a refrigerant; an evaporator that evaporates the condensed refrigerant; a compressor that compresses the evaporated refrigerant; a receiver capable of recovering the compressed refrigerant; and a switching valve capable of switching a discharge destination of the compressed refrigerant from the condenser to the receiver.

[0010] A control method according to the present disclosure performed by an air conditioner including a condenser that condenses a refrigerant, an evaporator that evaporates the condensed refrigerant, a compressor that compresses the evaporated refrigerant, a receiver capable of recovering the compressed refrigerant, and a switching valve capable of switching a discharge destination of the compressed refrigerant from the condenser to the receiver, the method including: controlling a flow path in the switching valve.

[0011] A program according to the present disclosure causes a computer in an air conditioner to control a flow path in a switching valve, the air conditioner including a condenser that condenses a refrigerant, an evaporator that evaporates the condensed refrigerant, a compressor that compresses the evaporated refrigerant, a receiver capable of recovering the compressed refrigerant, and the switching valve capable of switching a discharge destination of the compressed refrigerant from the condenser to the receiver.

Advantageous Effects of Invention

[0012] According to the air conditioner, the control method, and the program according to the embodiment of the present disclosure, when the refrigerant leaks in the air conditioner, the leakage can be reduced.

Brief Description of Drawings

[0013]

Fig. 1 is a diagram showing an example of a configuration of an air conditioner according to a first embodiment of the present disclosure.

Fig. 2 is a diagram showing an example of a configuration of a control device according to the first embodiment of the present disclosure.

Fig. 3 is a first diagram for explaining a determination whether recovery of a refrigerant has been completed in the first embodiment of the present disclosure.

Fig. 4 is a second diagram for explaining a determination whether the recovery of the refrigerant has been completed in the first embodiment of the present disclosure.

Fig. 5 is a diagram showing an example of a processing flow of the air conditioner according to the first embodiment of the present disclosure.

Fig. 6 is a diagram showing an example of a configuration of an air conditioner according to a second embodiment of the present disclosure.

Fig. 7 is a diagram showing an example of a processing flow of the air conditioner according to the second embodiment of the present disclosure.

Fig. 8 is a schematic block diagram illustrating a configuration of a computer according to at least one embodiment.

Description of Embodiments

<First Embodiment>

[0014] Hereinafter, embodiments will be described in detail with reference to the drawings.

(Configuration of air conditioner)

[0015] The configuration of an air conditioner 1 according to a first embodiment of the present disclosure will be described.

[0016] The air conditioner 1 according to the first embodiment of the present disclosure is an air conditioner that recovers the refrigerant in the receiver, when the leakage of the refrigerant from the air conditioner is detected. As shown in Fig. 1, the air conditioner 1 includes an outdoor unit 10, an indoor unit 20, and a control device 30.

[0017] In the first embodiment, the air conditioner 1 will be described by using the operation during the cooling operation as an example (that is, by using the case of operating as a refrigerating cycle device as an example) among the heating and cooling operations of the air conditioner 1, and the operation during the heating operation will be described at the end of the first embodiment.

(Configuration of outdoor unit)

[0018] As shown in Fig. 1, the outdoor unit 10 includes a compressor 101, an accumulator 102, a switching valve 103 (an example of a switching valve), a four-way valve 104, a blower fan 105, a heat exchanger 106 (an example of a condenser, an example of a compressor), a throttle mechanism 107 (an example of an expansion valve), a check valve 108, a receiver 109, an on/off valve 110, a discharge temperature sensor 111, a receiver temperature sensor 112, and a gas sensor 113 (an example of a gas sensor).

[0019] The compressor 101 is a device that compresses a gaseous refrigerant. The refrigerant compressed by the compressor 101 is normally sent to the heat exchanger 106 via the switching valve 103 and the four-way valve 104.

[0020] The accumulator 102 is a device that separates a liquid refrigerant and a gaseous refrigerant. Only the gaseous refrigerant among the refrigerants separated by the accumulator 102 is sent to the compressor 101.

[0021] The switching valve 103 is a valve that switches the destination of the refrigerant discharged from the compressor 101.

[0022] For example, the switching valve 103 normally sets the destination of the refrigerant discharged from the compressor 101 to the heat exchanger 106. Further, when the leakage of the refrigerant is detected, the switching valve 103 uses the receiver 109 as the destination of the refrigerant discharged from the compressor 101.

[0023] The four-way valve 104 is a valve that switches between a cooling operation and a heating operation of the air conditioner 1. The four-way valve 104 uses the heat exchanger 106 as the destination of the refrigerant discharged from the compressor 101, during the cooling operation of the air conditioner 1. During the heating operation, the destination of the refrigerant is the heat exchanger 201.

[0024] The blower fan 105 is a fan that sends air to the heat exchanger 106.

[0025] The heat exchanger 106 operates as a condenser during the cooling operation of the air conditioner 1. That is, the gaseous refrigerant exchanges heat with the air sent by the blower fan 105 and becomes a liquid refrigerant. The liquid refrigerant in the heat exchanger 106 is sent to the throttle mechanism 107.

[0026] The throttle mechanism 107 includes a mechanism for reducing the pressure of the refrigerant and expanding the refrigerant. The throttle mechanism 107 reduces the temperature of the refrigerant. The throttle mechanism 107 is provided between the heat exchanger 106 and the heat exchanger 201, which will be described later. The throttle mechanism 107 is, for example, an electronic expansion valve.

[0027] The check valve 108 is a valve that prevents the backflow of the refrigerant. For example, when leakage of a refrigerant is detected and the receiver 109 is set as the destination of the refrigerant discharged from the compressor 101 by the switching valve 103, the check valve 108 sends the refrigerant only in the direction from the compressor 101 to the receiver 109.

[0028] The receiver 109 is a container that recovers and stores the refrigerant inside, when the leakage of the refrigerant is detected.

[0029] The on/off valve 110 is a valve that opens and closes the flow path of the refrigerant. For example, the on/off valve 110 is an electromagnetic valve.

[0030] The discharge temperature sensor 111 is a sensor that measures the temperature in the refrigerant discharge unit of the compressor 101. The discharge temperature sensor 111 is provided in the refrigerant discharge unit of the compressor 101.

[0031] The receiver temperature sensor 112 is a sensor that measures the temperature at the receiver 109. The receiver temperature sensor 112 is provided above the receiver 109.

[0032] The gas sensor 113 is a sensor that detects a gaseous refrigerant. For example, the gas sensor 113 is provided in the vicinity of the heat exchanger 106.

(Configuration of indoor unit)

[0033] As shown in Fig. 1, the indoor unit 20 includes a heat exchanger 201 (an example of a compressor and an example of a condenser), a blower fan 202, and a gas sensor 203 (an example of a gas sensor).

[0034] The blower fan 202 is a fan that sends air to the heat exchanger 201. The heat exchanger 201 operates

as an evaporator during the cooling operation of the air conditioner 1. That is, the refrigerant of which temperature is reduced by the throttle mechanism 107 exchanges heat with the air sent by the blower fan 202 and becomes a gaseous refrigerant. That is, the air conditioner 1 operates as a cooling cycle device.

[0035] The gas sensor 203 is a sensor that detects a gaseous refrigerant. For example, the gas sensor 203 is provided in the vicinity of the heat exchanger 201.

(Configuration of control device)

[0036] As shown in Fig. 2, the control device 30 includes a sensor information acquisition unit 301, a refrigerant leakage determination unit 302, a valve control unit 303 (an example of a first control unit and an example of a second control unit), a recovery completion determination unit 304 (an example of a determination unit), a fan control unit 305, and a storage unit 308.

[0037] The sensor information acquisition unit 301 acquires the measurement result of the temperature measured by the discharge temperature sensor 111 or the receiver temperature sensor 112. Further, the sensor information acquisition unit 301 acquires the detection result of the refrigerant from the gas sensor 113 and the gas sensor 203.

[0038] The refrigerant leakage determination unit 302 determines whether or not the refrigerant is leaking in the air conditioner 1, based on the detection result of the gas sensor 113 or the gas sensor 203.

[0039] For example, when the gas sensor 113 detects the refrigerant, the refrigerant leakage determination unit 302 determines that the refrigerant is leaking in the outdoor unit 10.

[0040] Further, for example, when the gas sensor 203 detects the refrigerant, the refrigerant leakage determination unit 302 determines that the refrigerant is leaking in the indoor unit 20.

[0041] The valve control unit 303 controls the switching valve 103, the four-way valve 104, the throttle mechanism 107, and the on/off valve 110.

[0042] For example, during the normal cooling operation of the air conditioner 1, the valve control unit 303 controls the flow path of the refrigerant in the switching valve 103 to connect the compressor 101 and the four-way valve 104, and connect the check valve 108 and the on/off valve 110. Further, the valve control unit 303 controls the flow path of the refrigerant in the four-way valve 104 to connect the switching valve 103 and the heat exchanger 106 and connect the accumulator 102 and the heat exchanger 201. Further, the valve control unit 303 performs control such that the opening degree of the throttle mechanism 107 becomes an appropriate opening degree. Further, the valve control unit 303 controls the on/off valve 110 to be shut off.

[0043] Further, for example, when the leakage of a refrigerant is detected in the cooling operation of the air conditioner 1, the valve control unit 303 controls the flow path of the refrigerant in the switching valve 103 to connect the compressor 101 and the check valve 108, and connect the four-way valve 104 and the on/off valve 110. Further, the valve control unit 303 controls the flow path of the refrigerant in the four-way valve 104 to connect the switching valve 103 and the heat exchanger 106 and connect the accumulator 102 and the heat exchanger 201. Further, the valve control unit 303 controls the opening degree of the throttle mechanism 107 to full open. Further, the valve control unit 303 controls the on/off valve 110 to be shut off.

[0044] The recovery completion determination unit 304 determines whether or not the recovery of the refrigerant in the receiver 109 has been completed, based on the measurement result of the discharge temperature sensor 111 or the measurement result of the receiver temperature sensor 112.

[0045] For example, when the refrigerant is recovered in the receiver 109, as shown in Fig. 3, the temperature measured by the receiver temperature sensor 112 rises, and then the temperature rise slows down. Therefore, the recovery completion determination unit 304 determines that the recovery of the refrigerant has been completed, when the measurement result of the receiver temperature sensor 112 determines that the rise has slowed down after the rise.

[0046] Further, for example, when the refrigerant is recovered in the receiver 109, the temperature measured by the discharge temperature sensor 111 decreases as shown in Fig. 4. The measurement result of the discharge temperature sensor 111 reaches the lower limit of the temperature when the refrigerant runs out, and then the temperature rises due to the heat of the motor of the compressor 101. Therefore, when it is determined that the measurement result of the discharge temperature sensor 111 decreases to the lower limit of the temperature and then increases, the recovery completion determination unit 304 determines that the recovery of the refrigerant has been completed.

[0047] The fan control unit 305 controls the rotation of the blower fan 105 and the blower fan 202.

[0048] The compressor control unit 306 controls the operation of the compressor 101.

[0049] For example, the compressor control unit 306 controls the compressor 101 to be in an operating state or a stopped state.

[0050] The error notification unit 307 makes a notification of the leakage of the refrigerant.

[0051] For example, the error notification unit 307 displays the leakage of the refrigerant on a display unit provided in the room or a display unit of the remote controller.

[0052] The storage unit 308 stores various types of information necessary for the process performed by the control device 30.

[0053] For example, the storage unit 308 stores the temperature threshold value used by the recovery completion determination unit 304 to determine whether or not the recovery of the refrigerant in the receiver 109 has

been completed.

[0054] With the above-described configuration, during the normal cooling operation of the air conditioner 1, the refrigerant flows through a flow path that circulates in the order of the compressor 101, the switching valve 103, the four-way valve 104, the heat exchanger 106, the throttle mechanism 107, the heat exchanger 201, the four-way valve 104, the accumulator 102, and the compressor 101.

(Process performed by the air conditioner)

[0055] Next, the process of the air conditioner 1 according to the first embodiment of the present disclosure will be described.

[0056] Here, the processing flow of the air conditioner 1 when the leakage of the refrigerant is detected in the heat exchanger 106 that operates as a condenser during the normal cooling operation of the air conditioner 1 shown in Fig. 5 will be described.

[0057] The air conditioner 1 is in a state of the normal cooling operation. That is, the valve control unit 303 controls the flow path of the refrigerant in the switching valve 103 to connect the compressor 101 and the four-way valve 104, and connect the check valve 108 and the on/off valve 110. Further, the valve control unit 303 controls the flow path of the refrigerant in the four-way valve 104 to connect the on/off valve 110 and the heat exchanger 106 and connect the accumulator 102 and the heat exchanger 201. Further, the valve control unit 303 performs control such that the opening degree of the throttle mechanism 107 becomes an appropriate opening degree. Further, the valve control unit 303 controls the on/off valve 110 to be shut off.

[0058] In this state, the refrigerant leakage determination unit 302 determines whether or not the refrigerant is leaking in the air conditioner 1, based on the detection result of the gas sensor 113 or the gas sensor 203.

[0059] Specifically, the refrigerant leakage determination unit 302 determines that the refrigerant is leaking when the gas sensor 113 or the gas sensor 203 detects the refrigerant.

[0060] Here, the gas sensor 113 detects the refrigerant.

[0061] The sensor information acquisition unit 301 acquires a detection result indicating that the refrigerant has been detected from the gas sensor 113.

[0062] When acquiring a detection result indicating that the sensor information acquisition unit 301 has detected the refrigerant from the gas sensor 113, the refrigerant leakage determination unit 302 determines that the refrigerant is leaking in the outdoor unit 10 (step S1).

[0063] The valve control unit 303 controls the flow path of the refrigerant in the switching valve 103 to connect the compressor 101 and the check valve 108, and connect the four-way valve 104 and the on/off valve 110 (step S2).

[0064] The valve control unit 303 controls the opening degree of the throttle mechanism 107 to full open (step S3). The fan control unit 305 stops the rotation of the blower fan 202 (step S4). In addition, the process of step S3 and step S4 reduces the gasification of the refrigerant, so that the density of the refrigerant is increased. As a result, the refrigerant can be efficiently recovered in the receiver 109.

[0065] The recovery completion determination unit 304 determines whether or not the recovery of the refrigerant in the receiver 109 has been completed, based on the measurement result of the discharge temperature sensor 111 or the measurement result of the receiver temperature sensor 112 (step S5).

[0066] When the recovery completion determination unit 304 determines that the recovery of the refrigerant in the receiver 109 has not been completed (NO in step S5), the process returns to the process of step S5.

[0067] Further, when the recovery completion determination unit 304 determines that the recovery of the refrigerant in the receiver 109 has been completed (YES in step S5), the compressor control unit 306 controls the compressor 101 to stop (from the operating state) (step S6). Then, the error notification unit 307 notifies the leakage of the refrigerant (step S7).

[0068] In this way, when the refrigerant leaks in the heat exchanger 106 that operates as a condenser, the air conditioner 1 can reduce the leakage of the refrigerant from the heat exchanger 106. In this case, the air conditioner 1 can recover the refrigerant on the inlet side of the heat exchanger 106. Therefore, the air conditioner 1 can recover the refrigerant more safely than the case where the refrigerant is recovered on the outlet side of the heat exchanger 106.

[0069] Further, in the cooling operation of the air conditioner 1, even when the refrigerant leaks from the heat exchanger 201 operating as an evaporator, and other places, and the gas sensor 113 or the gas sensor 203 detects the refrigerant, similarly, the receiver 109 may recover the refrigerant.

[0070] Further, in the heating operation of the air conditioner 1, the heat exchanger 106 operates as an evaporator, the heat exchanger 201 operates as a condenser, and the valve control unit 303 controls the flow path of the refrigerant in the four-way valve 104 to connect the switching valve 103 and the heat exchanger 201 and connect the accumulator 102 and the heat exchanger 106. The rotation of the blower fan 105 is stopped in step S4.

[0071] Then, in the heating operation of the air conditioner 1, even when the refrigerant leaks from the heat exchanger 201 operating as a condenser, the heat exchanger 106 operating as an evaporator, and other places, and the gas sensor 113 or the gas sensor 203 detects the refrigerant, similarly, the receiver 109 may recover the refrigerant.

[0072] When the refrigerant leaks in the heat exchanger 201 during the heating operation of the air conditioner 1, the air conditioner 1 can recover the refrigerant on the

inlet side of the heat exchanger 201. Therefore, the air conditioner 1 can recover the refrigerant more safely than the case where the refrigerant is recovered on the outlet side of the heat exchanger 201.

(Action and effect of air conditioner)

[0073] The air conditioner 1 according to the first embodiment of the present disclosure has been described above.

[0074] The air conditioner (1) according to the first embodiment of the present disclosure includes a condenser (106, 201) that condenses a refrigerant, an evaporator (201, 106) that evaporates the condensed refrigerant, a compressor (101) that compresses the evaporated refrigerant, a receiver (109) capable of recovering the compressed refrigerant, and a switching valve (103) capable of switching a discharge destination of the compressed refrigerant from the condenser (106, 201) to the receiver (109).

[0075] By the air conditioner (1), when the leakage of the refrigerant is detected, the refrigerant can be recovered on the inlet side of the condenser (106, 201). As a result, the air conditioner (1) can reduce the leakage, when the refrigerant leaks in the air conditioner.

<Second Embodiment>

(Configuration of air conditioner)

[0076] The configuration of the air conditioner 1 according to the second embodiment of the present disclosure will be described.

[0077] The air conditioner 1 according to the second embodiment of the present disclosure is an air conditioner that uses a receiver as a substitute for an accumulator as well as for the recovery of a refrigerant. As shown in Fig. 6, the air conditioner 1 includes the outdoor unit 10, the indoor unit 20, and the control device 30. Hereinafter, the air conditioner 1 will be described with a focus on the differences from the first embodiment.

[0078] In the second embodiment, the air conditioner 1 will be described by using the operation during the cooling operation as an example (that is, by using the case of operating as a refrigerating cycle device as an example) among the heating and cooling operations of the air conditioner 1, and the operation during the heating operation will be described at the end of the second embodiment.

(Configuration of outdoor unit)

[0079] As shown in Fig. 6, the outdoor unit 10 includes the compressor 101, the switching valve 103, the four-way valve 104, the blower fan 105, the heat exchanger 106, the throttle mechanism 107, the check valve 108, the receiver 109, a first on/off valve 110, a discharge temperature sensor 111, a receiver temperature sensor 112, a gas sensor 113, a second on/off valve 114, a first three-way valve 115 (an example of a switching valve), and a second three-way valve 116 (an example of a switching valve).

[0080] The first three-way valve 115 and the second three-way valve 116 are valves added to operate the receiver 109 as an accumulator in addition to recovering the refrigerant.

[0081] The valve control unit 303 controls the switching valve 103, the four-way valve 104, the throttle mechanism 107, the first on/off valve 110, the second on/off valve 114, the first three-way valve 115, and the second three-way valve 116.

[0082] For example, during the normal cooling operation of the air conditioner 1, the valve control unit 303 controls the flow path of the refrigerant in the switching valve 103 to connect the compressor 101 and the four-way valve 104, and connect the check valve 108 and the second on/off valve 114. Further, the valve control unit 303 controls the flow path of the refrigerant in the four-way valve 104 to connect the switching valve 103 and the heat exchanger 106 and connect the first three-way valve 115 and the heat exchanger 201. Further, the valve control unit 303 controls the opening degree of the throttle mechanism 107 to an appropriate opening degree. Further, the valve control unit 303 controls the first on/off valve 110 to open. Further, the valve control unit 303 controls the second on/off valve 114 to be shut off. Further, the valve control unit 303 controls the first three-way valve 115 to connect the four-way valve 104 and the first on/off valve 110. Further, the valve control unit 303 controls the second three-way valve 116 to connect the compressor 101 and the receiver 109.

[0083] Further, for example, when the leakage of a refrigerant is detected in the cooling operation of the air conditioner 1, the valve control unit 303 controls the flow path of the refrigerant in the switching valve 103 to connect the compressor 101 and the check valve 108, and connect the four-way valve 104 and the second on/off valve 114. Further, the valve control unit 303 controls the flow path of the refrigerant in the four-way valve 104 to connect the switching valve 103 and the heat exchanger 106 and connect the first three-way valve 115 and the heat exchanger 201. Further, the valve control unit 303 controls the opening degree of the throttle mechanism 107 to full open. Further, the valve control unit 303 controls the first on/off valve 110 to be shut off. Further, the valve control unit 303 controls the second on/off valve 114 to be shut off. Further, the valve control unit 303 controls the first three-way valve 115 to connect the compressor 101 and the four-way valve 104. Further, the valve control unit 303 controls the second three-way valve 116 to connect the check valve 108 and the receiver 109.

[0084] With the above-described configuration, during the normal cooling operation of the air conditioner 1, the refrigerant flows through a flow path that circulates in the order of the compressor 101, the switching valve 103,

the four-way valve 104, the heat exchanger 106, the throttle mechanism 107, the heat exchanger 201, the four-way valve 104, the first three-way valve 115, the first on/off valve 110, the receiver 109, the second three-way valve 116, and the compressor 101.

[0085] In Fig. 6, the arrow indicated by the solid line indicates the flow of the refrigerant during the normal cooling operation of the air conditioner 1. Further, the arrow shown by the broken line indicates the flow of the refrigerant when the leakage of the refrigerant is detected in the cooling operation of the air conditioner 1.

(Process performed by the air conditioner)

[0086] Next, the process of the air conditioner 1 according to the second embodiment of the present disclosure will be described.

[0087] Here, the processing flow of the air conditioner 1 when the leakage of the refrigerant is detected in the heat exchanger 106 that operates as a condenser during the normal cooling operation of the air conditioner 1 shown in Fig. 7 will be described.

[0088] The air conditioner 1 is in a state of the normal cooling operation. That is, the valve control unit 303 controls the flow path of the refrigerant in the switching valve 103 to connect the compressor 101 and the four-way valve 104, and connect the check valve 108 and the second on/off valve 114. Further, the valve control unit 303 controls the flow path of the refrigerant in the four-way valve 104 to connect the switching valve 103 and the heat exchanger 106 and connect the first three-way valve 115 and the heat exchanger 201. Further, the valve control unit 303 performs control such that the opening degree of the throttle mechanism 107 becomes an appropriate opening degree. Further, the valve control unit 303 controls the first on/off valve 110 to open. Further, the valve control unit 303 controls the second on/off valve 114 to be shut off. Further, the valve control unit 303 controls the first three-way valve 115 to connect the four-way valve 104 and the first on/off valve 110. Further, the valve control unit 303 controls the second three-way valve 116 to connect the compressor 101 and the receiver 109.

[0089] In this state, the refrigerant leakage determination unit 302 determines whether or not the refrigerant is leaking in the air conditioner 1, based on the detection result of the gas sensor 113 or the gas sensor 203.

[0090] Specifically, the refrigerant leakage determination unit 302 determines that the refrigerant is leaking when the gas sensor 113 or the gas sensor 203 detects the refrigerant.

[0091] Here, the gas sensor 113 detects the gaseous refrigerant.

[0092] The sensor information acquisition unit 301 acquires a detection result indicating that the refrigerant has been detected from the gas sensor 113.

[0093] When acquiring a detection result indicating that the sensor information acquisition unit 301 has detected the refrigerant from the gas sensor 113, the refrigerant leakage determination unit 302 determines that the refrigerant is leaking in the outdoor unit 10 (step S1).

[0094] The valve control unit 303 controls the flow path of the refrigerant in the switching valve 103 to connect the compressor 101 and the check valve 108, and connect the four-way valve 104 and the second on/off valve 114, controls the first on/off valve 110 to be shut off, controls the first three-way valve 115 to connect the compressor 101 and the four-way valve 104, and controls the second three-way valve 116 to connect the check valve 108 and the receiver 109 (step S11).

[0095] The valve control unit 303 controls the opening degree of the throttle mechanism 107 to full open (step S3). The fan control unit 305 stops the rotation of the blower fan 202 (step S4).

[0096] The recovery completion determination unit 304 determines whether or not the recovery of the refrigerant in the receiver 109 has been completed, based on the measurement result of the discharge temperature sensor 111 or the measurement result of the receiver temperature sensor 112 (step S5).

[0097] When the recovery completion determination unit 304 determines that the recovery of the refrigerant in the receiver 109 has not been completed (NO in step S5), the process returns to the process of step S5.

[0098] Further, when the recovery completion determination unit 304 determines that the recovery of the refrigerant in the receiver 109 has been completed (YES in step S5), the compressor control unit 306 controls the compressor 101 to stop (from the operating state) (step S6). Then, the error notification unit 307 notifies the leakage of the refrigerant (step S7).

[0099] In this way, when the refrigerant leaks in the heat exchanger 106 that operates as a condenser, the air conditioner 1 can reduce the leakage of the refrigerant from the heat exchanger 106. In this case, the air conditioner 1 can recover the refrigerant on the inlet side of the heat exchanger 106. Therefore, the air conditioner 1 can recover the refrigerant more safely than the case where the refrigerant is recovered on the outlet side of the heat exchanger 106.

[0100] Further, in the cooling operation of the air conditioner 1, even when the refrigerant leaks from the heat exchanger 201 operating as an evaporator, and other places, and the gas sensor 113 or the gas sensor 203 detects the refrigerant, similarly, the receiver 109 may recover the refrigerant.

[0101] Further, in the heating operation of the air conditioner 1, the heat exchanger 106 operates as an evaporator, the heat exchanger 201 operates as a condenser, and the valve control unit 303 controls the flow path of the refrigerant in the four-way valve 104 to connect the switching valve 103 and the heat exchanger 201 and connect the accumulator 102 and the heat exchanger 106. The rotation of the blower fan 105 is stopped in step S4.

[0102] Then, in the heating operation of the air condi-

tioner 1, even when the refrigerant leaks from the heat exchanger 201 operating as a condenser, the heat exchanger 106 operating as an evaporator, and other places, and the gas sensor 113 or the gas sensor 203 detects the refrigerant, similarly, the receiver 109 may recover the refrigerant.

[0103] When the refrigerant leaks in the heat exchanger 201 during the heating operation of the air conditioner 1, the air conditioner 1 can recover the refrigerant on the inlet side of the heat exchanger 201. Therefore, the air conditioner 1 can recover the refrigerant more safely than the case where the refrigerant is recovered on the outlet side of the heat exchanger 201.

(Action and effect of air conditioner)

[0104] The air conditioner 1 according to the second embodiment of the present disclosure has been described above.

[0105] The air conditioner (1) according to the second embodiment of the present disclosure includes a receiver (109) that operates as an accumulator that separates a liquid refrigerant and a gaseous refrigerant.

[0106] This air conditioner (1) eliminates the need for an accumulator, and the air conditioner 1 can be manufactured easily and inexpensively.

[0107] In another embodiment of the present disclosure, the control device 30 may be provided in the outdoor unit 10 or the indoor unit 20.

[0108] In the process according to the embodiment of the present disclosure, the order of processing may be changed as long as appropriate processing is performed.

[0109] Each of the storage unit 308 and the storage device (including a register and a latch) in the embodiment of the present disclosure may be provided anywhere within a range in which appropriate information is transmitted and received. Further, a plurality of the storage units 308 and the storage devices may be present in places within a range in which appropriate information is transmitted and received, and may distribute and store data.

[0110] Although the embodiment of the present disclosure has been described, the above-described control device 30 and other control devices may have a computer system inside. Then, the procedures of the processes described above are stored in a computer-readable recording medium in the form of a program, and the above processes are performed by the program being read and executed by the computer. A specific example of a computer is shown below.

[0111] Fig. 8 is a schematic block diagram illustrating a configuration of a computer according to at least one embodiment.

[0112] As shown in Fig. 8, a computer 5 includes a CPU 6, a main memory 7, a storage 8, and an interface 9.

[0113] For example, each of the above-described control device 30 and other control devices is mounted on the computer 5. The operation of each processing unit described above is stored in the storage 8 in the form of a program. The CPU 6 reads a program from the storage 8, expands the read program into the main memory 7, and executes the above process according to the program. Further, CPU 6 secures a storage area corresponding to each of the above-described storage units in the main memory 7, according to the program.

[0114] Examples of the storage 8 include a Hard Disk Drive (HDD), a Solid State Drive (SSD), a magnetic disk, an optical magnetic disk, a Compact Disc Read Only Memory (CD-ROM), a Digital Versatile Disc Read Only Memory (DVD-ROM), a semiconductor memory, and the like. The storage 8 may be an internal medium directly connected to the bus of the computer 5, or may be an external medium connected to the computer 5 through the interface 9 or a communication line. Further, when this program is delivered to the computer 5 through a communication line, the computer 5 receiving the delivered program may develop the program in the main memory 7 and execute the above process. In at least one embodiment, the storage 8 is a non-transitory tangible storage medium.

[0115] Further, the above program may implement a part of the above-described functions. Further, the program may be a so-called difference file (difference program), which can implement the above-described functions in combination with a program already recorded in the computer system.

[0116] Although some embodiments of the present disclosure have been described, these embodiments are examples and do not limit the scope of the disclosure. These embodiments may be subject to various additions, various omissions, various replacements, and various changes without departing from the gist of the disclosure.

<Additional Notes>

[0117] The air conditioner (1), the control method, and the program described in each embodiment of the present disclosure are understood as follows, for example.

[0118]

(1) An air conditioner (1) according to a first aspect includes a condenser (106, 201) that condenses a refrigerant, an evaporator (201, 106) that evaporates the condensed refrigerant, a compressor (101) that compresses the evaporated refrigerant, a receiver (109) capable of recovering the compressed refrigerant, and a switching valve (103, 115, 116) capable of switching a discharge destination of the compressed refrigerant from the condenser (106, 201) to the receiver (109).

[0119] By the air conditioner (1), when the leakage of the refrigerant is detected, the refrigerant can be recovered on the inlet side of the condenser (106, 201). As a result, the air conditioner (1) can reduce the leakage,

when the refrigerant leaks in the air conditioner.

[0120] (2) The air conditioner (1) according to a second aspect is the air conditioner (1) according to (1) and may further include a gas sensors (113, 203) that detects leakage of the refrigerant, in which the switching valve (103, 115, 116) may switch the discharge destination from the condenser (106, 201) to the receiver (109), when the gas sensor (113, 203) detects the leakage.

[0121] The air conditioner (1) makes it possible to detect the leakage of the refrigerant and appropriately switch the discharge destination.

[0122] (3) The air conditioner (1) according to a third aspect is the air conditioner (1) according to (1) or (2), in which the receiver (109) may operate as an accumulator that separates a liquid refrigerant and a gaseous refrigerant.

[0123] This air conditioner (1) eliminates the need for an accumulator, and the air conditioner 1 can be manufactured easily and inexpensively.

[0124] (4) The air conditioner (1) according to a fourth aspect is the air conditioner (1) according to any one of (1) to (3) and may further include a first control unit (303) that controls a flow path in the switching valve (103, 115, 116).

[0125] The air conditioner (1) makes it possible to appropriately control the flow path in the switching valve (103, 115, 116).

[0126] (5) The air conditioner (1) according to a fifth aspect is the air conditioner (1) according to any one of (1) to (4) and may further include an expansion valve (107) provided between the evaporator (201, 106) and the condenser (106, 201) and capable of controlling a valve opening degree to full open, when the discharge destination is switched from the condenser (106, 201) to the receiver.

[0127] With this air conditioner (1), the temperature of the refrigerant is reduced and the density of the refrigerant is increased. As a result, the refrigerant can be safely recovered to the receiver (109).

[0128] (6) The air conditioner (1) according to a sixth aspect is the air conditioner (1) according to (5) and may further include a second control unit (303) that controls the valve opening degree.

[0129] The air conditioner (1) makes it possible to appropriately control the valve opening degree.

[0130] (7) The air conditioner (1) according to a seventh aspect is the air conditioner (1) according to any one of (1) to (6), and may further include a determination unit (304) that determines whether or not recovery of the refrigerant by the receiver (109) has been completed.

[0131] The air conditioner (1) makes it possible to determine the completion of the recovery of the refrigerant. As a result, it is not necessary to perform unnecessary control after the recovery of the refrigerant has been completed.

[0132] (8) The air conditioner (1) according to an eighth aspect is the air conditioner (1) according to (7), in which the determination unit (304) may determine whether or not the recovery has been completed, based on a temperature at a discharge unit of the compressor (101) or a temperature at the receiver (109).

[0133] The air conditioner (1) makes it possible to determine the completion of the recovery of the refrigerant by using an easy method. As a result, it is not necessary to perform unnecessary control after the recovery of the refrigerant has been completed.

[0134] (9) A control method according to a ninth aspect performed by an air conditioner (1) including a condenser (106, 201) that condenses a refrigerant, an evaporator (201, 106) that evaporates the condensed refrigerant, a compressor (101) that compresses the evaporated refrigerant, a receiver (109) capable of recovering the compressed refrigerant, and a switching valve (103, 115, 116) capable of switching a discharge destination of the compressed refrigerant from the condenser (106, 201) to the receiver (109), the method including: controlling a flow path in the switching valve (103, 115, 116).

[0135] According to this control method, it is possible to recover the refrigerant on the inlet side of the condenser (106, 201), when the leakage of the refrigerant is detected. As a result, the control method can reduce the leakage, when the refrigerant leaks in the air conditioner.

[0136] (10) A program according to a tenth aspect causes a computer (5) in an air conditioner to control a flow path in a switching valve (103, 115, 116), the air conditioner (1) including a condenser (106, 201) that condenses a refrigerant, an evaporator (201, 106) that evaporates the condensed refrigerant, a compressor (101) that compresses the evaporated refrigerant, a receiver (109) capable of recovering the compressed refrigerant, and the switching valve (103, 115, 116) capable of switching a discharge destination of the compressed refrigerant from the condenser (106, 201) to the receiver (109).

[0137] According to this program, it is possible to recover the refrigerant on the inlet side of the condenser (106, 201), when the leakage of the refrigerant is detected. As a result, the program can reduce the leakage, when the refrigerant leaks in the air conditioner.

Industrial Applicability

[0138] According to the air conditioner, the control method, and the program according to the embodiment of the present disclosure, when the refrigerant leaks in the air conditioner, the leakage can be reduced.

Reference Signs List

[0139]

1	Air conditioner
5	Computer
6	CPU
7	Main memory
8	Storage
9	Interface

10	Outdoor unit
20	Indoor unit
30	Control device
101	Compressor
102	Accumulator
103	Switching valve
104	Four-way valve
105, 202	Blower fan
106, 201	Heat exchanger
107	Throttle mechanism
108	Check valve
109	Receiver
110, 114	On/off valve
111	Discharge temperature sensor
112	Receiver temperature sensor
113, 203	Gas sensor
301	Sensor information acquisition unit
302	Refrigerant leakage determination unit
303	Valve control unit
304	Recovery completion determination unit
305	Fan control unit
306	Compressor control unit
307	Error notification unit
308	Storage unit

Claims

1. An air conditioner comprising:

a condenser that condenses a refrigerant;
an evaporator that evaporates the condensed refrigerant;
a compressor that compresses the evaporated refrigerant;
a receiver capable of recovering the compressed refrigerant; and
a switching valve capable of switching a discharge destination of the compressed refrigerant from the condenser to the receiver.

2. The air conditioner according to claim 1, further comprising:

a gas sensor that detects leakage of the refrigerant, wherein
the switching valve switches the discharge destination from the condenser to the receiver, when the gas sensor has detected the leakage.

3. The air conditioner according to claim 1 or 2, wherein the receiver operates as an accumulator that separates a liquid refrigerant and a gaseous refrigerant.

4. The air conditioner according to any one of claims 1 to 3, further comprising:
a first control unit that controls a flow path in the switching valve.

5. The air conditioner according to any one of claims 1 to 4, further comprising:
an expansion valve provided between the evaporator and the condenser and capable of controlling a valve opening degree to full open, when the discharge destination is switched from the condenser to the receiver.

6. The air conditioner according to claim 5, further comprising:
a second control unit that controls the valve opening degree of the expansion valve.

7. The air conditioner according to any one of claims 1 to 6, further comprising:
a determination unit that determines whether or not recovery of the refrigerant by the receiver has been completed.

8. The air conditioner according to claim 7, wherein
the determination unit determines whether or not the recovery has been completed, based on a temperature at a discharge unit of the compressor or a temperature at the receiver.

9. A control method performed by an air conditioner including a condenser that condenses a refrigerant, an evaporator that evaporates the condensed refrigerant, a compressor that compresses the evaporated refrigerant, a receiver capable of recovering the compressed refrigerant, and a switching valve capable of switching a discharge destination of the compressed refrigerant from the condenser to the receiver, the method comprising:
controlling a flow path in the switching valve.

10. A program causing a computer in an air conditioner to control a flow path in a switching valve, the air conditioner including a condenser that condenses a refrigerant, an evaporator that evaporates the condensed refrigerant, a compressor that compresses the evaporated refrigerant, a receiver capable of recovering the compressed refrigerant, and the switching valve capable of switching a discharge destination of the compressed refrigerant from the condenser to the receiver.

FIG. 1

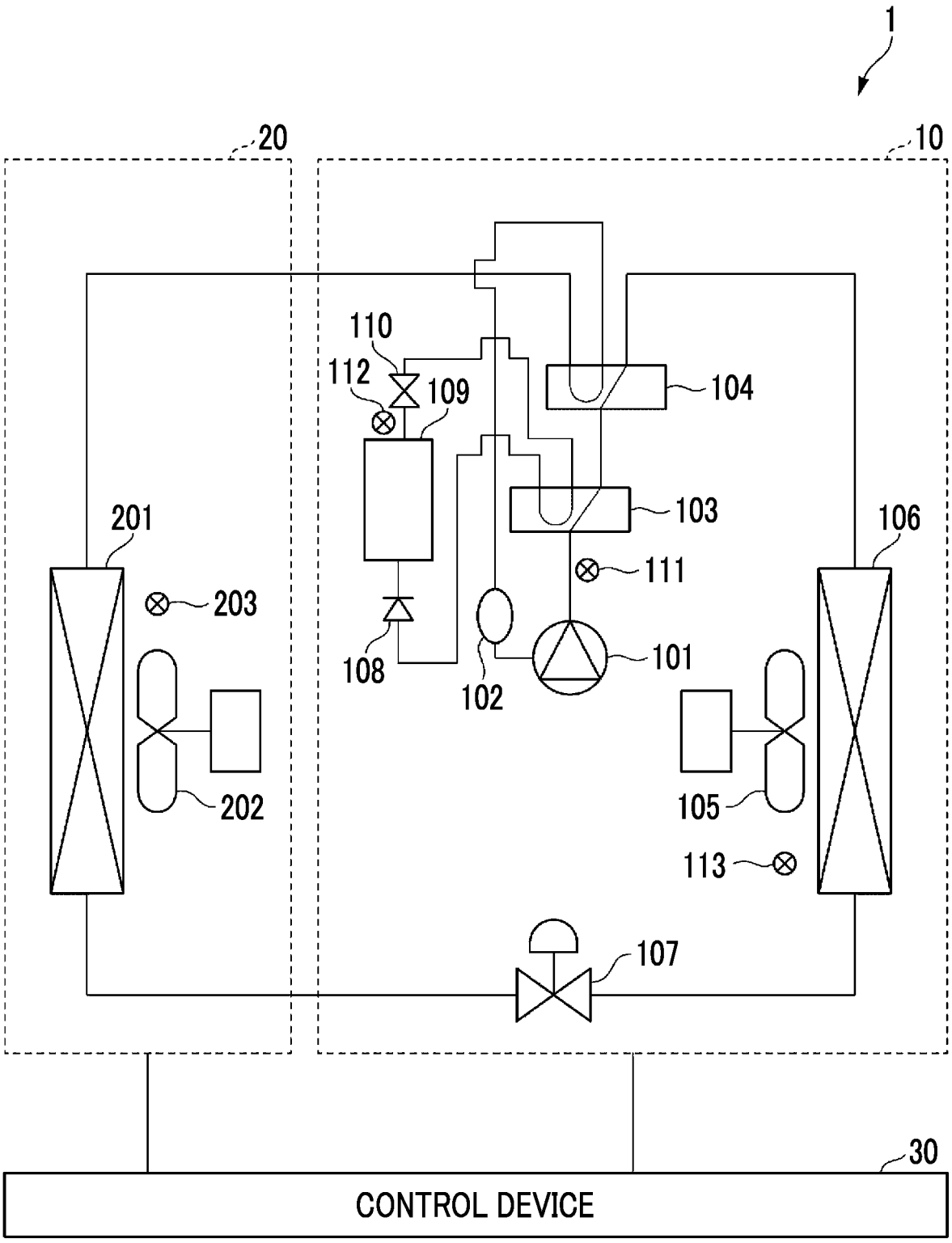

1
20
10
110
112
109
104
103
201
106
111
203
108
102
101
105
202
113
107
30
CONTROL DEVICE

FIG. 2

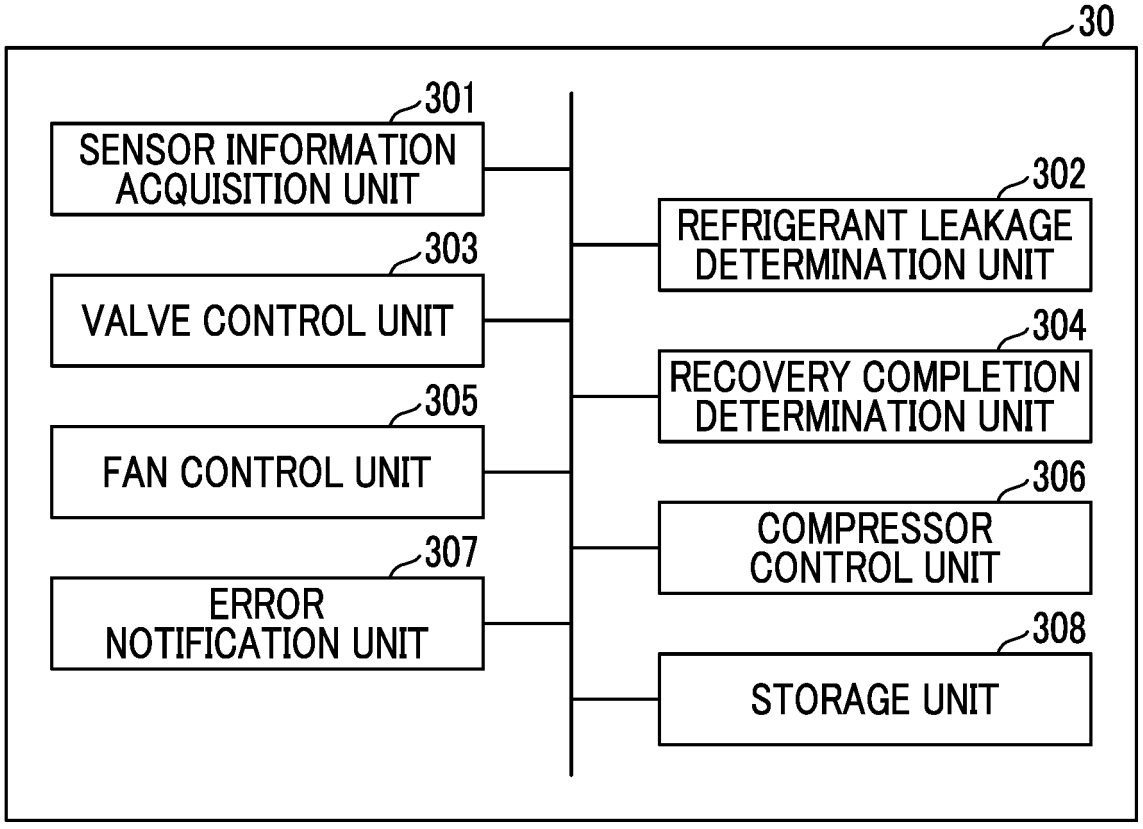

30
301
SENSOR INFORMATION ACQUISITION UNIT
302
REFRIGERANT LEAKAGE DETERMINATION UNIT
303
VALVE CONTROL UNIT
304
RECOVERY COMPLETION DETERMINATION UNIT
305
FAN CONTROL UNIT
306
COMPRESSOR CONTROL UNIT
307
ERROR NOTIFICATION UNIT
308
STORAGE UNIT

FIG. 3

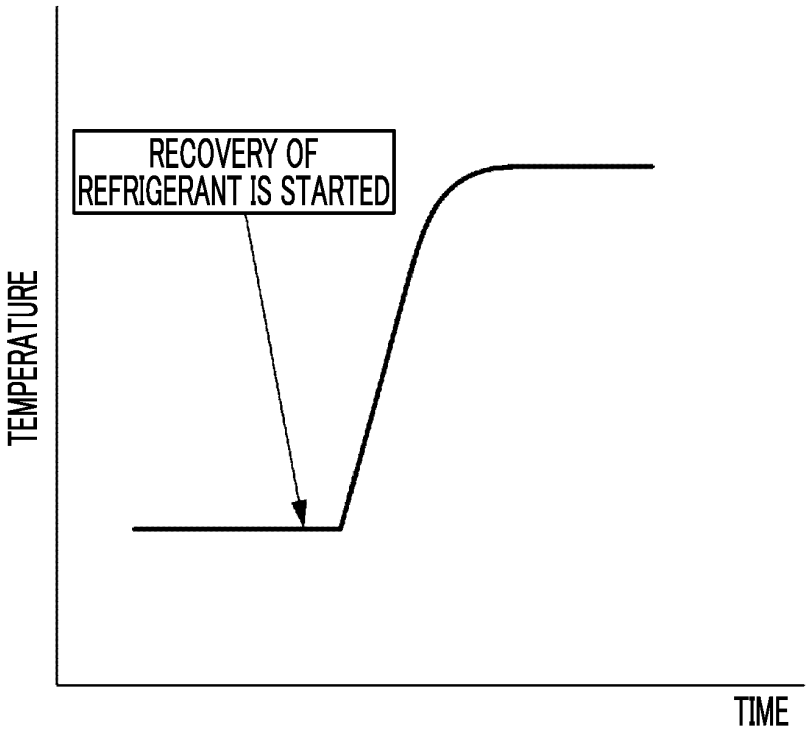

RECOVERY OF
REFRIGERANT IS STARTED
TEMPERATURE
TIME

FIG. 4

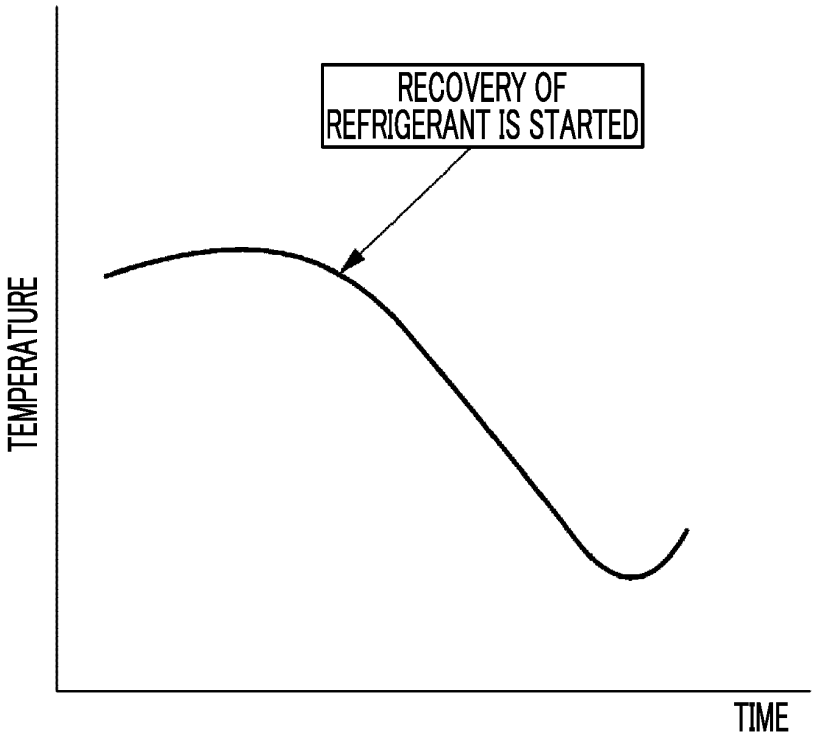

RECOVERY OF
REFRIGERANT IS STARTED
TEMPERATURE
TIME

FIG. 5

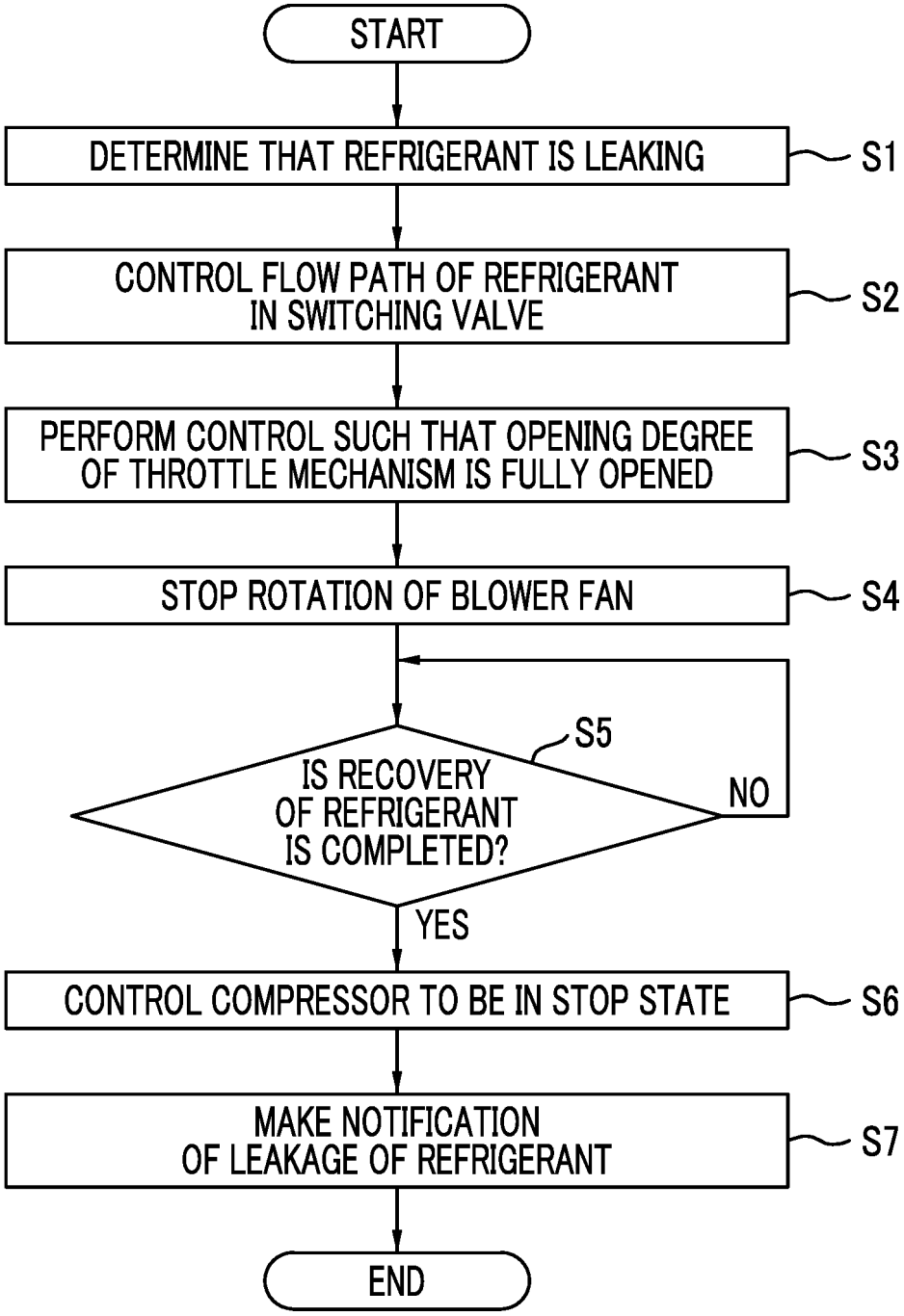

START
DETERMINE THAT REFRIGERANT IS LEAKING
S1
CONTROL FLOW PATH OF REFRIGERANT IN SWITCHING VALVE
S2
PERFORM CONTROL SUCH THAT OPENING DEGREE OF THROTTLE MECHANISM IS FULLY OPENED
S3
STOP ROTATION OF BLOWER FAN
S4
S5
IS RECOVERY OF REFRIGERANT IS COMPLETED?
NO
YES
CONTROL COMPRESSOR TO BE IN STOP STATE
S6
MAKE NOTIFICATION OF LEAKAGE OF REFRIGERANT
S7
END

FIG. 6

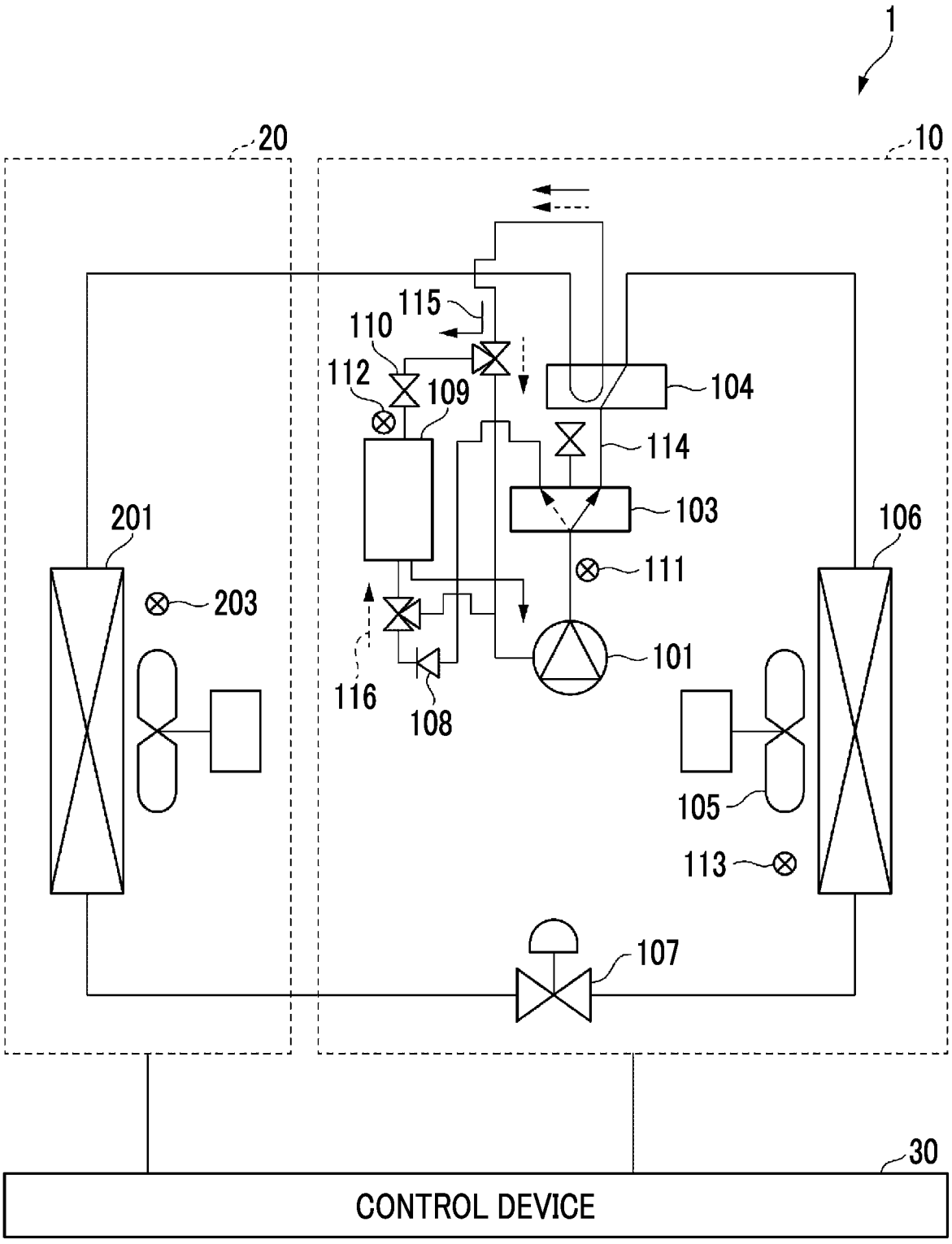

1
20
10
115
110
112
109
104
114
103
201
106
111
203
101
116
108
105
113
107
30
CONTROL DEVICE

FIG. 7

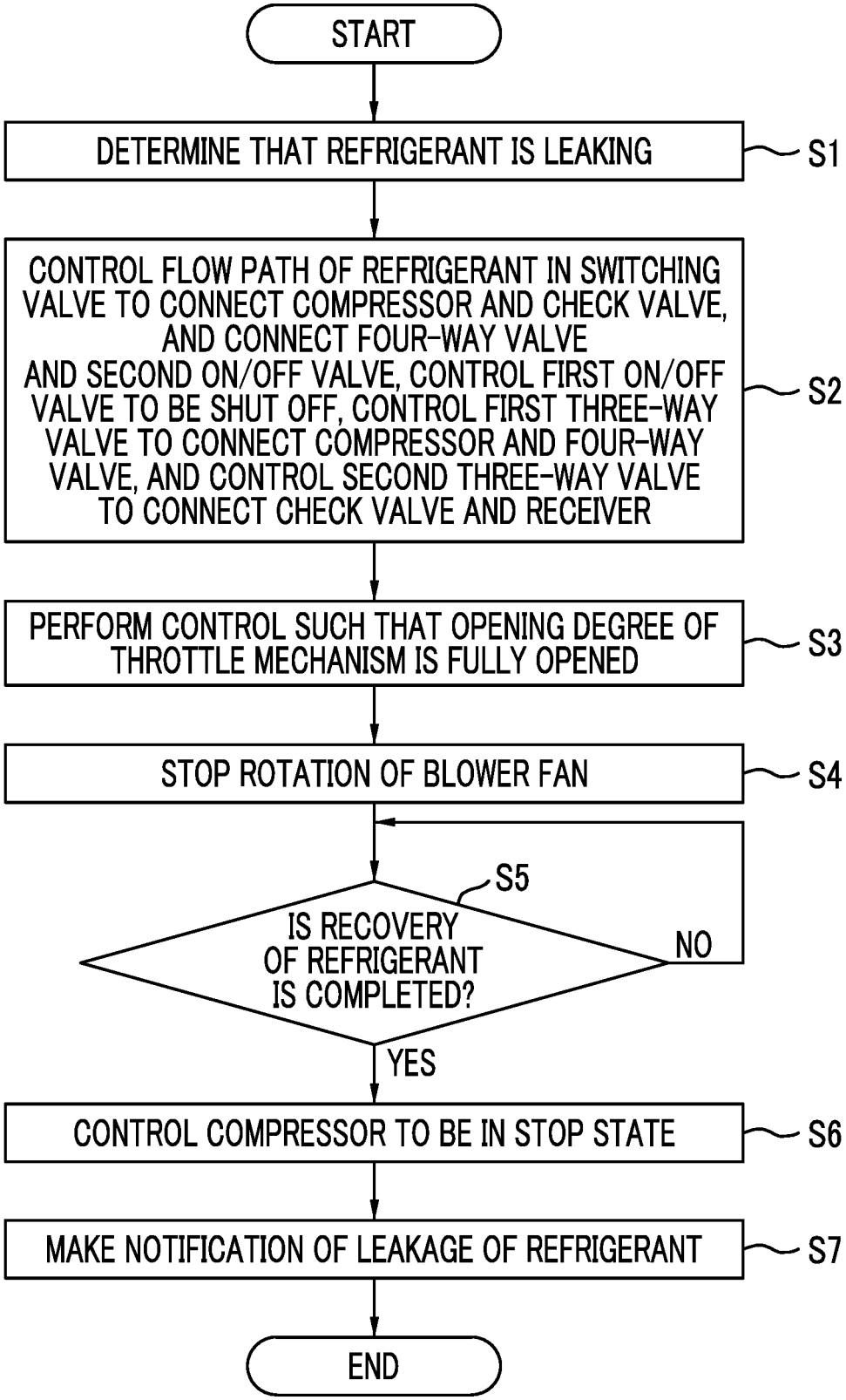
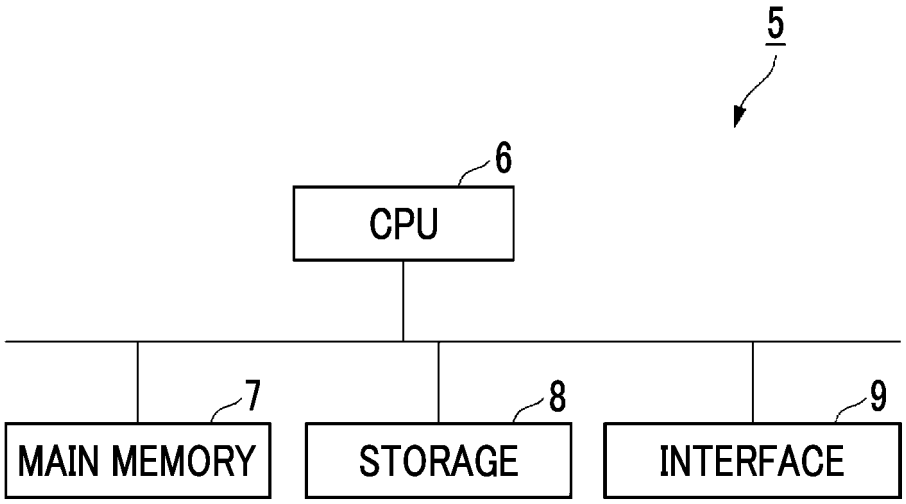

START
DETERMINE THAT REFRIGERANT IS LEAKING
S1
CONTROL FLOW PATH OF REFRIGERANT IN SWITCHING VALVE TO CONNECT COMPRESSOR AND CHECK VALVE, AND CONNECT FOUR-WAY VALVE AND SECOND ON/OFF VALVE, CONTROL FIRST ON/OFF VALVE TO BE SHUT OFF, CONTROL FIRST THREE-WAY VALVE TO CONNECT COMPRESSOR AND FOUR-WAY VALVE, AND CONTROL SECOND THREE-WAY VALVE TO CONNECT CHECK VALVE AND RECEIVER
S2
PERFORM CONTROL SUCH THAT OPENING DEGREE OF THROTTLE MECHANISM IS FULLY OPENED
S3
STOP ROTATION OF BLOWER FAN
S4
S5
IS RECOVERY OF REFRIGERANT IS COMPLETED?
NO
YES
CONTROL COMPRESSOR TO BE IN STOP STATE
S6
MAKE NOTIFICATION OF LEAKAGE OF REFRIGERANT
S7
END

FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/014205

A. CLASSIFICATION OF SUBJECT MATTER
F25B 43/00(2006.01)i; F25B 49/02(2006.01)i; F25B 1/00(2006.01)i
FI: F25B49/02 520M; F25B43/00 Z; F25B1/00 391

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B43/00; F25B49/02; F25B1/00

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 2019/053771 A1 (MITSUBISHI ELECTRIC CORP.) 21 March 2019 (2019-03-21) paragraphs [0031]-[0034], fig. 1-10	1-4, 9-10 5-8
Y	JP 2016-84984 A (DAIKIN INDUSTRIES, LTD.) 19 May 2016 (2016-05-19) paragraph [0082]	5-8
Y	JP 2018-200136 A (JOHNSON CONTROLS-HITACHI AIR CONDITIONING) 20 December 2018 (2018-12-20) paragraph [0054]	7-8

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 April 2021 (15.04.2021)	18 May 2021 (18.05.2021)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/014205

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
WO 2019/053771 A1	21 Mar. 2019	(Family: none)	
JP 2016-84984 A	19 May 2016	(Family: none)	
JP 2018-200136 A	20 Dec. 2018	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2020066032 A **[0002]**
- WO 2017175299 A **[0005]**