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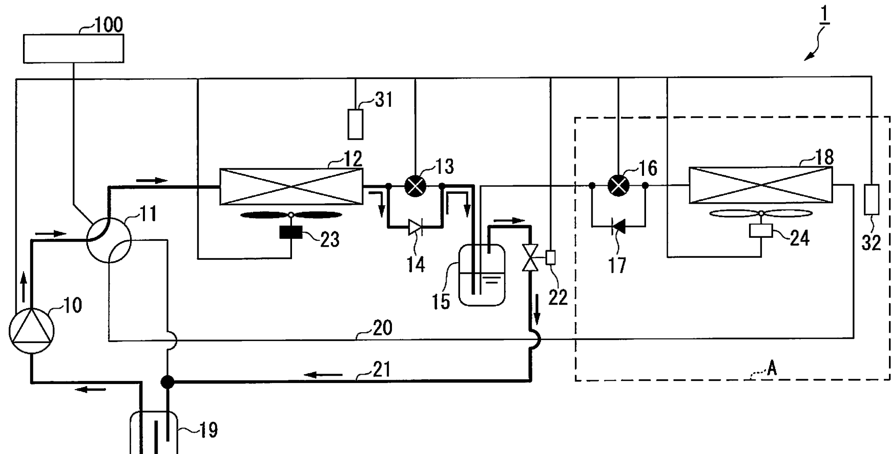
(54) REFRIGERANT CIRCUIT SYSTEM, CONTROL DEVICE AND CONTROL METHOD

(57) A refrigerant circuit system includes a refrigerant circuit that includes a compressor, a condenser, a receiver tank, an expansion valve, an evaporator, an accumulator, a bypass circuit connecting a gas-phase portion of the receiver tank to the accumulator, and an opening/closing valve controlling opening and closing of the bypass circuit, and a control device that controls an operation of the refrigerant circuit, in which the control device performs a frost suppression operation of defrosting the evaporator by circulating a refrigerant ejected from the compressor in an order of the condenser, the receiver tank, the bypass circuit, the accumulator, and the compressor before pausing a internal heating operation in the refrigerant circuit.

FIG. 3



EP 3 540 338 A1

Description

Technical Field

[0001] The present invention relates to a refrigerant circuit system, a control device, and a control method.

[0002] Priority is claimed on Japanese Patent Application No. 2016-242476, filed on December 14, 2016, the content of which is incorporated herein by reference.

Background Art

[0003] In the related art, a heating function of a transportation refrigeration unit is generally realized according to a hot water heating method using cooling water in a vehicle engine. This method includes a risk in that trouble with an engine cooling circuit directly influences traveling of a vehicle. With the advancement of engines in terms of high efficiency, engine exhaust heat has been reduced, and thus it is difficult to obtain sufficient heating performance by using engine cooling water. Under these circumstances, a transportation refrigeration unit which can efficiently perform heating by using a heat pump has been proposed (for example, PTL 1).

[0004] However, in a case of a heating operation using the heat pump, the greatest technical problem is deterioration in heating performance due to the accumulation of frost on a heat exchanger. Regarding such a problem, PTL 2 discloses a technique in which a defrost operation is performed by circulating a refrigerant among a plurality of provided external heat exchangers without using an internal heat exchanger during the defrost operation for the external heat exchangers.

[0005] PTL 3 discloses an air conditioner provided with a refrigerant circuit which includes a compressor, an indoor heat exchanger, a first flow control valve, an outdoor heat exchanger, and a four-way valve, in which the indoor heat exchanger is divided into a plurality of portions, a second flow control valve is provided therebetween, a gas-liquid separation container is provided between the first flow control valve and the indoor heat exchanger or the outdoor heat exchanger, and a third flow control valve is provided on a gas bypass circuit which is connected to an intake side of the compressor from the gas-liquid separation container. PTL 3 discloses that, according to the action, during a defrost operation for the outdoor heat exchanger, an operation mode is performed in which the four-way valve is switched to a refrigeration circuit, and the first flow control valve and the third flow control valve are fully opened, and thus the defrost operation is performed without a refrigerant flowing into an indoor unit.

[0006] When the techniques disclosed in PTLs 2 and 3 are used, a refrigerant does not flow into the internal (indoor) heat exchanger during the defrost operation, and thus it is possible to reduce the influence on an internal (indoor) temperature due to the defrost operation.

Citation List

Patent Literature

[0007]

[PTL 1] Japanese Patent No. 5535510
[PTL 2] Japanese Unexamined Patent Application, First Publication No. 2016-151410
[PTL 3] Japanese Unexamined Patent Application, First Publication No. 2007-85730

Summary of Invention

Technical Problem

[0008] However, the refrigerant circuit disclosed in PTL 2 has a problem that a plurality of external heat exchangers are necessary, and thus cost is increased. The typical defrost operation disclosed in PTLs 2 and 3 is started after frost accumulation progresses to some extent, and thus there is a problem that deterioration in heating performance due to the progress of frost accumulation before starting of the defrost operation cannot be prevented.

[0009] The present invention provides a refrigerant circuit system, a control device, and a control method capable of solving the above-described problems.

Solution to Problem

[0010] According to a first aspect of the present invention, there is provided a refrigerant circuit system including a refrigerant circuit that includes a compressor compressing a refrigerant, a condenser condensing the refrigerant compressed by the compressor, a receiver tank storing part of the condensed refrigerant, an expansion valve depressing the refrigerant flowing out of the receiver tank, an evaporator evaporating the depressed refrigerant, an accumulator supplying a refrigerant gas of a refrigerant flowing out of the evaporator to the compressor, a bypass circuit connecting a gas-phase portion of the receiver tank to the accumulator, and an opening/closing valve controlling opening and closing of the bypass circuit; and a control device that controls an operation of the refrigerant circuit, in which the control device performs a frost suppression operation of defrosting the evaporator by circulating a refrigerant ejected from the compressor in the order of the condenser, the receiver tank, the bypass circuit, the accumulator, and the compressor before pausing an internal heating operation in the refrigerant circuit.

[0011] According to a second aspect of the present invention, in a case where the internal heating operation is paused, the control device performs the frost suppression operation on the condition that a predetermined frost suppression operation condition is established, and pauses the internal heating operation instead of performing the frost suppression operation in a case where the frost suppression operation condition is not established.

[0012] According to a third aspect of the present invention, in a case where the frost suppression operation is started, the control device finishes the frost suppression operation on the condition of satisfying at least one of a time for which the frost suppression operation is continuously performed being equal to or more than a predetermined time and a predetermined defrost finishing condition being established.

[0013] According to a fourth aspect of the present invention, the control device determines whether or not a defrost operation is to be performed before determining whether or not the frost suppression operation is to be performed, and determines that the frost suppression operation is to be performed in a case where it is determined that the defrost operation is not to be performed.

[0014] According to a fifth aspect of the present invention, the control device stops the frost suppression operation, and resumes the internal heating operation, in a case where a predetermined internal heating operation return condition is established during execution of the frost suppression operation.

[0015] According to a sixth aspect of the present invention, the control device pauses the internal heating operation after the frost suppression operation is finished, and resumes the internal heating operation in a case where the internal heating operation return condition is established.

[0016] According to a seven aspect of the present invention, the refrigerant circuit further includes a liquid return pipe that connects a liquid-phase portion of the receiver tank to an upstream side of the opening/closing valve in the bypass circuit.

[0017] According to an eighth aspect of the present invention, there is provided a control device controlling an operation of a refrigerant circuit that includes a compressor compressing a refrigerant, a condenser condensing the refrigerant compressed by the compressor, a receiver tank storing part of the condensed refrigerant, an expansion valve depressing the refrigerant flowing out of the receiver tank, an evaporator evaporating the depressed refrigerant, an accumulator supplying a refrigerant gas of a refrigerant flowing out of the evaporator to the compressor, a bypass circuit connecting a gas-phase portion of the receiver tank to the accumulator, and an opening/closing valve controlling opening and closing of the bypass circuit, in which the control device performs defrosting the evaporator by circulating a refrigerant ejected from the compressor in an order of the condenser, the receiver tank, the bypass circuit, the accumulator, and the compressor before pausing an internal heating operation in the refrigerant circuit.

[0018] According to a ninth aspect of the present invention, there is provided a control method for a refrigerant circuit that includes a compressor compressing a refrigerant, a condenser condensing the refrigerant compressed by the compressor, a receiver tank storing part of the condensed refrigerant, an expansion valve depressing the refrigerant flowing out of the receiver tank, an evaporator evaporating the depressed refrigerant, an accumulator supplying a refrigerant gas of a refrigerant flowing out of the evaporator to the compressor, a bypass circuit connecting a gas-phase portion of the receiver tank to the accumulator, and an opening/closing valve controlling opening and closing of the bypass circuit, the control method including causing a control device controlling an operation of the refrigerant circuit to perform a frost suppression operation of defrosting the evaporator by circulating a refrigerant ejected from the compressor in an order of the condenser, the receiver tank, the bypass circuit, the accumulator, and the compressor before pausing an internal heating operation in the refrigerant circuit.

[0019] According to a tenth aspect of the present invention, the refrigerant circuit further includes a liquid return pipe that connects a liquid-phase portion of the receiver tank to an upstream side of the opening/closing valve in the bypass circuit, and, in a case where the frost suppression operation is performed, the control device circulates the refrigerant ejected from the compressor in an order of the condenser, the receiver tank, the bypass circuit, the accumulator, and the compressor, and supplies a refrigerant liquid to the bypass circuit from the liquid-phase portion of the receiver tank such that the refrigerant liquid is added to the circulated refrigerant.

Advantageous Effects of Invention

[0020] According to the refrigerant circuit system, a control device, and a control method, high heating performance can be maintained by preventing frost accumulating on an evaporator without influence on a use side (condenser side) in an internal heating operation.

Brief Description of Drawings

[0021]

FIG. 1 is a first diagram illustrating a refrigerant circuit system in a first embodiment of the present invention.

FIG. 2 is a second diagram illustrating the refrigerant circuit system in the first embodiment of the present invention.

FIG. 3 is a third diagram illustrating the refrigerant circuit system in the first embodiment of the present invention.

FIG. 4 is a diagram for explaining transition of an operation mode during an internal heating operation in the first embodiment of the present invention.

FIG. 5 is a flowchart illustrating a process in a control device in the first embodiment of the present invention.

FIG. 6 is a diagram illustrating a refrigerant circuit system in a second embodiment of the present invention.

FIG. 7 is a diagram for explaining transition of an operation mode during an internal heating operation in the related art.

Description of Embodiments

<First Embodiment

[0022] Hereinafter, a refrigerant circuit system according to a first embodiment of the present invention will be described with reference to FIGS. 1 to 5 and 7.

[0023] FIG. 1 is a first diagram illustrating a refrigerant circuit system in a first embodiment of the present invention.

[0024] FIG. 2 is a second diagram illustrating the refrigerant circuit system in the first embodiment of the present invention.

[0025] FIG. 1 illustrates a refrigerant circuit system 1 (a refrigerant circuit and a control device thereof) used for a transportation refrigeration unit which cools or heats a cold insulation box mounted on a loading space of a refrigeration vehicle or the like.

[0026] As illustrated in FIG. 1, the refrigerant circuit system 1 is configured to include a compressor 10, a four-way valve 11, an external heat exchanger 12, an external expansion valve 13, an external check valve 14, a receiver tank 15, an internal expansion valve 16, an internal check valve 17, an internal heat exchanger 18, an accumulator 19, a main pipe 20 connecting the above-described elements to each other, a bypass pipe 21, an opening/closing valve 22, an external fan 23, an internal fan 24, and a control device 100. The refrigerant circuit system 1 is provided with a plurality of sensors measuring a temperature or pressure of a refrigerant or the like. For example, a temperature sensor 31 measuring a temperature of the external heat exchanger 12 is provided around the external heat exchanger 12, and a temperature sensor 32 measuring a temperature of the box inside A (inside a cold insulation box) is provided in the box inside A. The configuration of the refrigerant circuit system 1 illustrated in FIG. 1 schematically illustrates a fundamental function of the refrigerant circuit system 1, and may include other constituent elements.

[0027] The refrigerant circuit illustrated in FIG. 1 is a reverse cycle type refrigerant circuit, and can perform switching between an internal heating operation and a cooling operation under the control of the control device 100. FIG. 1 illustrates the refrigerant circuit system 1 during the cooling operation, and FIG. 2 illustrates the refrigerant circuit system 1 during the internal heating operation.

[0028] The compressor 10 compresses a refrigerant, and ejects the compressed high-pressure refrigerant. The four-way valve 11 changes a direction in which the refrigerant flows between the internal heating operation and the cooling operation. The external heat exchanger 12 performs heat exchanger between the refrigerant and outdoor air. For example, the external heat exchanger 12 functions as a condenser during the cooling operation, so as to dissipate heat outdoors, and functions as an evaporator, so as to absorb heat from the outdoor side. The external expansion valve 13 is controlled to be brought into a closed state during the cooling operation, and decompresses the high-pressure refrigerant during the internal heating operation. The external check valve 14 causes the refrigerant to pass therethrough instead of the external expansion valve 13 during the cooling operation. The receiver tank 15 is a pressure container which temporarily stores part of the refrigerant flowing through the refrigerant circuit. Two-phase refrigerants such as a gas and a liquid are mixed to be present in the receiver tank 15. Part of the refrigerant stored in the receiver tank 15 flows out thereof and is circulated in the refrigerant circuit. The internal expansion valve 16 is controlled to be brought into a closed state during the internal heating operation and depresses the high-pressure refrigerant during the cooling operation. The internal check valve 17 causes the refrigerant to pass therethrough instead of the internal expansion valve 16 during the internal heating operation. The internal heat exchanger 18 performs heat exchanger between the refrigerant and air of the box inside A. The internal heat exchanger 18 functions as an evaporator during the cooling operation, so as to absorb heat from air of the box inside A, and functions as a condenser during the internal heating operation, so as to dissipate heat to air of the box inside A. The accumulator 19 is a pressure container provided on the upstream side of the compressor 10. The accumulator 19 separates a refrigerant to be applied to the compressor 10 into a gas and a liquid, supplies a refrigerant gas to an intake side of the compressor 10, and prevents a refrigerant liquid from being taken into the compressor 10. The bypass pipe 21 is a bypass circuit which connects a gas-phase portion of the receiver tank 15 to the accumulator 19, and bypasses a path reaching the accumulator 19 from the receiver tank 15 via the internal heat exchanger 18. The bypass pipe 21 is provided with the opening/closing valve 22 controlling opening and closing of the bypass circuit.

[0029] The control device 100 controls an operation of the refrigerant circuit system 1. For example, the control device 100 performs switching among a plurality of operation modes such as the cooling operation and the internal heating operation. In a case where the external heat exchanger 12 and the internal heat exchanger 18 are frosted, a defrost operation is performed.

(Cooling operation: FIG. 1)

[0030] During the cooling operation, the control device 100 switches the four-way valve 11 such that a refrigerant is circulated in an order of the compressor 10, the four-way valve 11, the external heat exchanger 12, the external check valve 14, the receiver tank 15, the internal expansion valve 16, the internal heat exchanger 18, the four-way valve 11, the accumulator 19, and the compressor 10. The control device 100 controls the external expansion valve 13 and the opening/closing valve 22 to be brought into a closed state, and operates the external fan 23 and the internal fan 24. In FIG. 1, a direction in which the refrigerant flows is indicated by a solid arrow. The control device 100 performs control of the number of revolutions of the compressor 10 or adjustment of an opening degree of the internal expansion valve 16 according to a target temperature of the box inside A.

(Internal heating operation: FIG. 2)

[0031] During the internal heating operation, the control device 100 switches the four-way valve 11 such that a refrigerant is circulated in an order of the compressor 10, the four-way valve 11, the internal heat exchanger 18, the internal check valve 17, the receiver tank 15, the external expansion valve 13, the external heat exchanger 12, the four-way valve 11, the accumulator 19, and the compressor 10. The control device 100 controls the internal expansion valve 16 and the opening/closing valve 22 to be brought into a closed state, and operates the external fan 23 and the internal fan 24. In FIG. 2, a direction in which the refrigerant flows is indicated by a dashed arrow. The control device 100 performs control of the number of revolutions of the compressor 10 or adjustment of an opening degree of the external expansion valve 13 according to a target temperature of the box inside A.

(Defrost operation during cooling operation)

[0032] In a defrost operation during the cooling operation, the control device 100 circulates a refrigerant in an opposite direction to the cooling operation, so as to remove frost on the internal heat exchanger 18. In other words, a direction in which the refrigerant flows is a direction of a dashed arrow in FIG. 2. In this case, the control device 100 stops an operation of the internal fan 24. Control of operations of other constituent elements is the same as in the internal heating operation.

[0033] Next, a description will be made of a defrost operation during the internal heating operation. In the related art, in a defrost operation during the internal heating operation, frost on the external heat exchanger 12 is frequently removed by circulating a refrigerant in an opposite direction to the internal heating operation (the same direction as that in the cooling operation). In this case, the control device 100 suppresses the influence on the box inside A by stopping not only an operation of the external fan 23 but also an operation of the internal fan 24. However, in this method, since the internal heating operation is stopped during the defrost operation, and a refrigerant flows in the same manner as during the cooling operation, it is hard to prevent the influence on a temperature of the box inside A. Therefore, in the present embodiment, frost accumulating on the external heat exchanger 12 during the internal heating operation is coped with according to a configuration of the refrigerant circuit and a control method described below.

(Defrost operation during internal heating operation)

[0034] FIG. 3 is a third diagram illustrating the refrigerant circuit system in the first embodiment of the present invention.

[0035] With reference to FIG. 3, a description will be made of a defrost operation during the internal heating operation in the present embodiment.

[0036] In a defrost operation during the internal heating operation in the present embodiment, first, the control device 100 switches the four-way valve 11 such that a refrigerant flows in the same direction as that in the cooling operation. The control device 100 controls the external expansion valve 13 and the internal expansion valve 16 to be brought into a closed state and controls the opening/closing valve 22 to be brought into an opened state. The control device 100 stops operations of the external fan 23 and the internal fan 24. Through such control, in the refrigerant circuit during the defrost operation, a cycle is formed in which a refrigerant flows in an order of the compressor 10, the four-way valve 11, the external heat exchanger 12, the external check valve 14, and the receiver tank 15, and a refrigerant gas reaches the accumulator 19 from the receiver tank 15 via the bypass pipe 21 and returns to the compressor 10. In the refrigerant circuit, the refrigerant does not flow through the box inside A side, and the defrost operation can be performed without the internal heat exchanger 18 absorbing heat from air of the box inside A. Thus, it is possible to reduce a temperature change of the box inside A due to the defrost operation.

[0037] In the present embodiment, it is possible to prevent frost from accumulating on the external heat exchanger 12 by performing control (frost suppression operation) of reducing a frequency of defrost operations occurring during the internal heating operation.

[0038] Next, with reference to FIGS. 4 and 7, a description will be made of the frost suppression operation of the present embodiment by exemplifying the configurations of the refrigerant circuit in FIGS. 1 to 3.

[0039] FIG. 4 is a diagram for explaining transition of an operation mode during an internal heating operation according to the first embodiment of the present invention. FIG. 7 is a diagram for explaining transition of an operation mode during an internal heating operation in the related art.

[0040] First, with reference to FIG. 7, a description will be made of transition of an operation mode during an internal heating operation in the related art. In a control method of the related art, in a case where a defrost condition is established during an internal heating operation, the control device 100 causes an operation mode to transition to a defrost operation. In a case where a defrost finishing condition is established during execution of the defrost operation, the control device 100 causes an operation mode to transition to a internal heating operation and resumes the internal heating operation. In a case where a temperature of the box inside A reaches a set temperature (or a temperature in a predetermined range including the set temperature) during the internal heating operation, the control device 100 causes an operation mode to transition to an internal heating pause operation, so as to pause the internal heating operation. In a case where a temperature of the box inside A is deviated from the set temperature during the internal heating pause operation, the control device 100 causes an operation mode to transition to an internal heating operation, and resumes the internal heating operation. As mentioned above, according to the operation mode transition control of the related art, when a defrost condition is established, transition to a defrost operation occurs, and the defrost operation is continuously performed until a defrost finishing condition is established. During that time, an internal heating operation for maintaining a temperature of the box inside A to be a set temperature is stopped. For example, in an environment in which a temperature of external air is low, frost accumulation on the external heat exchanger 12 easily occurs, and thus there is a probability that the defrost operation may be frequently performed. Then, there is a probability that a temperature of the box inside A is hardly maintained to be a set temperature.

[0041] In contrast, in the present embodiment, as illustrated in FIG. 4, in a case where a temperature of the box inside A reaches a set temperature during an internal heating operation, the control device 100 causes an operation mode to transition to a frost suppression operation instead of an internal heating pause operation, so as to perform the frost suppression operation. In a case where a temperature of the box inside A is maintained to be a temperature in a predetermined range (the heating pause condition is persistent) even though the frost suppression operation is finished, the control device 100 causes an operation mode to transition to an internal heating pause operation. In a case where a temperature of the box inside A is deviated from the set temperature during the frost suppression operation, the control device 100 causes an operation mode to transition to an internal heating operation and resumes the internal heating operation. Consequently, a temperature of the box inside A can be maintained to be the set temperature. In a case where a temperature of the box inside A is reduced to be deviated from the set temperature after transition to the internal heating pause operation, the control device 100 causes an operation mode to an internal heating operation and performs the internal heating operation.

[0042] Next, a description will be made of a frost suppression operation. In a case where an operation mode transitions to a frost suppression operation from an internal heating operation, the control device 100 switches the four-way valve 11 such that a refrigerant flows in the same direction as that during the cooling operation and performs control of bringing the external expansion valve 13 and the internal expansion valve 16 into a closed state, bringing the opening/closing valve 22 into an opened state, and stopping the external fan 23 and the internal fan 24. In other words, in the frost suppression operation, a refrigerant is circulated in the same refrigerant circuit as that in the defrost operation (FIG. 3), and thus the progress of frost accumulating on the external heat exchanger 12 is suppressed. An expansion valve (not illustrated) may be provided, for example, between the intake side of the compressor 10 and the accumulator 19, and pressure of a refrigerant during the frost suppression operation may be performed by using the expansion valve.

[0043] In a case where the frost suppression operation is performed in the same refrigerant circuit as that during the cooling operation in which a refrigerant does not flow through the bypass pipe 21, the refrigerant flows through the internal heat exchanger 18, and this influences a temperature of the box inside A. However, in the refrigerant circuit during the frost suppression operation of the present embodiment, a refrigerant does not flow through the box inside A side, and thus a temperature of the box inside A is not influenced (the internal heat exchanger 18 does not absorb heat). As described with reference to FIG. 4, the frost suppression operation of the present embodiment is performed at a timing at which a temperature of the box inside A reaches a set temperature due to an internal heating operation, and thus the internal heating operation is temporarily paused. A state at this time is a state in which a refrigerant is not required to be supplied to the internal heat exchanger 18. Since the refrigerant circuit during the frost suppression operation illustrated in FIG. 3 is separate from the box inside A side, a refrigerant is not supplied to the internal heat exchanger 18, and a temperature of the box inside A is appropriately maintained due to an internal heating operation performed until right before. Therefore, such a refrigerant circuit is convenient.

[0044] For example, in a case of a defrost operation of the related art, the defrost operation is started in a case where a defrost condition is established regardless of a temperature of the box inside A. During that time, a temperature of the box inside A may not be appropriate. However, in the present embodiment, the frost suppression operation of the present embodiment is performed only in a case where a temperature of the box inside A is appropriate, and the appropriately maintained temperature of the box inside A is hardly influenced due to the configuration of the refrigerant circuit. In a case where a temperature of the box inside A is not appropriate, an internal heating operation is started, and thus control of appropriately maintaining a temperature of the box inside A is performed. Therefore, in a case where the frost suppression operation of the present embodiment is employed, frost accumulation can be suppressed while appropriately maintaining a temperature of the box inside A.

[0045] Due to the frost suppression operation, heating performance of the refrigerant circuit can be maintained by frequently removing frost from the external heat exchanger 12, and a state in which a frost condition is established during an internal heating operation can also be prevented. Therefore, it is possible to prevent transition to a defrost operation during the internal heating operation regardless of a temperature state of the box inside A.

[0046] Next, a description will be made of transition of an operation mode during an internal heating operation.

[0047] FIG. 5 is a flowchart illustrating a process in the control device in the first embodiment of the present invention.

[0048] It is assumed that the refrigerant circuit system 1 performs an internal heating operation on the basis of a user's operation or the like of giving an instruction for starting the internal heating operation. A target temperature is set, and control for reaching a range within a predetermined temperature is performed. The temperature sensor 31 measures a temperature of the external heat exchanger 12 and outputs the temperature to the control device 100. The temperature sensor 32 measures a temperature of the box inside A and outputs the temperature to the control device 100.

[0049] First, the control device 100 determines whether or not there is an operation stopping request for the internal heating operation (step S11). In a case where there is the operation stopping request (step S11; Yes), the control device 100 performs stopping control such as stopping of the compressor 10. In a case where there is no operation stopping request (step S11; No), subsequently, the control device 100 determines whether or not a cooling operation condition is established (step S12). The cooling operation condition is a condition for switching an operation mode to a cooling operation from the internal heating operation such that a temperature of the box inside A is reduced to an appropriate temperature range in a case where a temperature of the box inside A is excessively increased due to the internal heating operation. In a case where it is determined that the cooling operation condition is established (YES in step S12; Yes), the control device 100 switches an operation mode to the cooling operation. In other words, the control device 100 switches a circuit to the refrigerant circuit exemplified in FIG. 1 from the refrigerant circuit exemplified in FIG. 2 and performs the cooling operation.

[0050] In a case where a temperature of the box inside A reaches a temperature in an appropriate range due to the cooling operation, the control device 100 switches an operation mode to the internal heating operation again, and performs the processes in step S11 and the subsequent steps.

[0051] In a case where it is determined that the cooling operation condition is not established (step S12; No), subsequently, the control device 100 determines whether or not a defrost operation condition is established (step S13). The defrost operation condition is determined with a state in which frost accumulating on the external heat exchanger 12 may progress as a reference. For example, in a case where pressure of the refrigerant measured by a pressure sensor (not illustrated) provided in the refrigerant circuit system 1 is equal to or less than predetermined pressure, the control device 100 determines that the defrost operation condition is established. In other cases, the control device 100 may determine a defrost operation condition on the basis of a plurality of conditions such as a temperature of the external heat exchanger 12 measured by the temperature sensor 31. In a case where it is determined that the defrost operation condition is established (step S13; Yes), the control device 100 switches an operation mode to a defrost operation. In other words, the control device 100 switches a circuit to the refrigerant circuit exemplified in FIG. 3 from the refrigerant circuit exemplified in FIG. 2 and performs the defrost operation. The defrost operation is continuously performed until a defrost operation finishing condition such as a condition in which a temperature of the external heat exchanger 12 measured by the temperature sensor 31 reaches a predetermined temperature. In a case where the defrost operation is finished, the control device 100 switches an operation mode to an internal heating operation and performs the processes in step S11 and the subsequent steps.

[0052] In a case where it is determined that the defrost operation condition is not established (step S13; No), subsequently, the control device 100 determines whether or not an internal heating pause condition is established (step S14). The internal heating pause condition is a condition for temporarily pausing the internal heating operation in order to prevent waste of restricted energy available in a refrigeration vehicle in a case where a temperature of the box inside A reaches an appropriate temperature due to the internal heating operation. For example, in a case where the internal heating pause condition is that a predetermined time elapses in a state in which a temperature of the box inside A is equal to or higher than a predetermined temperature, the control device 100 determines whether or not the internal heating pause condition is established by monitoring a change in a temperature measured by the temperature sensor 32. In a case where it is determined that the internal heating pause condition is not established (step S14; No), the control device 100 repeatedly performs the processes in step S11 and the subsequent steps while continuously performing the internal heating operation.

[0053] On the other hand, in a case where it is determined that the internal heating pause condition is established (step S14; Yes), the control device 100 determines whether or not a frost suppression operation condition is established (step S15). The frost suppression operation condition is that, for example, a temperature of the external heat exchanger 12 is a predetermined low temperature, pressure of a refrigerant is equal to or lower than predetermined pressure, an external temperature is equal to or less than a predetermined temperature, and a predetermined time (for example, 30 minutes) or more has elapsed after the previous frost suppression operation is performed. In a case where one or a plurality of conditions among the conditions are established, the control device 100 determines that the frost suppression operation condition is established. A milder condition than the defrost operation condition is set as the frost suppression operation condition. For example, in a case where a temperature of the external heat exchanger 12 measured by the temperature sensor is equal to or lower than a predetermined temperature, the control device 100 determines that the frost suppression operation condition is established.

[0054] In a case where it is determined that the frost suppression operation condition is established (step S15; Yes), the control device 100 causes an operation mode to transition to a frost suppression operation. In other words, the control device 100 switches a circuit to the refrigerant circuit exemplified in FIG. 3 from the refrigerant circuit exemplified in FIG. 2 and performs the frost suppression operation (step S16). During the frost suppression operation, the control device 100 also performs the following determination, and performs transition to an operation mode corresponding to a situation as appropriate.

[0055] First, the control device 100 determines whether or not there is an operation stopping request (step S17). In a case where it is determined that there is the operation stopping request (step S17; Yes) by performing the same determination as in step S11, the control device 100 performs stopping control. In a case where there is no operation stopping request (step S17; No), the control device 100 determines whether or not a cooling operation condition is established (step S18). In a case where it is determined that the cooling operation condition is established in the same manner as in step S12 (step S18; Yes), the control device 100 switches a circuit to the refrigerant circuit exemplified in FIG. 1 from the refrigerant circuit exemplified in FIG. 2 and performs the cooling operation.

[0056] In a case where it is determined that the cooling operation condition is not established (step S18; No), subsequently, the control device 100 determines whether or not an internal heating operation return condition is established (step S19). The internal heating operation return condition is a condition for determining whether or not the internal heating operation is required to be resumed in a case where a temperature of the box inside A is reduced during stopping of the internal heating operation. For example, in a case where a temperature of the box inside A is equal to or lower than a predetermined temperature, the control device 100 determines that the internal heating operation return condition is established. In a case where it is determined that the internal heating operation return condition is established (step S19; Yes), the control device 100 causes an operation mode to transition to the internal heating operation. Specifically, the control device 100 switches a circuit to the refrigerant circuit exemplified in FIG. 2 from the refrigerant circuit exemplified in FIG. 3 and performs the internal heating operation (step S25).

[0057] On the other hand, in a case where it is determined that the internal heating operation return condition is not established (step S19; No), the control device 100 determines whether or not a frost suppression operation finishing condition is established (step S20). The frost suppression operation finishing condition for determining finishing of the frost suppression operation includes, for example, either one of the following two conditions.

1. The frost suppression operation is continuously performed for a predetermined time (for example, two minutes) or more.
2. A defrost finishing condition (for example, a temperature of the external heat exchanger 12 reaches a predetermined temperature) is established.

[0058] In a case where either one of the two conditions is established, the control device 100 determines that the frost suppression operation finishing condition is established. In a case where it is determined that the frost suppression operation finishing condition is not established (step S20; No), the control device 100 repeatedly performs the determination from step S17 while continuously performing the frost suppression operation. In a case where it is determined that the frost suppression operation finishing condition is established (step S20; Yes), the control device 100 causes an operation mode to transition to an internal heating pause operation (step S21). In the internal heating pause operation, the control device 100 stops an operation of the compressor 10 such that the refrigerant is not circulated.

[0059] The control device 100 may also perform the same determination as in the frost suppression operation during the internal heating pause operation, and may perform transition to an operation mode corresponding to a situation. First, the control device 100 determines whether or not there is an operation stopping request (step S22). In a case where there is the operation stopping request (step S22; Yes), the control device 100 performs stopping control. In a case where there is no operation stopping request (step S22; No), the control device 100 determines whether or not a cooling operation condition is established (step S23). In a case where it is determined that the cooling operation condition is established (step S23; Yes), the control device 100 switches a circuit to the refrigerant circuit exemplified in FIG. 1, and performs the cooling operation.

[0060] In a case where it is determined that the cooling operation condition is not established (step S23; No), subsequently, the control device 100 determines whether or not an internal heating operation return condition is established (step S24). In a case where it is determined that the internal heating operation return condition is established (step S24; Yes), the control device 100 causes an operation mode to transition to the internal heating operation (step S25). In a case where it is determined that the internal heating operation return condition is not established (step S24; No), the control device 100 repeatedly performs the process from step S22 while continuously performing the internal heating pause operation.

[0061] According to the present embodiment, the frost suppression operation is performed when frost is light by using an operation pause time (after the internal heating pause condition is established) during the internal heating operation, and thus it is possible to maintain a state (a state in which a frost amount is small) in which the external heat exchanger 12 can exhibit performance thereof at all times. Since the frost suppression operation is performed for an internal heating operation pause time by using the refrigerant circuit which is physically separate from the box inside A, there is no influence on a temperature of the box inside A which is appropriately controlled due to an internal heating operation of the related art, and a temperature of the box inside A can be maintained in a desired temperature range. Since the frost suppression operation is performed for the internal heating operation pause time, it is possible to considerably reduce a frequency of performing a defrost operation. Thus, high heating performance can be maintained at all times, and thus a temperature change of the box inside A due to a defrost operation can be prevented. A complex circuit configuration such as provision of a plurality of heat exchangers for defrosting the external heat exchanger 12 is not necessary, and thus cost can be reduced. Since a refrigerant circuit can be used in common to the frost suppression operation and the defrost operation, a new configuration for the frost suppression operation is not required to be added, and thus cost can be reduced.

<Second Embodiment

[0062] Hereinafter, with reference to FIG. 6, a refrigerant circuit system according to a second embodiment of the present invention will be described.

[0063] FIG. 6 is a diagram illustrating a refrigerant circuit system in a second embodiment of the present invention.

[0064] As illustrated in FIG. 6, a refrigerant circuit system 1A is configured to include a compressor 10, a four-way valve 11, an external heat exchanger 12, an external expansion valve 13, an external check valve 14, a receiver tank 15, an internal expansion valve 16, an internal check valve 17, an internal heat exchanger 18, an accumulator 19, a main pipe 20, a bypass pipe 21, an opening/closing valve 22, an external fan 23, an internal fan 24, a liquid return pipe 25, and a control device 100. The refrigerant circuit system 1 is provided with, for example, a temperature sensor 31 and a temperature sensor 32. An oil return hole 26 is provided on a lower part of a U-shaped pipe in the accumulator 19. A refrigerator oil flowing into the refrigerant circuit from the compressor 10 returns to the compressor 10 via the U-shaped pipe in the accumulator 19 from the oil return hole 26.

[0065] The refrigerant circuit system 1A of the present embodiment includes the liquid return pipe 25 which connects a liquid-phase portion of the receiver tank 15 to an upstream side of the opening/closing valve 22 in the bypass pipe 21. In a case where a refrigerant is circulated in a refrigerant circuit (FIG. 3) during a frost suppression operation, a high-pressure and high-temperature refrigerant flows into the external heat exchanger 12 from the compressor 10, so as to heat the external heat exchanger 12 such that frost thereon is melted. The refrigerant in a gas-liquid two-phase state partially liquefied due to heat dissipation in the external heat exchanger 12 flows into the receiver tank 15. A refrigerant gas which has flown into the receiver tank 15 and a refrigerant gas obtained by partially gasifying a refrigerant liquid due to the receiver tank 15 absorbing heat from ambient air return to the compressor 10 via the bypass pipe 21. In a case where a liquefied refrigerant amount in the external heat exchanger 12 is compared with a gasified refrigerant amount in the receiver tank 15 in the refrigerant circuit illustrated in FIG. 3, an amount of a refrigerant which is liquefied and is stored in the receiver tank 15 is larger than a gasified refrigerant amount, and thus the liquefied refrigerant tends to be accumulated in the receiver tank 15. Therefore, an amount of a refrigerant circulated in the refrigerant circuit is reduced during the frost suppression operation, and this leads to an operation state in which a density of a refrigerant taken into the compressor 10 is low. In this state, since an amount of a circulated refrigerant is small, there is a tendency that high heating performance cannot be obtained. A refrigerator oil tends to be accumulated in the receiver tank 15 along with a refrigerant liquid, and thus a long-term operation may be hardly performed due to shortage of the refrigerator oil in the compressor 10.

[0066] Therefore, in the second embodiment, the liquid return pipe 25 is added from a portion (liquid-phase portion) where a refrigerant liquid is accumulated in a lower part of the receiver tank 15 toward the upstream side of the opening/closing valve 22 of the bypass pipe 21, and thus part of the refrigerant liquid accumulated in the receiver tank 15 is supplied to the inside of the circuit in which a refrigerant gas is circulated. Then, the refrigerant liquid is circulated in the refrigerant circuit along with the refrigerant gas, and thus a circulated refrigerant amount is increased. Consequently, it is possible to prevent deterioration in heating performance due to refrigerant shortage. The refrigerator oil dissolved in the refrigerant liquid returns to the compressor 10 via the liquid return pipe 25, the bypass pipe 21, the accumulator 19, the U-shaped pipe in the accumulator 19 in this order along with the refrigerant liquid, and thus it is possible to solve the problem that an operation time is restricted due to refrigerator oil shortage.

[0067] In order to prevent the refrigerant liquid from being accumulated in the accumulator 19, a size or a pressure loss of the liquid return pipe 25 is designed such that an amount of the refrigerant liquid passing through the liquid return pipe 25 does not exceed an amount of a refrigerant which is supplied to the compressor 10 from the oil return hole 26 via the U-shaped pipe in the accumulator 19.

[0068] According to the second embodiment, in addition to the effect of the first embodiment, it is possible to improve heating performance due to an increase of a circulated refrigerant amount in a frost suppression operation or a defrost operation, or to perform a long-term operation due to the refrigerator oil return effect. Since the heating performance is improved, it is possible to suppress frost and to perform defrosting in a short period of time even without performing a frost suppression operation or a defrost operation for a long period of time, and thus to reduce power consumption in a refrigeration vehicle.

[0069] A constituent element in the embodiments may be replaced with a well-known constituent element within the scope without departing from the spirit of the present invention. The technical scope of the present invention is not limited to the embodiments, and may be variously modified within the scope without departing from the spirit of the present invention.

Industrial Applicability

[0070] According to the refrigerant circuit system, the control device, and the control method, high heating performance can be maintained by preventing frost from accumulating on an evaporator without influencing a use side (condenser side) in an internal heating operation.

Reference Signs List

[0071]

1 AND 1A	REFRIGERANT CIRCUIT SYSTEM
10	COMPRESSOR
11	FOUR-WAY VALVE
12	EXTERNAL HEAT EXCHANGER
13	EXTERNAL EXPANSION VALVE
14	EXTERNAL CHECK VALVE
15	RECEIVER TANK
16	INTERNAL EXPANSION VALVE
17	INTERNAL CHECK VALVE
18	INTERNAL HEAT EXCHANGER
19	ACCUMULATOR
20	MAIN PIPE
21	BYPASS PIPE (BYPASS CIRCUIT)
22	OPENING/CLOSING VALVE
23	EXTERNAL FAN
24	INTERNAL FAN
25	LIQUID RETURN PIPE
26	OIL RETURN HOLE
31 AND 32	TEMPERATURE SENSOR
100	CONTROL DEVICE

Claims

1. A refrigerant circuit system comprising:

   a refrigerant circuit that includes a compressor compressing a refrigerant, a condenser condensing the refrigerant compressed by the compressor, a receiver tank storing part of the condensed refrigerant, an expansion valve depressing the refrigerant flowing out of the receiver tank, an evaporator evaporating the depressed refrigerant, an accumulator supplying a refrigerant gas of a refrigerant flowing out of the evaporator to the compressor, a bypass circuit connecting a gas-phase portion of the receiver tank to the accumulator, and an opening/closing valve controlling opening and closing of the bypass circuit; and
   a control device that controls an operation of the refrigerant circuit,
   wherein the control device performs a frost suppression operation of defrosting the evaporator by circulating a refrigerant ejected from the compressor in an order of the condenser, the receiver tank, the bypass circuit, the accumulator, and the compressor before pausing an internal heating operation in the refrigerant circuit.

2. The refrigerant circuit system according to claim 1, wherein, in a case where the internal heating operation is paused, the control device performs the frost suppression operation on the condition that a predetermined frost suppression operation condition is established, and pauses the internal heating operation instead of performing the frost suppression operation in a case where the frost suppression operation condition is not established.

3. The refrigerant circuit system according to claim 1 or 2,
   wherein, in a case where the frost suppression operation is started, the control device finishes the frost suppression operation on the condition of satisfying at least one of a time for which the frost suppression operation is continuously performed being equal to or more than a predetermined time and a predetermined defrost finishing condition being established.

4. The refrigerant circuit system according to any one of claims 1 to 3,
   wherein the control device determines whether or not a defrost operation is to be performed before determining whether or not the frost suppression operation is to be performed, and determines that the frost suppression operation is to be performed in a case where it is determined that the defrost operation is not to be performed.

5. The refrigerant circuit system according to any one of claims 1 to 4,
wherein the control device stops the frost suppression operation, and resumes the internal heating operation, in a case where a predetermined internal heating operation return condition is established during execution of the frost suppression operation.

6. The refrigerant circuit system according to claim 5, wherein the control device pauses the internal heating operation after the frost suppression operation is finished, and resumes the internal heating operation in a case where the internal heating operation return condition is established.

7. The refrigerant circuit system according to any one of claims 1 to 6,
wherein the refrigerant circuit further includes a liquid return pipe that connects a liquid-phase portion of the receiver tank to an upstream side of the opening/closing valve in the bypass circuit.

8. A control device controlling an operation of a refrigerant circuit that includes a compressor compressing a refrigerant, a condenser condensing the refrigerant compressed by the compressor, a receiver tank storing part of the condensed refrigerant, an expansion valve depressing the refrigerant flowing out of the receiver tank, an evaporator evaporating the depressed refrigerant, an accumulator supplying a refrigerant gas of a refrigerant flowing out of the evaporator to the compressor, a bypass circuit connecting a gas-phase portion of the receiver tank to the accumulator, and an opening/closing valve controlling opening and closing of the bypass circuit,
wherein the control device performs defrosting the evaporator by circulating a refrigerant ejected from the compressor in an order of the condenser, the receiver tank, the bypass circuit, the accumulator, and the compressor before pausing an internal heating operation in the refrigerant circuit.

9. A control method for a refrigerant circuit that includes a compressor compressing a refrigerant, a condenser condensing the refrigerant compressed by the compressor, a receiver tank storing part of the condensed refrigerant, an expansion valve depressing the refrigerant flowing out of the receiver tank, an evaporator evaporating the depressed refrigerant, an accumulator supplying a refrigerant gas of a refrigerant flowing out of the evaporator to the compressor, a bypass circuit connecting a gas-phase portion of the receiver tank to the accumulator, and an opening/closing valve controlling opening and closing of the bypass circuit, the control method comprising:
causing a control device controlling an operation of the refrigerant circuit to perform a frost suppression operation of defrosting the evaporator by circulating a refrigerant ejected from the compressor in an order of the condenser, the receiver tank, the bypass circuit, the accumulator, and the compressor before pausing an internal heating operation in the refrigerant circuit.

10. The control method according to claim 9,
wherein the refrigerant circuit further includes a liquid return pipe that connects a liquid-phase portion of the receiver tank to an upstream side of the opening/closing valve in the bypass circuit, and
wherein, in a case where the frost suppression operation is performed, the control device circulates the refrigerant ejected from the compressor in an order of the condenser, the receiver tank, the bypass circuit, the accumulator, and the compressor, and supplies a refrigerant liquid to the bypass circuit from the liquid-phase portion of the receiver tank such that the refrigerant liquid is added to the circulated refrigerant.

Amended claims under Art. 19.1 PCT

1. (Amended) A refrigerant circuit system comprising:

a refrigerant circuit that includes a compressor compressing a refrigerant, a condenser condensing the refrigerant compressed by the compressor, a receiver tank storing part of the condensed refrigerant, an expansion valve depressing the refrigerant flowing out of the receiver tank, an evaporator evaporating the depressed refrigerant, an accumulator supplying a refrigerant gas of a refrigerant flowing out of the evaporator to the compressor, a bypass circuit connecting a gas-phase portion of the receiver tank to the accumulator, and an opening/closing valve controlling opening and closing of the bypass circuit; and
a control device that controls an operation of the refrigerant circuit,
wherein the control device determines whether or not a defrost operation is to be performed, and, in a case where it is determined that the defrost operation is not to be performed, performs a frost suppression operation of defrosting the evaporator by circulating a refrigerant ejected from the compressor in the order of the evaporator, the receiver tank, the bypass circuit, the accumulator, and the compressor on the condition that a predetermined frost suppression operation is established before pausing an internal heating operation in the refrigerant circuit.

2. (Amended) The refrigerant circuit system according to claim 1, wherein, in a case where the internal heating operation is paused, and the frost suppression operation condition is not established, the control device pauses the internal heating operation instead of performing the frost suppression operation.

3. (New) The refrigerant circuit system according to claim 1 or 2,
wherein the frost suppression operation condition includes any one of a temperature of the evaporator being equal to or less than a predetermined temperature, pressure of the refrigerant being equal to or less than predetermined pressure, an external temperature being equal to or less than a predetermined temperature, and a predetermined time or more having elapsed from the previous frost suppression operation.

4. (Amended) The refrigerant circuit system according to any of claims 1 to 3,
wherein, in a case where the frost suppression operation is started, the control device finishes the frost suppression operation on the condition of satisfying at least one of a time for which the frost suppression operation is continuously performed being equal to or more than a predetermined time and a predetermined defrost finishing condition being established.

5. (Original) The refrigerant circuit system according to any one of claims 1 to 4,
wherein the control device stops the frost suppression operation, and resumes the internal heating operation, in a case where a predetermined internal heating operation return condition is established during execution of the frost suppression operation.

6. (Original) The refrigerant circuit system according to claim 5,
wherein the control device pauses the internal heating operation after the frost suppression operation is finished, and resumes the internal heating operation in a case where the internal heating operation return condition is established.

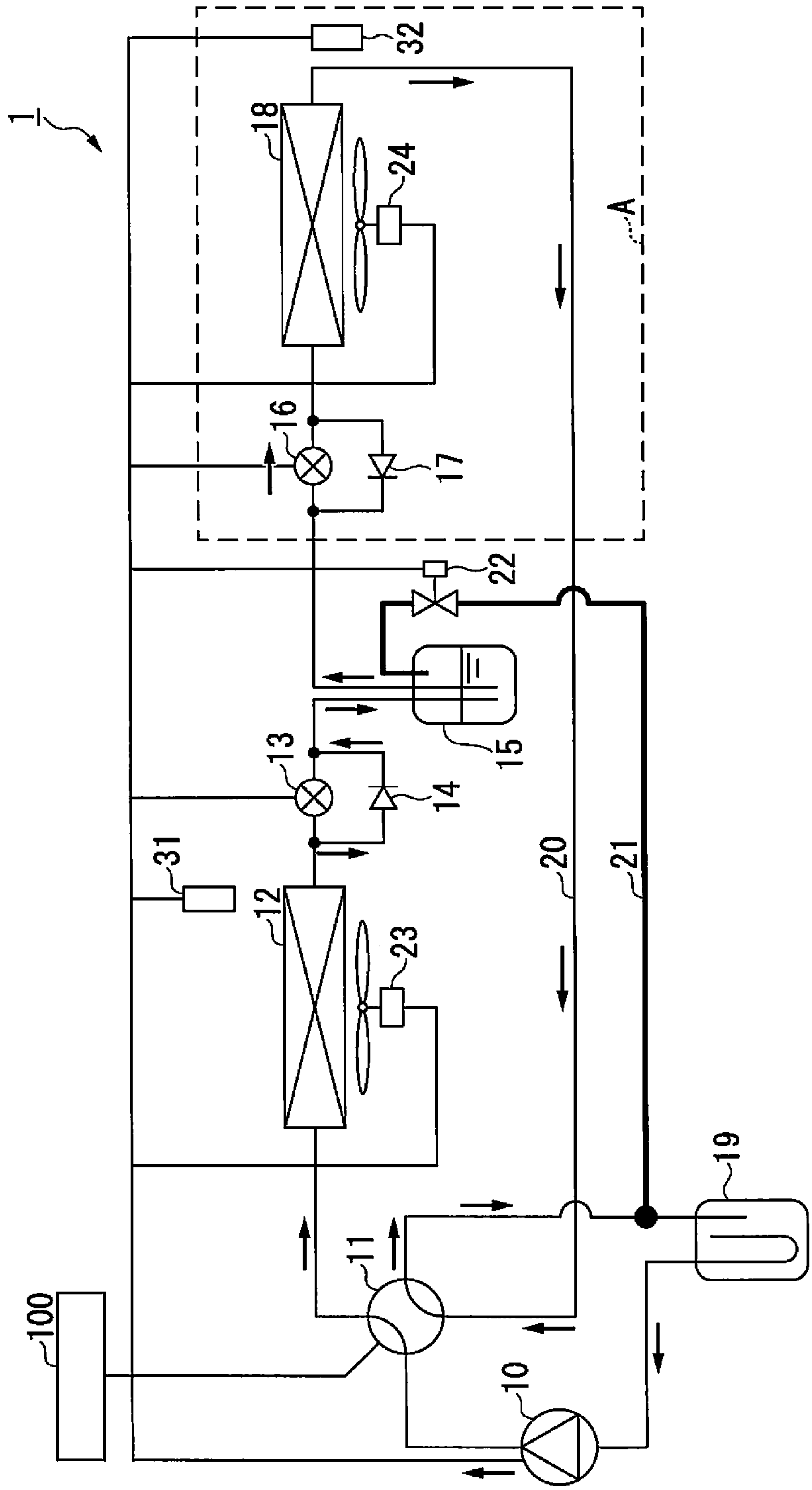
7. (Original) The refrigerant circuit system according to any one of claims 1 to 6,
wherein the refrigerant circuit further includes a liquid return pipe that connects a liquid-phase portion of the receiver tank to an upstream side of the opening/closing valve in the bypass circuit.

8. (Amended) A control device controlling an operation of a refrigerant circuit that includes a compressor compressing a refrigerant, a condenser condensing the refrigerant compressed by the compressor, a receiver tank storing part of the condensed refrigerant, an expansion valve depressing the refrigerant flowing out of the receiver tank, an evaporator evaporating the depressed refrigerant, an accumulator supplying a refrigerant gas of a refrigerant flowing out of the evaporator to the compressor, a bypass circuit connecting a gas-phase portion of the receiver tank to the accumulator, and an opening/closing valve controlling opening and closing of the bypass circuit,
wherein the control device determines whether or not a defrost operation is to be performed, and, in a case where it is determined that the defrost operation is not to be performed, performs a frost suppression operation of defrosting the evaporator by circulating a refrigerant ejected from the compressor in an order of the evaporator, the receiver tank, the bypass circuit, the accumulator, and the compressor on the condition that a predetermined frost suppression operation is established before pausing an internal heating operation in the refrigerant circuit.

9. (Amended) A control method for a refrigerant circuit that includes a compressor compressing a refrigerant, a condenser condensing the refrigerant compressed by the compressor, a receiver tank storing part of the condensed refrigerant, an expansion valve depressing the refrigerant flowing out of the receiver tank, an evaporator evaporating the depressed refrigerant, an accumulator supplying a refrigerant gas of a refrigerant flowing out of the evaporator to the compressor, a bypass circuit connecting a gas-phase portion of the receiver tank to the accumulator, and an opening/closing valve controlling opening and closing of the bypass circuit, the control method comprising:
causing a control device controlling an operation of the refrigerant circuit to determine whether or not a defrost operation is to be performed, and, in a case where it is determined that the defrost operation is not to be performed, to perform a frost suppression operation of defrosting the evaporator by circulating a refrigerant ejected from the compressor in an order of the evaporator, the receiver tank, the bypass circuit, the accumulator, and the compressor on the condition that a predetermined frost suppression operation is established before pausing an internal heating operation in the refrigerant circuit.

10. (Amended) The control method according to claim 9,
wherein the refrigerant circuit further includes a liquid return pipe that connects a liquid-phase portion of the receiver tank to an upstream side of the opening/closing valve in the bypass circuit, and
wherein, in a case where the frost suppression operation is performed, the control device circulates the refrigerant ejected from the compressor in an order of the evaporator, the receiver tank, the bypass circuit, the accumulator, and the compressor, and supplies a refrigerant liquid to the bypass circuit from the liquid-phase portion of the receiver tank such that the refrigerant liquid is added to the circulated refrigerant.

FIG. 1



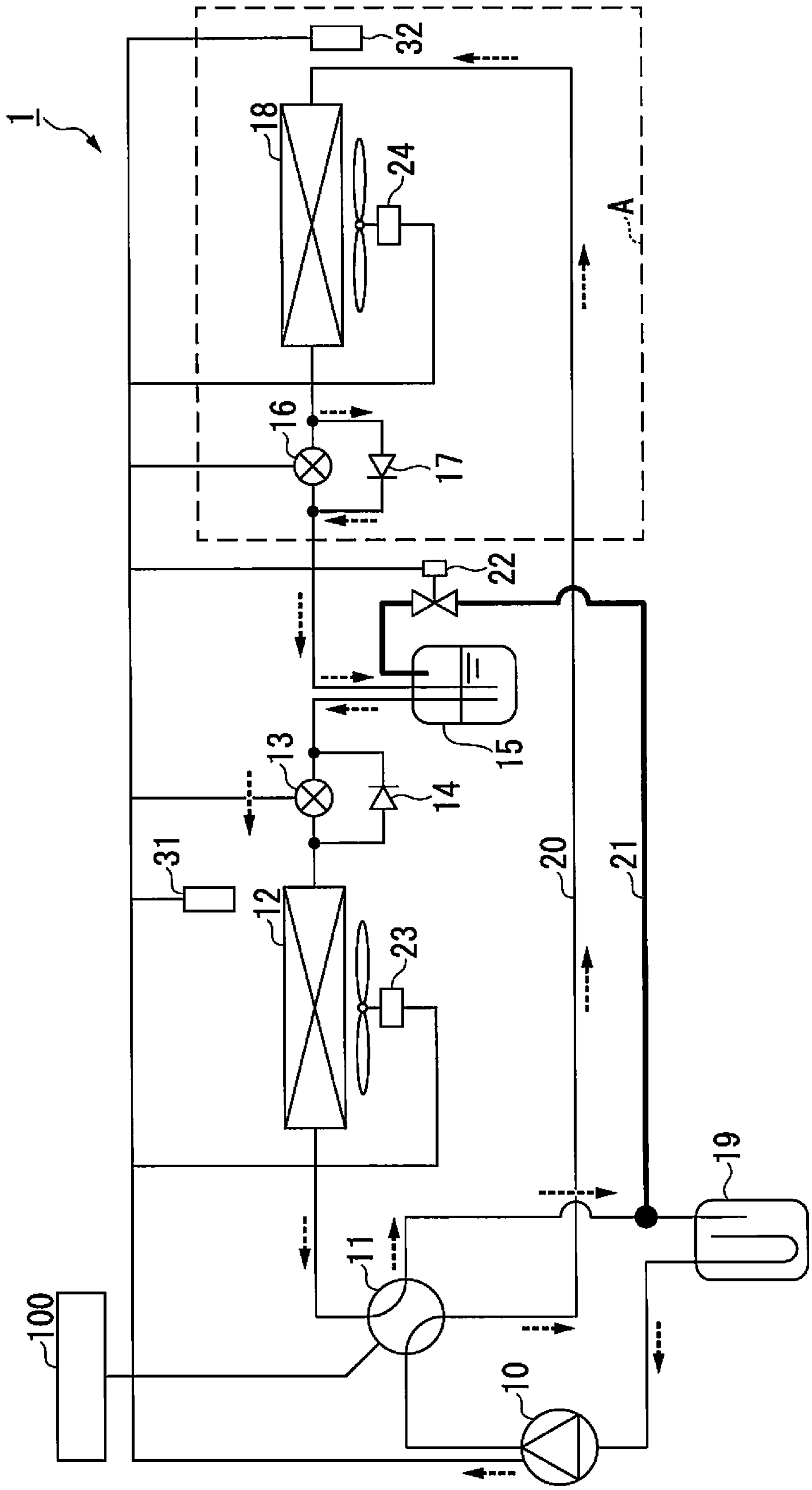


FIG. 2

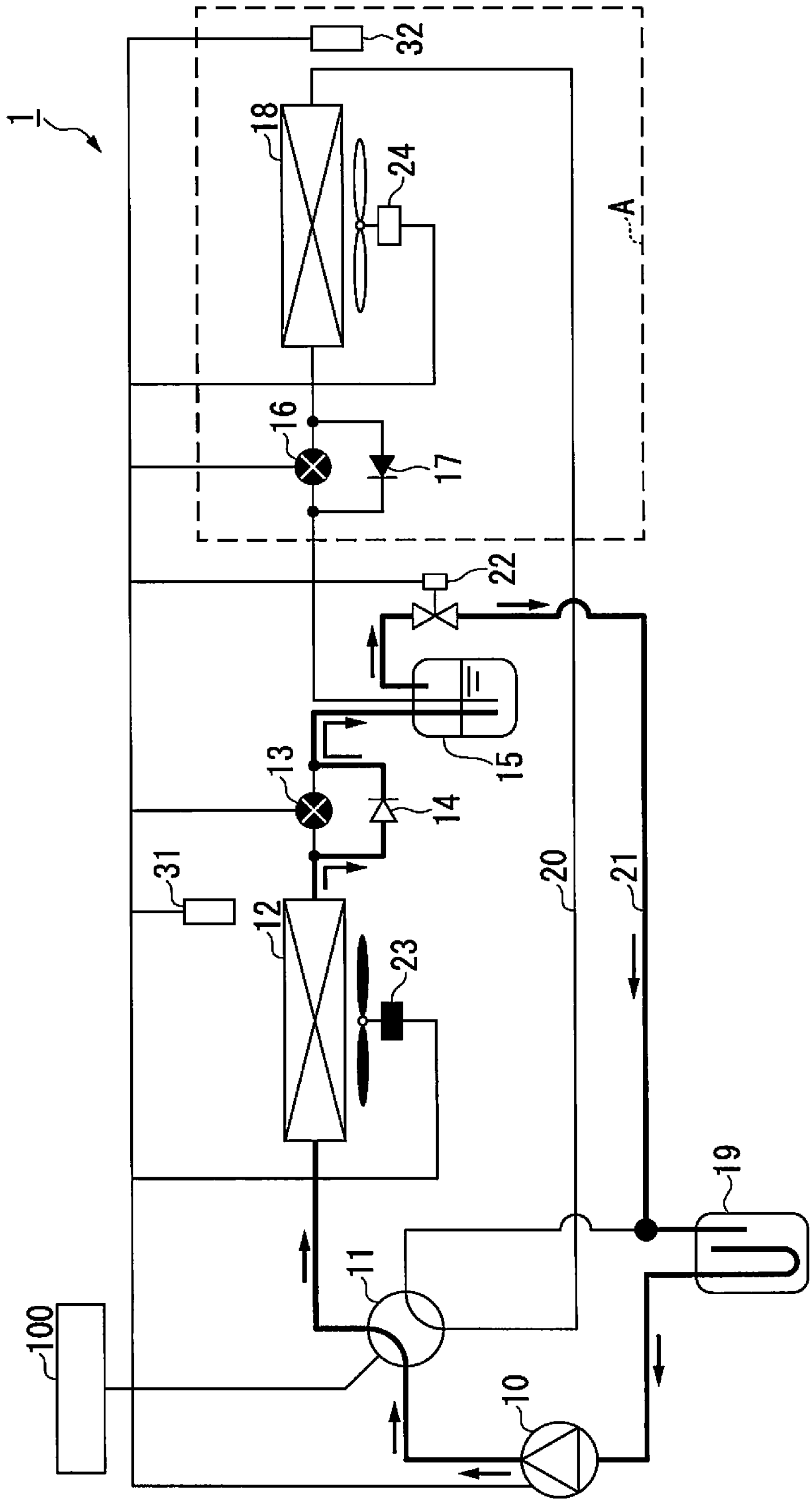
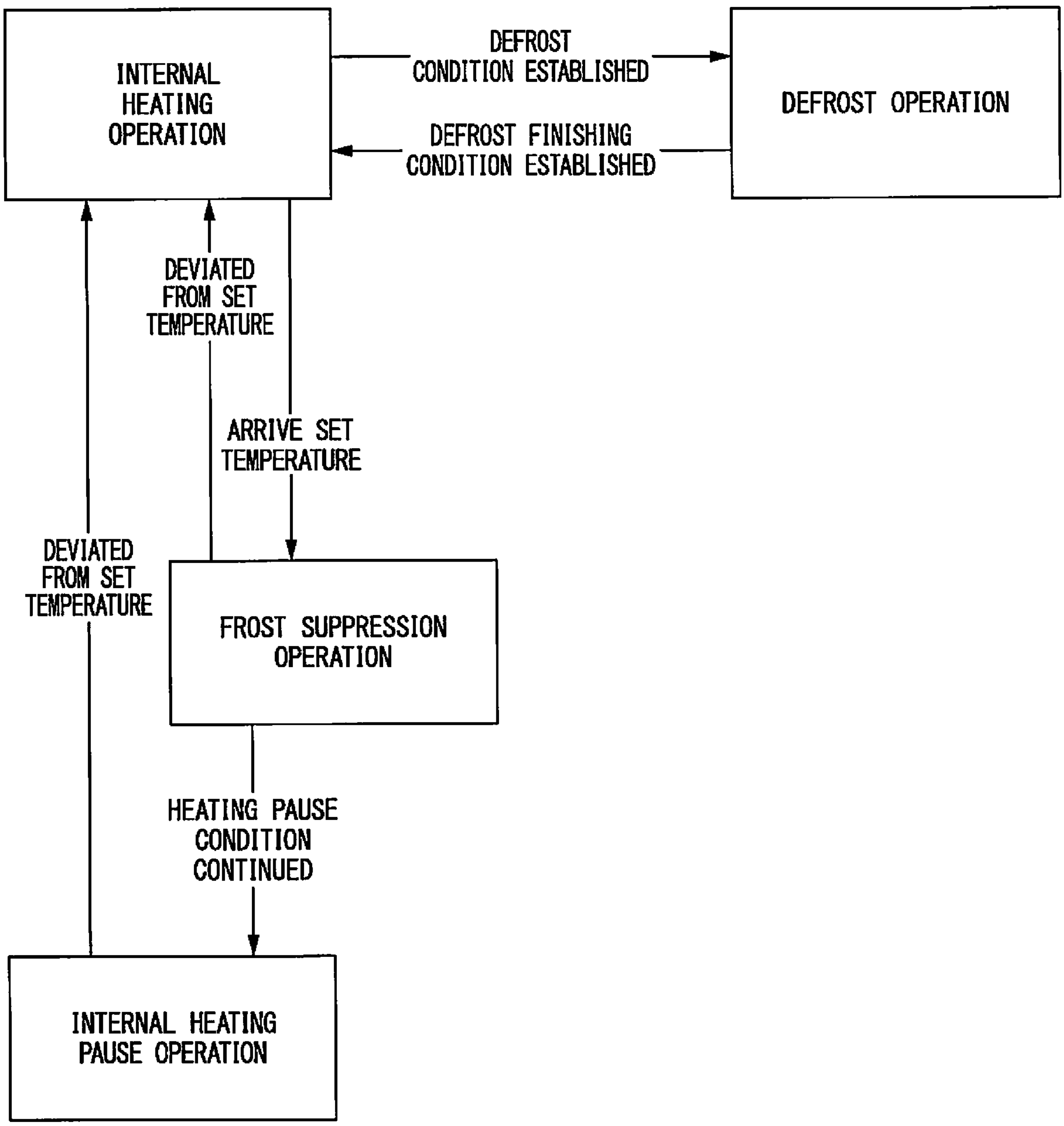


FIG. 3

FIG. 4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TEMPERATURE
ARRIVE SET
TEMPERATURE
DEVIATED
FROM SET
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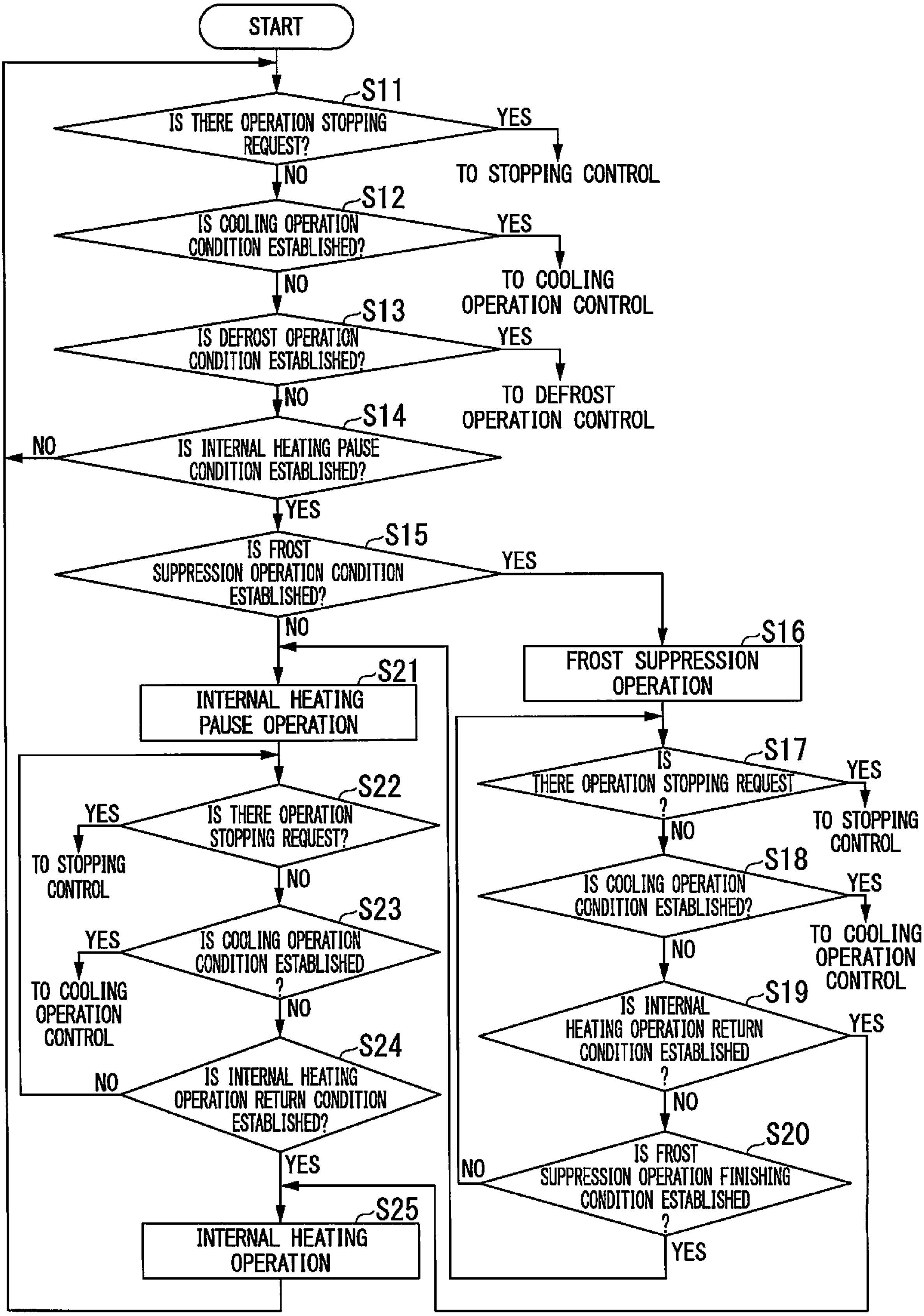
OPERATION
HEATING PAUSE
CONDITION
CONTINUED
INTERNAL HEATING
PAUSE OPERATION

FIG. 5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TO STOPPING CONTROL
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NO
S13
IS DEFROST OPERATION CONDITION ESTABLISHED?
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TO DEFROST OPERATION CONTROL
NO
S14
IS INTERNAL HEATING PAUSE CONDITION ESTABLISHED?
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YES
S15
IS FROST SUPPRESSION OPERATION CONDITION ESTABLISHED?
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NO
S16
FROST SUPPRESSION OPERATION
S21
INTERNAL HEATING PAUSE OPERATION
S17
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TO STOPPING CONTROL
NO
S22
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YES
TO STOPPING CONTROL
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S18
IS COOLING OPERATION CONDITION ESTABLISHED?
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NO
S23
IS COOLING OPERATION CONDITION ESTABLISHED ?
YES
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S19
IS INTERNAL HEATING OPERATION RETURN CONDITION ESTABLISHED ?
YES
NO
S24
IS INTERNAL HEATING OPERATION RETURN CONDITION ESTABLISHED?
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IS FROST SUPPRESSION OPERATION FINISHING CONDITION ESTABLISHED ?
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YES
S25
INTERNAL HEATING OPERATION

FIG. 6

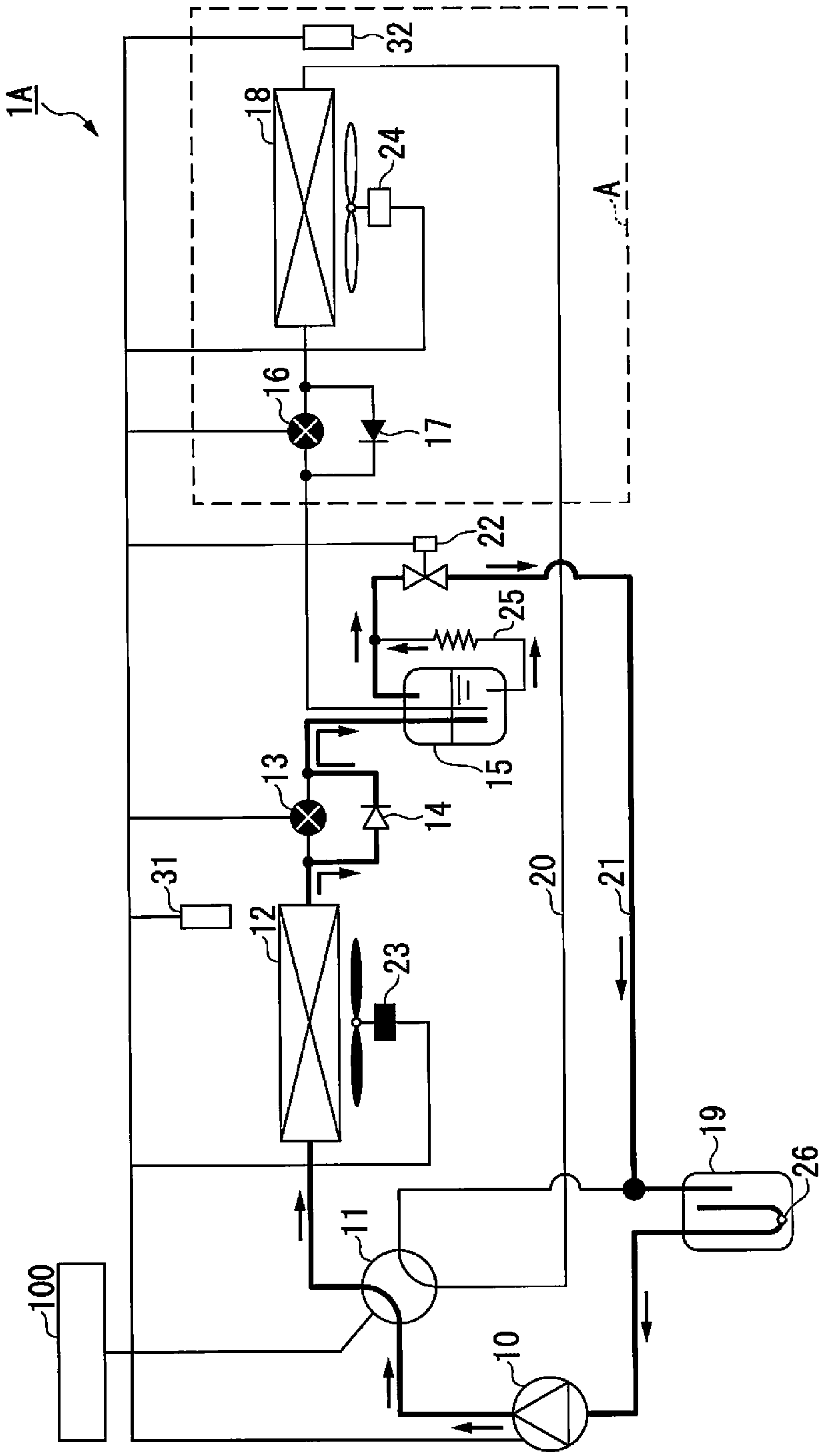
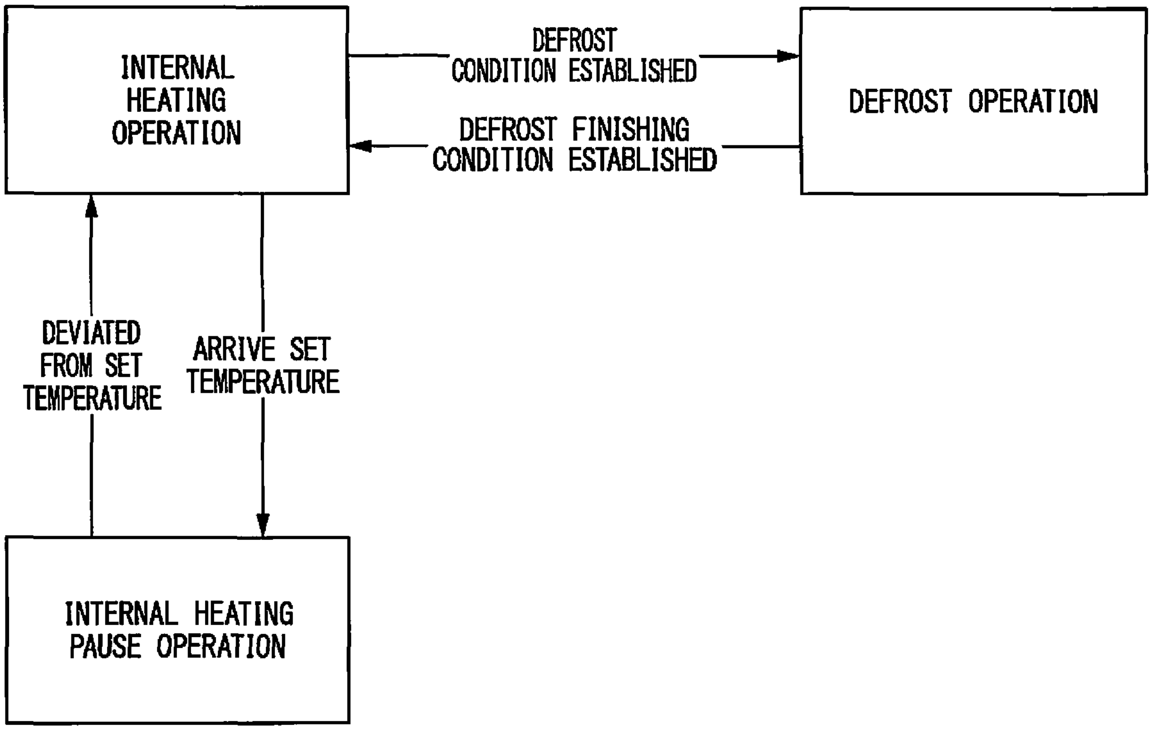


FIG. 7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DEFROST CONDITION ESTABLISHED
DEFROST OPERATION
DEFROST FINISHING CONDITION ESTABLISHED
DEVIATED FROM SET TEMPERATURE
ARRIVE SET TEMPERATURE
INTERNAL HEATING PAUSE OPERATION

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/042001

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F25B47/02(2006.01)i, F24F11/41(2018.01)i, F25B1/00(2006.01)i, F25D11/00(2006.01)i, F25D21/06(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F25B47/02, F24F11/41, F25B1/00, F25D11/00, F25D21/06

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	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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.
Y A	JP 2011-247476 A (ARYSTA LIFESCIENCE CORPORATION) 08 December 2011, paragraphs [0001]-[0027], fig. 1-2 (Family: none)	1-3, 5-10 4
Y A	JP 2007-278536 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 25 October 2007, paragraphs [0007]-[0069], fig. 1-9 (Family: none)	1-3, 5-10 4
Y A	JP 11-294885 A (TOSHIBA CORP.) 29 October 1999, paragraphs [0107]-[0117], fig. 17 (Family: none)	1-3, 5-10 4
Y	JP 57-182041 A (SHARP CORP.) 09 November 1982, page 1, left column, line 5 to page 1, right column, line 9 (Family: none)	3, 5-7, 10

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 January 2018 (23.01.2018)	30 January 2018 (30.01.2018)

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

International application No.
PCT/JP2017/042001

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2003-83646 A (FUJI ELECTRIC CO., LTD.) 19 March 2003, paragraphs [0009], [0022], fig. 1-3 (Family: none)	1-10
A	JP 2014-66413 A (DAIKIN INDUSTRIES, LTD.) 17 April 2014, paragraphs [0002]-[0049], fig. 1-5 (Family: none)	1-10
A	JP 2004-53207 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 19 February 2004, paragraphs [0001]-[0049], fig. 1-4 (Family: none)	1-10

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2016242476 A **[0002]**
- JP 5535510 B **[0007]**
- JP 2016151410 A **[0007]**
- JP 2007085730 A **[0007]**