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(54) **AIR CONDITIONER AND METHOD FOR DETERMINING THE AMOUNT OF REFRIGERANT THEREIN**

KLIMAANLAGE UND VERFAHREN ZUR BESTIMMUNG DER DARIN ENTHALTENEN
KÄLTEMITTELMENGE

CLIMATISEUR ET PROCÉDÉ POUR DÉTERMINER LA QUANTITÉ D AGENT FRIGORIGÈNE DANS
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Description

TECHNICAL FIELD

[0001] The present invention relates to the function of determining the adequacy of the quantity of refrigerant with which the inside of a refrigerant circuit of an air conditioning apparatus is charged and particularly relates to the function of determining the adequacy of the quantity of refrigerant with which the inside of a refrigerant circuit of an air conditioning apparatus where a heat source unit and a utilization unit are interconnected via refrigerant connection pipes is charged.

BACKGROUND ART

[0002] Conventionally, there is air conditioning apparatus such as in JP-ANo. 2006-23072 that performs refrigerant quantity determination operation where the quantity of refrigerant is determined on the basis of the degree of supercooling in the condenser. In the technology of JP-ANo. 2006-23072, the refrigerant quantity determination operation is performed a first time (e.g., at the time of installation of the air conditioning apparatus) and periodically (e.g., every year after the time of installation, etc.) in the air conditioning apparatus. In this refrigerant quantity determination operation, control is performed such that the degree of superheat and the evaporation pressure in the evaporator become constant in a cooling operation state, and the degree of supercooling in the condenser is measured. Then, in the refrigerant quantity determination operation, whether or not the refrigerant is leaking is determined on the basis of the difference between the degree of supercooling that has been measured at that time and the degree of supercooling that was measured the first time or before then.

[0003] WO2008/035418 A1 (and family member EP 1 970 651 A1) discloses a refrigerating air-conditioning system and a method for detecting a refrigerant leakage capable of automatically detecting a slight refrigerant leakage, while performing an air-conditioning operation, regardless of an environmental condition or installation condition. Accordingly, a judging means for judging the refrigerant leakage of a refrigerating cycle on the basis of a past data relating to a past refrigerant volume of the refrigerating cycle at a past time point and a new data relating to the refrigerant volume at a time point after performing a plurality of times of stopping and starting up operations of the refrigerating cycle since the past time point, is provided in the refrigerating air conditioning system constituting a refrigerating cycle by connecting an outdoor unit including a compressor, an outdoor heat exchanger, and a throttling device, and one or a plurality of indoor units each including an indoor heat exchanger and a throttling device with communication piping.

[0004] In a multi-type air conditioner according to EP 1 876 403 A1, the adequacy of the refrigerant quantity charged in the air conditioner can be accurately judged,

even when the refrigerant quantity charged on site is inconsistent, or even when a reference value of the operation state quantity, which is used for judging the adequacy of the refrigerant quantity, fluctuates depending on the pipe length of the refrigerant communication pipe, combination of utilization units, and the difference in the installation height among each unit. In an air conditioner including a refrigerant circuit configured by the interconnection of a heat source unit and utilization units via refrigerant communication pipes, a refrigerant quantity judging system judges the adequacy of the refrigerant quantity and includes a state quantity storing means and a refrigerant quantity judging means. The state quantity storing means stores the operation state quantity of constituent equipment or the refrigerant flowing in the refrigerant circuit in which refrigerant is charged up to an initial refrigerant quantity by on-site refrigerant charging. The refrigerant quantity judging means compares the operation state quantity during test operation as a reference value with a current value of the operation state quantity, and thereby judges the adequacy of the refrigerant quantity.

SUMMARY OF THE INVENTION

<Technical Problem>

[0005] However, in the refrigerant quantity determination operation, even in the case of a condition where the quantity of the refrigerant with which the refrigerant circuit is charged is the same, sometimes the heat exchange efficiency of the heat source-side heat exchanger changes because of the influence of disturbances such as dirt in the outdoor heat exchanger, the installation situation of the outdoor unit, and wind and rain, and there is the fear that variations will appear in the degree of supercooling that is measured. For this reason, in the refrigerant quantity determination operation, even in a case where there is not much change in the quantity of the refrigerant with which the refrigerant circuit is charged when the determination based on the degree of supercooling is performed, there is the fear that the quantity of the refrigerant will be determined to have changed. In order to ensure that variations in the degree of supercooling do not occur, it is conceivable to make the air volume of the heat source-side fan constant. However, when the air volume of the heat source-side fan is made constant, there is the fear that the pressure inside the heat source-side heat exchanger functioning as a condenser when the outside air temperature has changed will increase and decrease and that this pressure will become too high or too low. Thus, from the standpoints of high-pressure protection and high-low differential pressure securement, making the air volume of the heat source-side fan constant is not realistic. Further, it is also conceivable to divide the degree of supercooling target value according to the value of the outside air temperature, but problems arise in that the amount of data to be

stored ends up becoming large, it is necessary to install a memory with a large capacity, and production costs become larger.

[0006] It is a problem of the present invention to provide an air conditioning apparatus that reduces refrigerant quantity adequacy determination errors while realizing high-pressure protection, high-low differential pressure securement, and production cost control.

<Solution to the Problem>

[0007] An air conditioning apparatus pertaining to a first aspect of the invention comprises the features of claim 1.

[0008] In the air conditioning apparatus of this aspect of the invention, it is a separate type air conditioning apparatus where the refrigerant circuit is configured as a result of the heat source unit and the utilization unit being interconnected via the refrigerant connection pipes and which is capable of performing at least cooling operation. The reason "at least" is used here is because the air conditioning apparatus to which the present invention can be applied include air conditioning apparatus that can also perform another operation such as heating operation other than cooling operation. Additionally, this air conditioning apparatus is configured such that it can switch between and operate in normal operation such as cooling operation (hereinafter called "normal operation mode") and a refrigerant quantity determination operation mode where the utilization unit is forcibly caused to perform the cooling operation. This air conditioning apparatus detects the degree of supercooling of the refrigerant in the outlet of the heat source-side heat exchanger and determines the adequacy of the quantity of the refrigerant with which the inside of the refrigerant circuit is charged on the basis of a relative degree of supercooling value obtained by dividing the degree of supercooling by a function of outside air temperature and condensation temperature, and this relative degree of supercooling value is corrected by the outside air temperature and the condensation temperature, so even in cases where the outside air temperature conditions differ (in cases where the adequacy of the quantity of the refrigerant is performed periodically, the potential for the outside air temperatures to differ between the first time and the second time, and there is the fear that the degree of supercooling will fluctuate depending on changes in the outside air temperature) and even in cases where the condensation temperature conditions differ (in cases where the condensation temperatures differ because of influences resulting from disturbances such as dirt in the outdoor heat exchanger, the installation situation of the outdoor unit, and wind and rain), the relative degree of supercooling can be kept at a fairly constant value when the quantity of the refrigerant inside the refrigerant circuit virtually does not change. In this manner, by using this relative degree of supercooling value as an index for performing the refrigerant quantity adequacy determination, the de-

termination of the adequacy of the quantity of the refrigerant inside the refrigerant circuit can be performed virtually without being affected by the aforementioned disturbances, and the adequacy of the quantity of the refrigerant inside the refrigerant circuit can be determined with virtually no errors.

[0009] An air conditioning apparatus pertaining to a second aspect of the invention is the air conditioning apparatus pertaining to the first aspect of the invention, wherein the refrigerant quantity adequacy determining means periodically performs the refrigerant quantity adequacy determination.

[0010] In the air conditioning apparatus of this aspect of the invention, the adequacy of the quantity of the refrigerant with which the inside of the refrigerant circuit is charged can be precisely determined by periodically (e.g., once every year) performing the operation resulting from the refrigerant quantity determination operation mode, and if there is a change in the quantity of the refrigerant, it can be quickly discovered.

[0011] An air conditioning apparatus pertaining to a third aspect of the invention is the air conditioning apparatus pertaining to any of the first to second aspects of the invention, wherein the compressor is driven by a motor controlled by an inverter and is operated such that its speed resulting from the motor always becomes a predetermined speed in the refrigerant quantity determination operation mode.

[0012] Consequently, in the air conditioning apparatus of this aspect of the invention, the operating capacity of the compressor can be controlled with high precision.

[0013] An air conditioning apparatus refrigerant quantity determination method pertaining to a fourth aspect of the invention is a refrigerant quantity determination method comprising the features of claim 4.

[0014] In the air conditioning apparatus in which this aspect of the invention is employed, it is a method that is performed in a separate type air conditioning apparatus where the refrigerant circuit is configured as a result of the heat source unit and the utilization unit being interconnected via the refrigerant connection pipes and which is capable of performing at least cooling operation. The reason "at least" is used here is because the air conditioning apparatus to which the present invention can be applied include air conditioning apparatus that can also perform another operation such as heating operation other than cooling operation. Additionally, this air conditioning apparatus is configured such that it can switch between and operate in normal operation such as cooling operation (hereinafter called a "normal operation mode") and a refrigerant quantity determination operation mode where the utilization unit is forcibly caused to perform the cooling operation. This air conditioning apparatus detects the degree of supercooling of the refrigerant in the outlet of the heat source-side heat exchanger and determines the adequacy of the quantity of the refrigerant with which the inside of the refrigerant circuit is charged on the basis of a relative degree of supercooling value ob-

tained by dividing the degree of supercooling by a function of outside air temperature and condensation temperature, and this relative degree of supercooling value is corrected by the outside air temperature and the condensation temperature, so even in cases where the outside air temperature conditions differ (in cases where the adequacy of the quantity of the refrigerant is performed periodically, the potential for the outside air temperatures to differ between the first time and the second time, and there is the fear that the degree of supercooling will fluctuate depending on changes in the outside air temperature) and even in cases where the condensation temperature conditions differ (in cases where the condensation temperatures differ because of influences resulting from disturbances such as dirt in the outdoor heat exchanger, the installation situation of the outdoor unit, and wind and rain), the relative degree of supercooling can be kept at a fairly constant value when the quantity of the refrigerant inside the refrigerant circuit virtually does not change. In this manner, by using this relative degree of supercooling value as an index for performing the refrigerant quantity adequacy determination, the determination of the adequacy of the quantity of the refrigerant inside the refrigerant circuit can be performed virtually without being affected by the aforementioned disturbances, and the adequacy of the quantity of the refrigerant inside the refrigerant circuit can be determined with virtually no errors.

<Advantageous Effects of the Invention>

[0015] In the air conditioning apparatus pertaining to the first aspect of the invention, by using the relative degree of supercooling value as an index for performing the refrigerant quantity adequacy determination, the determination of the adequacy of the quantity of the refrigerant inside the refrigerant circuit can be performed virtually without being affected by the aforementioned disturbances, and the adequacy of the quantity of the refrigerant inside the refrigerant circuit can be determined with virtually no errors.

[0016] In the air conditioning apparatus pertaining to the second aspect of the invention, the adequacy of the quantity of the refrigerant with which the inside of the refrigerant circuit is charged can be precisely determined by periodically (e.g., once every year) performing the operation resulting from the refrigerant quantity determination operation mode, and if there is a change in the quantity of the refrigerant, it can be quickly discovered.

[0017] In the air conditioning apparatus pertaining to the third aspect of the invention, the operating capacity of the compressor can be controlled with high precision.

[0018] In the air conditioning apparatus refrigerant quantity determination method pertaining to the fourth aspect of the invention, by using this relative degree of supercooling value as an index for performing the refrigerant quantity adequacy determination, the determination of the adequacy of the quantity of the refrigerant inside the refrigerant circuit can be performed virtually with-

out being affected by the aforementioned disturbances, and the adequacy of the quantity of the refrigerant inside the refrigerant circuit can be determined with virtually no errors.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a general refrigerant circuit diagram of an air conditioning apparatus of one embodiment pertaining to the present invention.

FIG. 2 is a schematic diagram showing states of refrigerant flowing through the inside of the refrigerant circuit in cooling operation.

FIG. 3 is a flowchart of initial setup operation.

FIG. 4 is a schematic diagram showing states of the refrigerant flowing through the inside of the refrigerant circuit in a refrigerant quantity determination operation mode (initial setup operation and determination operation).

FIG. 5 is a flowchart of determination operation.

FIG. 6 is a graph showing a condensation temperature T_c and an outdoor heat exchanger outlet temperature T_l when an outdoor temperature T_a with respect to outdoor fan air volume is constant.

FIG. 7 is a graph showing a distribution of degree of supercooling values with respect to outdoor fan air volume.

FIG. 8 is a graph showing a distribution of relative degree of supercooling values with respect to outdoor fan air volume.

DESCRIPTION OF THE EMBODIMENTS

[0020] Embodiments of an air conditioning apparatus pertaining to the present invention will be described below on the basis of the drawings.

(1) Configuration of Air Conditioning Apparatus

[0021] FIG. 1 is a general refrigerant circuit diagram of an air conditioning apparatus 1 of one embodiment pertaining to the present invention. The air conditioning apparatus 1 is an apparatus used to heat and cool the inside of a building or the like by performing vapor compression refrigeration cycle operation. The air conditioning apparatus 1 is mainly equipped with one outdoor unit 2, an indoor unit 4, and a liquid refrigerant connection pipe 6 and a gas refrigerant connection pipe 7 that interconnect the outdoor unit 2 and the indoor unit 4. That is, a vapor compression refrigerant circuit 10 of the air conditioning apparatus 1 of the present embodiment is configured as a result of the outdoor unit 2, the indoor unit 4, and the liquid refrigerant connection pipe 6 and the gas refrigerant connection pipe 7 being connected.

<Indoor Unit>

[0022] The indoor unit 4 is installed by being embedded in or hung from a ceiling inside a room in a building or the like or by being mounted on a wall surface inside a room. The indoor unit 4 is connected to the outdoor unit 2 via the liquid refrigerant connection pipe 6 and the gas refrigerant connection pipe 7 and configures part of the refrigerant circuit 10.

[0023] Next, the configuration of the indoor unit 4 will be described.

[0024] The indoor unit 4 mainly has an indoor-side refrigerant circuit 11 that configures part of the refrigerant circuit 10. This indoor-side refrigerant circuit 11 mainly has an indoor heat exchanger 41 serving as a utilization-side heat exchanger.

[0025] In the present embodiment, the indoor heat exchanger 41 is a cross-fin type fin-and-tube heat exchanger configured by heat transfer tubes and numerous fins and is a heat exchanger that functions as an evaporator of the refrigerant during cooling operation to cool the room air and functions as a condenser of the refrigerant during heating operation to heat the room air. In the present embodiment, the indoor heat exchanger 41 is a cross-fin type fin-and-tube heat exchanger, but the indoor heat exchanger 41 is not limited to this and may also be another type of heat exchanger.

[0026] In the present embodiment, the indoor unit 4 has an indoor fan 42 serving as a blower fan for sucking the room air into the inside of the unit, allowing heat to be exchanged with the refrigerant in the indoor heat exchanger 41, and thereafter supplying the air to the inside of the room as supply air. The indoor fan 42 is a fan that can vary the volume of air it supplies to the indoor heat exchanger 41 and, in the present embodiment, is a centrifugal fan or a multiblade fan driven by a motor 42m comprising a DC fan motor or the like.

[0027] Further, in the indoor unit 4, an indoor temperature sensor 43 that detects the temperature of the room air (that is, the indoor temperature) flowing into the inside of the unit is disposed on a room air suction opening side of the indoor unit 4. In the present embodiment, the indoor temperature sensor 43 comprises a thermistor. Further, the indoor unit 4 has an indoor-side controller 44 that controls the operation of each part configuring the indoor unit 4. Additionally, the indoor-side controller 44 has a microcomputer and a memory disposed in order to perform control of the indoor unit 4 and is configured such that it can exchange control signals and the like with a remote controller (not shown) for individually operating the indoor unit 4 and such that it can exchange control signals and the like with the outdoor unit 2 via a transmission line 8a.

<Outdoor Unit>

[0028] The outdoor unit 2 is installed outdoors of a building or the like, is connected to the indoor unit 4 via

the liquid refrigerant connection pipe 6 and the gas refrigerant connection pipe 7, and configures the refrigerant circuit 10 together with the indoor unit 4.

[0029] Next, the configuration of the outdoor unit 2 will be described. The outdoor unit 2 mainly has an outdoor-side refrigerant circuit 12 that configures part of the refrigerant circuit 10. This outdoor-side refrigerant circuit 12 mainly has a compressor 21, a four-way switching valve 22, an outdoor heat exchanger 23 serving as a heat source-side heat exchanger, an outdoor expansion valve 33 serving as an expansion mechanism, an accumulator 24, a liquid-side stop valve 25, and a gas-side stop valve 26.

[0030] The compressor 21 is a compressor whose operating capacity can be varied and, in the present embodiment, is a positive displacement compressor driven by a motor 21m whose speed is controlled by an inverter. In the present embodiment, the compressor 21 comprises only one compressor, but the compressor 21 is not limited to this, and two or more compressors may also be connected in parallel depending on the connection number of the indoor units and the like.

[0031] The four-way switching valve 22 is a valve for switching the direction of the flow of the refrigerant such that, during the cooling operation, the four-way switching valve 22 can interconnect the discharge side of the compressor 21 and the gas side of the outdoor heat exchanger 23 and also interconnect the suction side of the compressor 21 (specifically, the accumulator 24) and the gas refrigerant connection pipe 7 side to cause the outdoor heat exchanger 23 to function as a condenser of the refrigerant compressed by the compressor 21 and to cause the indoor heat exchanger 41 to function as an evaporator of the refrigerant condensed in the outdoor heat exchanger 23 (a cooling operation state: see the solid lines of the four-way switching valve 22 in FIG. 1) and such that, during the heating operation, the four-way switching valve 22 can interconnect the discharge side of the compressor 21 and the gas refrigerant connection pipe 7 side and also interconnect the suction side of the compressor 21 and the gas side of the outdoor heat exchanger 23 to cause the indoor heat exchanger 41 to function as a condenser of the refrigerant compressed by the compressor 21 and to cause the outdoor heat exchanger 23 to function as an evaporator of the refrigerant condensed in the indoor heat exchanger 41 (a heating operation state: see the broken lines of the four-way switching valve 22 in FIG. 1).

[0032] In the present embodiment, the outdoor heat exchanger 23 is a cross-fin type fin-and-tube heat exchanger configured by heat transfer tubes and numerous fins and is a heat exchanger that functions as a condenser of the refrigerant during the cooling operation and functions as an evaporator of the refrigerant during the heating operation. The gas side of the outdoor heat exchanger 23 is connected to the four-way switching valve 22, and the liquid side of the outdoor heat exchanger 23 is connected to the liquid refrigerant connection pipe 6. In the

present embodiment, the outdoor heat exchanger 23 is a cross-fin type fin-and-tube heat exchanger, but the outdoor heat exchanger 23 is not limited to this and may also be another type of heat exchanger.

[0033] In the present embodiment, the outdoor expansion valve 33 is a motor-driven expansion valve placed on the downstream side of the outdoor heat exchanger 23 in the flow direction of the refrigerant in the refrigerant circuit 10 when performing the cooling operation (in the present embodiment, the outdoor expansion valve 33 is connected to the liquid side of the outdoor heat exchanger 23) in order to adjust, for example, the pressure and the flow rate of the refrigerant flowing through the inside of the outdoor-side refrigerant circuit 12; the outdoor expansion valve 33 can also shut off passage of the refrigerant.

[0034] In the present embodiment, the outdoor unit 2 has an outdoor fan 27 serving as a blower fan for sucking outdoor air into the inside of the unit, allowing heat to be exchanged with the refrigerant in the outdoor heat exchanger 23, and thereafter expelling the air to the outdoors. This outdoor fan 27 is a fan that can vary the volume of the air it supplies to the outdoor heat exchanger 23 and, in the present embodiment, is a propeller fan driven by a motor 27m comprising a DC fan motor or the like.

[0035] The accumulator 24 is connected between the four-way switching valve 22 and the compressor 21 and is a container that can accumulate surplus refrigerant generated inside the refrigerant circuit 10 depending on, for example, fluctuations in the operating load of the indoor unit 4.

[0036] The liquid-side stop valve 25 and the gas-side stop valve 26 are valves disposed in openings to which external devices and pipes (specifically, the liquid refrigerant connection pipe 6 and the gas refrigerant connection pipe 7) connect. The liquid-side stop valve 25 is connected to the outdoor heat exchanger 23. The gas-side stop valve 26 is connected to the four-way switching valve 22.

[0037] Further, various sensors are disposed in the outdoor unit 2. Specifically, an evaporation pressure sensor 28 that detects the pressure of the gas refrigerant that has flowed in from the indoor heat exchanger 41, a condensation pressure sensor 29 that detects the condensation pressure of the refrigerant condensed by the outdoor heat exchanger 23, a suction temperature sensor 30 that detects the suction temperature of the compressor 21, and a liquid-side temperature sensor 31 that detects the temperature of the refrigerant in a liquid state or in a gas-liquid two-phase state on the liquid side of the outdoor heat exchanger 23 are disposed in the outdoor unit 2. An outdoor temperature sensor 32 that detects the temperature of the outdoor air (that is, the outdoor temperature) flowing into the inside of the unit is disposed on an outdoor air suction opening side of the outdoor unit 2. In the present embodiment, the suction temperature sensor 30, the liquid-side temperature sensor 31, and

the outdoor temperature sensor 32 comprise thermistors. Further, the outdoor unit 2 is equipped with an outdoor-side controller 34 that controls the operation of each part configuring the outdoor unit 2. Additionally, the outdoor-side controller 34 has a microcomputer and a memory disposed in order to perform control of the outdoor unit 2 and an inverter circuit that controls the motor 21m, and the outdoor-side controller 34 is configured such that it can exchange control signals and the like with the indoor-side controller 44 of the indoor unit 4. That is, a controller 8 that performs operation control of the entire air conditioning apparatus 1 is configured by the indoor-side controller 44, the outdoor-side controller 34, and the transmission line 8a that interconnects the controllers 34 and 44.

[0038] As described above, the refrigerant circuit 10 of the air conditioning apparatus 1 is configured as a result of the indoor-side refrigerant circuit 11, the outdoor-side refrigerant circuit 12, and the refrigerant connection pipes 6 and 7 being connected. Additionally, the air conditioning apparatus 1 of the present embodiment uses the four-way switching valve 22 to switch between the cooling operation and the heating operation and performs operation, and the air conditioning apparatus 1 performs control of each device of the outdoor unit 2 and the indoor unit 4 according to the operating load of the indoor unit 4.

(2) Operation of Air Conditioning Apparatus

[0039] Next, the operation of the air conditioning apparatus 1 of the present embodiment will be described.

[0040] As operation modes of the air conditioning apparatus 1 of the present embodiment, there are a normal operation mode, where control of each device of the outdoor unit 2 and the indoor unit 4 is performed according to the operating load of the indoor unit 4, and a refrigerant quantity determination operation mode, where the degree of supercooling of the refrigerant in the outlet of the outdoor heat exchanger 23 functioning as a condenser is detected while the indoor unit 4 is run in the cooling operation and the adequacy of the quantity of refrigerant with which the inside of the refrigerant circuit 10 is charged is judged. Additionally, in the normal operation mode, there are the cooling operation and the heating operation, and in the refrigerant quantity determination operation mode, there is refrigerant leak detection operation.

[0041] The operation in each operation mode of the air conditioning apparatus 1 will be described below.

<Normal Operation Mode>

[0042] First, the cooling operation in the normal operation mode will be described.

[0043] During the cooling operation, the four-way switching valve 22 is in the state indicated by the solid lines in FIG. 1, that is, a state where the discharge side of the compressor 21 is connected to the gas side of the

outdoor heat exchanger 23 and where the suction side of the compressor 21 is connected to the gas side of the indoor heat exchanger 41. Here, the liquid-side stop valve 25 and the gas-side stop valve 26 are placed in an open state. Further, the opening degree of the outdoor expansion valve 33 is adjusted such that the degree of supercooling of the refrigerant in the outlet of the outdoor heat exchanger 23 becomes a predetermined value. In the present embodiment, the degree of supercooling of the refrigerant in the outlet of the outdoor heat exchanger 23 is detected by converting the refrigerant pressure (the condensation pressure) value on the outlet side of the outdoor heat exchanger 23 detected by the condensation pressure sensor 29 into the saturation temperature value of the refrigerant and subtracting the refrigerant temperature value detected by the liquid-side temperature sensor 31 from this saturation temperature value of the refrigerant.

[0044] When the compressor 21 and the outdoor fan 27 are started in this state of the refrigerant circuit 10, low-pressure gas refrigerant is sucked into the compressor 21, is compressed, and becomes high-pressure gas refrigerant. Thereafter, the high-pressure gas refrigerant is sent to the outdoor heat exchanger 23 via the four-way switching valve 22, undergoes heat exchange with the outside air supplied by the outdoor fan 27, is condensed, and becomes high-pressure liquid refrigerant. Then, the high-pressure liquid refrigerant has its pressure reduced by the outdoor expansion valve 33, becomes low-pressure refrigerant in a gas-liquid two-phase state, and is sent to the indoor unit 4 via the liquid-side stop valve 25 and the liquid refrigerant connection pipe 6. Here, the outdoor expansion valve 33 controls the flow rate of the refrigerant flowing through the inside of the outdoor heat exchanger 23 such that the degree of supercooling in the outlet of the outdoor heat exchanger 23 becomes the predetermined value, so the high-pressure liquid refrigerant that has been condensed in the outdoor heat exchanger 23 reaches a state where it has the predetermined degree of supercooling.

[0045] The low-pressure refrigerant in the gas-liquid two-phase state that has been sent to the indoor unit 4 is sent to the indoor heat exchanger 41 and undergoes heat exchange with the inside air, is evaporated, and becomes low-pressure gas refrigerant in the indoor heat exchanger 41. Then, refrigerant with a flow rate corresponding to the required operating load in the air-conditioned space where the indoor unit 4 is installed flows in the indoor heat exchanger 41.

[0046] This low-pressure gas refrigerant is sent to the outdoor unit 2 via the gas refrigerant connection pipe 7 and flows into the accumulator 24 via the gas-side stop valve 26 and the four-way switching valve 22. Then, the low-pressure gas refrigerant that has flowed into the accumulator 24 is again sucked into the compressor 21. Here, surplus refrigerant accumulates in the accumulator 24 depending on the operating load of the indoor unit 4, such as, for example, when the operating load of the

indoor unit 4 is small or when the indoor unit 4 is stopped.

[0047] Here, the state of distribution of the refrigerant in the refrigerant circuit 10 when it is performing the cooling operation in the normal operation mode is such that, as shown in FIG. 2, the refrigerant takes each of the states of a liquid state (the filled-in hatching portions in FIG. 2), a gas-liquid two-phase state (the grid-like hatching portions in FIG. 2), and a gas state (the diagonal line hatching portion in FIG. 2). Specifically, the portion from near the outlet of the outdoor heat exchanger 23 to the outdoor expansion valve 33 is filled with the refrigerant in the liquid state. Additionally, the portion in the middle of the outdoor heat exchanger 23 and the portion between the outdoor expansion valve 33 and near the inlet of the indoor heat exchanger 41 are filled with the refrigerant in the gas-liquid two-phase state. Further, the portion from the middle portion of the indoor heat exchanger 41, via the gas refrigerant connection pipe 7, the accumulator 24 excluding a part thereof, and the compressor 21, to near the inlet of the outdoor heat exchanger 23 is filled with the refrigerant in the gas state. Sometimes accumulated liquid refrigerant accumulates as surplus refrigerant in the part of the accumulator 24 that is excluded here. Here, FIG. 2 is a schematic diagram showing states of the refrigerant flowing through the inside of the refrigerant circuit 10 in the cooling operation.

[0048] Next, the heating operation in the normal operation mode will be described.

[0049] During the heating operation, the four-way switching valve 22 is in the state indicated by the broken lines in FIG. 1, that is, a state where the discharge side of the compressor 21 is connected to the gas side of the indoor heat exchanger 41 and where the suction side of the compressor 21 is connected to the gas side of the outdoor heat exchanger 23. The opening degree of the outdoor expansion valve 33 is adjusted in order to reduce the pressure of the refrigerant flowing into the outdoor heat exchanger 23 to a pressure that can allow the refrigerant to evaporate in the outdoor heat exchanger 23 (that is, the evaporation pressure). Further, the liquid-side stop valve 25 and the gas-side stop valve 26 are placed in an open state.

[0050] When the compressor 21 and the outdoor fan 27 are started in this state of the refrigerant circuit 10, low-pressure gas refrigerant is sucked into the compressor 21, is compressed, becomes high-pressure gas refrigerant, and is sent to the indoor unit 4 via the four-way switching valve 22, the gas-side stop valve 26, and the gas refrigerant connection pipe 7.

[0051] Then, the high-pressure gas refrigerant that has been sent to the indoor unit 4 undergoes heat exchange with the inside air, is condensed, and becomes high-pressure liquid refrigerant in the indoor heat exchanger 41, and the high-pressure liquid refrigerant is thereafter sent to the outdoor unit 2 via the liquid refrigerant connection pipe 6. Then, refrigerant with a flow rate corresponding to the required operating load in the air-conditioned space where the indoor unit 4 is installed flows in the

indoor heat exchanger 41.

[0052] This high-pressure liquid refrigerant has its pressure reduced by the outdoor expansion valve 33 via the liquid-side stop valve 25, becomes low-pressure refrigerant in a gas-liquid two-phase state, and flows into the outdoor heat exchanger 23. Then, the low-pressure refrigerant in the gas-liquid two-phase state that has flowed into the outdoor heat exchanger 23 undergoes heat exchange with the outside air supplied by the outdoor fan 27, is evaporated, becomes low-pressure gas refrigerant, and flows into the accumulator 24 via the four-way switching valve 22. Then, the low-pressure gas refrigerant that has flowed into the accumulator 24 is again sucked into the compressor 21. Here, when a quantity of surplus refrigerant is generated inside the refrigerant circuit 10 depending on the operating load of the indoor unit 4, such as, for example, when the operating load of one of the indoor units 4 is small or when the indoor unit 4 is stopped, the surplus refrigerant accumulates in the accumulator 24 like during the cooling operation.

<Refrigerant Quantity Determination Operation Mode>

[0053] In the refrigerant quantity determination operation mode, the refrigerant leak detection operation is performed, and within that, the way of operation differs between operation that is first performed after the air conditioning apparatus 1 has been installed (hereinafter called "initial setup operation") and operation from the second time on (hereinafter called "determination operation"). For this reason, the refrigerant quantity determination operation mode will be divided between the initial setup operation and the determination operation and described below.

(Initial Setup Operation)

[0054] When a command to perform the refrigerant leak detection operation, which is one operation in the refrigerant quantity determination operation mode, is given through the remote controller (not shown) or directly with respect to the indoor-side controller 44 of the indoor unit 4 or the outdoor-side controller 34 of the outdoor unit 2 after the refrigerant circuit 10 has been configured by interconnecting the outdoor unit 2 charged beforehand with the refrigerant and the indoor unit 4 via the liquid refrigeration connection pipe 6 and the gas refrigerant connection pipe 7 on site, the initial setup operation is performed by the procedure of step S1 to step S7 described below (see FIG. 3). In FIG. 3, for the purpose of simplification, the relative degree of supercooling is written as "relative SC". -Step S1: Running of Indoor Unit in Cooling Operation (Outdoor Fan Air Volume at Maximum)-

[0055] First, in step S1, when a command to start the initial setup operation is issued, in the refrigerant circuit 10, the four-way switching valve 22 of the outdoor unit 2 is placed in the state indicated by the solid lines in FIG.

1, the compressor 21 and the outdoor fan 27 are started, and the cooling operation is forcibly performed in regard to all of the indoor units 4 (see FIG. 2). At this time, the speed of the motor 27m becomes a maximum such that the air volume of the outdoor fan 27 becomes a maximum. In step S1, the air volume of the outdoor fan 27 is maximized in the cooling operation, so the heat transfer coefficient in the air side of the efficiency of heat exchange performed by the outdoor heat exchanger 23 can be maximized, and the influence of disturbances can be reduced. The "disturbances" here are, for example, dirt in the outdoor heat exchanger 23, the installation situation of the outdoor unit 2, and wind and rain. Additionally, when the air volume of this outdoor fan 27 reaches a maximum, the initial setup operation moves to the next step S2.

-Step S2: Reading of Temperatures-

[0056] In step S2, reading of the indoor temperature detected by the indoor temperature sensor 43 and the outdoor temperature detected by the outdoor temperature sensor 32 is performed. When the indoor temperature and the outdoor temperature are detected, the initial setup operation moves to the next step S3.

-Step S3: Determination of Whether or Not Temperatures Are in Detectable Ranges-

[0057] In step S3, whether or not the indoor temperature and the outdoor temperature that have been detected are within predetermined temperature ranges suitable for the refrigerant quantity determination operation mode that are set beforehand is determined. In step S3, when the indoor temperature and the outdoor temperature are within the predetermined temperature ranges, the initial setup operation moves to the next step S4, and when the indoor temperature and the outdoor temperature are not within the predetermined temperature ranges, the cooling operation of step S1 is continued.

-Step S4: Determination of Whether or Not Relative Degree of Supercooling is Equal to or Greater than Predetermined Value-

[0058] In step S4, a relative degree of supercooling value is derived to determine whether or not the relative degree of supercooling value is equal to or greater than a predetermined value. The "relative degree of supercooling value" here is a value obtained by dividing the degree of supercooling value in the outlet of the outdoor heat exchanger 23 by the difference between the condensation temperature value and the outdoor temperature. The "relative degree of supercooling value" will be described in detail later. In the present embodiment, a value obtained by converting the pressure (the condensation pressure) value on the outlet side of the outdoor heat exchanger 23 detected by the condensation pres-

sure sensor 29 into the saturation temperature of the refrigerant is used for the condensation temperature value. In step S4, when it is determined that the relative degree of supercooling value is less than the predetermined value, the initial setup operation moves to the next step S5, and when it is determined that the relative degree of supercooling value is equal to or greater than the predetermined value, the initial setup operation moves to step S6.

-Step S5: Control of Relative Degree of Supercooling-

[0059] In step S5, the relative degree of supercooling value is less than the predetermined value, so the rotational frequency of the compressor 21 and the degree of superheat in the outlet of the indoor heat exchanger 41 are controlled such that the relative degree of supercooling value becomes equal to or greater than the predetermined value. For example, the cooling operation in step S1 is performed in a state where the rotational frequency of the compressor 21 is 40 Hz and the degree of superheat in the outlet of the indoor heat exchanger 41 is 5°C, and whether or not the relative degree of supercooling value is equal to or greater than the predetermined value is determined. In this operating state, when the relative degree of supercooling value is less than the predetermined value, the rotational frequency of the compressor 21 is left unchanged, the degree of superheat of the refrigerant in the outlet of the indoor heat exchanger 41 is raised by 5°C to 10°C, the relative degree of supercooling value is derived, and whether or not the relative degree of supercooling value will become equal to or greater than the predetermined value is determined. Then, when the relative degree of supercooling value is less than the predetermined value, this is repeated, and when the relative degree of supercooling value is less than the predetermined value even when the degree of superheat of the refrigerant in the outlet of the indoor heat exchanger 41 has risen as far as it can, the rotational frequency of the compressor 21 is raised from 40 Hz to 50 Hz, for example, the degree of superheat of the refrigerant in the outlet of the indoor heat exchanger 41 is lowered to 5°C, and whether or not the relative degree of supercooling value is equal to or greater than the predetermined value is similarly determined. Then, control is performed such that the relative degree of supercooling value becomes equal to or greater than the predetermined value by repeating raising the degree of superheat of the refrigerant in the outlet of the indoor heat exchanger 41 again by 5°C at a time as described above. Then, when the relative degree of supercooling value becomes equal to or greater than the predetermined value, the initial setup operation moves to step S6. Control of the degree of superheat of the refrigerant in the outlet of the indoor heat exchanger 41 (e.g., control to raise the degree of superheat from 5°C by 5°C at a time) is performed by narrowing the outdoor expansion valve 33 from an open state. Further, control of the degree of superheat of the refrigerant in the outlet of the indoor heat exchanger 41

is not limited to this and may also be performed by controlling the air volume of the indoor fan 42 or by combining control of the valve opening degree of the outdoor expansion valve 33 and control of the air volume of the indoor fan 42. The degree of superheat of the refrigerant in the outlet of the indoor heat exchanger 41 here is detected by subtracting, from the refrigerant temperature value detected by the suction temperature sensor 30, a value obtained by converting the evaporation pressure value detected by the evaporation pressure sensor 28 into the saturation temperature value of the refrigerant.

[0060] The degree of superheat is controlled so as to become a positive value by step S5; thus, as shown in FIG. 4, the state becomes one where surplus refrigerant is not accumulating in the accumulator 24, and the refrigerant that had accumulated in the accumulator 24 moves to the outdoor heat exchanger 23.

-Step S6: Storage of Relative Degree of Supercooling-

[0061] In step S6, the relative degree of supercooling value that is equal to or greater than the predetermined value in step S4 or step S6 is stored as an initial relative degree of supercooling value, and then the initial setup operation moves to the next step S7.

-Step S7: Storage of Parameters-

[0062] In step S7, the rotational frequency of the compressor 21, the rotational frequency of the indoor fan 42, the outdoor temperature Ta, and the indoor temperature Tb in the operating state at the time of the degree of supercooling value stored in step S6 are stored, and then the initial setup operation is ended.

(Determination Operation)

[0063] Next, the determination operation, which is operation that is performed periodically after the initial setup operation has been performed in the refrigerant quantity determination operation mode, will be described using FIG. 5. Here, FIG. 5 is a flowchart at the time of the determination operation. In FIG. 5, for the purpose of simplification, the relative degree of supercooling is written as "relative SC".

[0064] Here, a case where whether or not the refrigerant inside the refrigerant circuit is leaking to the outside due to some accidental cause is detected by switching to the determination operation, which is one operation in the refrigerant quantity determination operation mode, and performing operation periodically (e.g., once a month, when a load is not required in the air-conditioned space, etc.) at the time of the cooling operation or the heating operation in the normal operation mode will be taken as an example and described.

-Step S11: Determination of Whether or Not Normal Operation Mode has Gone On a Certain Amount of Time-

[0065] First, whether or not operation in the normal operation mode, such as the cooling operation or the heating operation described above, has gone on a certain amount of time (every month, etc.) is determined, and when operation in the normal operation mode has gone on a certain amount of time, the determination operation moves to the next step S12.

-Step S12: Running of Indoor Unit in Cooling Operation-

[0066] When operation in the normal operation mode has gone on a certain amount of time, in the refrigerant circuit 10, the four-way switching valve 22 of the outdoor unit 2 is placed in the state indicated by the solid lines in FIG. 1, the compressor 21 and the outdoor fan 27 are started, and the cooling operation is performed forcibly in regard to all of the indoor units 4 like in step S1 of the initial setup operation described above.

-Step S13: Reading of Temperatures-

[0067] In step S13, reading of the indoor temperature and the outdoor temperature is performed like in step S2 of the initial setup operation described above. When the indoor temperature and the outdoor temperature are detected, the detection operation moves to the next step S14.

-Step S14: Determination of Whether or Not Temperatures Are in Detectable Ranges-

[0068] In step S14, whether or not the indoor temperature and the outdoor temperature that have been detected are within the predetermined temperature ranges suitable for the refrigerant quantity determination operation mode that are set beforehand is determined like in step S3 of the initial setup operation described above. In step S14, when the indoor temperature and the outdoor temperature are within the predetermined temperature ranges, the determination operation moves to the next step S15, and when the indoor temperature and the outdoor temperature are not within the predetermined temperature ranges, the cooling operation of step S12 is continued.

-Step S15: Control in Conditions in Initial Setup Operation-

[0069] In step S15, the compressor 21 and the indoor fan 42 are controlled at the rotational frequency of the compressor 21 and the rotational frequency of the indoor fan 42 that were stored in step S7 of the initial setup operation described above. Thus, unless the quantity of the refrigerant inside the refrigerant circuit 10 has changed, the state of the refrigerant inside the refrigerant

circuit 10 can be regarded as a state that is the same as in the initial setup operation. That is, conditions that are identical to the conditions of the cooling operation that was performed in the initial setting operation become reproduced. When step S15 ends, the determination operation moves to the next step S16.

-Step S16: Determination of Adequacy of Refrigerant Quantity-

[0070] In step S16, the relative degree of supercooling is derived like in step S4 of the initial setup operation described above. Then, whether or not the difference (hereinafter called the relative degree of supercooling difference) between the initial relative degree of supercooling and the relative degree of supercooling is equal to or greater than a second predetermined value is determined. In step S16, when it is determined that the relative degree of supercooling difference is less than the second predetermined value, the determination operation is ended, and when it is determined that the relative degree of supercooling difference is equal to or greater than the second predetermined value, the determination operation moves to step S17.

-Step S17: Warning Indication-

[0071] In step S17, it is determined that leakage of the refrigerant is occurring, a warning indication informing that a refrigerant leak has been detected is given, and thereafter the determination operation is ended.

<Regarding Relative Degree of Supercooling Value>

[0072] The relative degree of supercooling value will be described on the basis of FIGS. 6 to 8.

[0073] First, FIG. 6 is a graph showing the condensation temperature T_c and the outdoor heat exchanger outlet temperature T_l when the outdoor temperature T_a with respect to outdoor fan air volume is constant. Looking at FIG. 6, in a condition where the outdoor temperature T_a is constant, as the outdoor fan air volume increases, the condensation temperature T_c and the outdoor heat exchanger outlet temperature T_l decrease. Additionally, the drop of that decrease is larger in the condensation temperature T_c than in the outdoor heat exchanger outlet temperature T_l . That is, it will be understood that when the outdoor fan air volume becomes larger, the degree of supercooling value that is the difference between the condensation temperature T_c and the outdoor heat exchanger outlet temperature T_l becomes smaller.

[0074] Here, when looking at FIG. 7, which is a graph showing a distribution of degree of supercooling values with respect to outdoor fan air volume, it will be understood that when the outdoor fan air volume increases, the degree of supercooling value becomes smaller. Further, in FIG. 7, variations in the degree of supercooling value become larger when the outdoor fan air volume is

small than when the outdoor fan air volume is large. This is thought to be because it is easier when the outdoor fan air volume is small to be affected by disturbances such as dirt in the outdoor heat exchanger, the installation situation of the outdoor unit, and wind and rain and it is more difficult when the outdoor fan air volume is large to be affected by disturbances. For this reason, by maximizing the outdoor fan air volume, variations in the detected degree of supercooling value can be suppressed and detection errors can be reduced.

[0075] Additionally, FIG. 8 is a graph showing a distribution of relative degree of supercooling values with respect to outdoor fan air volume. The relative degree of supercooling value is, as described above, a value obtained by dividing the degree of supercooling value by the difference between the condensation temperature and the outdoor temperature. Looking at FIG. 8, it will be understood that that value stays substantially between 0.3 and 0.4 regardless how large or small the outdoor fan air volume is and that it has few variations. For this reason, by utilizing this relative degree of supercooling value as an index when determining the adequacy of the quantity of the refrigerant, the adequacy of the quantity of the refrigerant can be determined without being affected as much as possible by disturbances and detection errors can be suppressed. Consequently, utilizing the relative degree of supercooling value to determine the adequacy of the quantity of the refrigerant is extremely useful.

(3) Characteristics of Air Conditioning Apparatus

(A)

[0076] In the air conditioning apparatus 1 of the present embodiment, the refrigerant circuit 10 is configured as a result of the outdoor unit 2 and the indoor unit 4 being interconnected via the refrigerant connection pipes 6 and 7. Additionally, this air conditioning apparatus 1 is configured such that it can switch between and operate in the normal operation such as the cooling operation (hereinafter called the normal operation mode) and the refrigerant quantity determination operation mode where the indoor unit 4 is forcibly caused to run in the cooling operation; the adequacy of the quantity of the refrigerant with which the inside of the refrigerant circuit 10 is charged can be determined by detecting the degree of supercooling of the refrigerant in the outlet of the outdoor heat exchanger 23.

(B)

[0077] In the air conditioning apparatus 1 of the present embodiment, the relative degree of supercooling value is employed as an index in the refrigerant quantity adequacy determination, and the relative degree of supercooling value is a value obtained by dividing the degree of supercooling value by the difference between the con-

densation temperature value and the outdoor temperature. Additionally, the relative degree of supercooling value stays substantially between 0.3 and 0.4 regardless of how large or small the outdoor fan air volume is, and it does not vary that much.

[0078] For this reason, by utilizing this relative degree of supercooling value as an index when determining the adequacy of the quantity of the refrigerant, the adequacy of the quantity of the refrigerant can be determined without being affected as much as possible by disturbances such as dirt in the outdoor heat exchanger, the installation situation of the outdoor unit, and wind and rain, and detection errors can be suppressed. Consequently, utilizing the relative degree of supercooling value to determine the adequacy of the quantity of the refrigerant is extremely useful.

(4) Modification 1

[0079] In the present embodiment, the degree of supercooling of the refrigerant in the outlet of the outdoor heat exchanger 23 is detected by converting the refrigerant pressure (which corresponds to the condensation pressure) value on the outlet side of the outdoor heat exchanger 23 detected by the condensation pressure sensor 29 into the saturation temperature value of the refrigerant and subtracting the refrigerant temperature value detected by the liquid-side temperature sensor 31 from this saturation temperature value of the refrigerant, but the invention is not limited to this.

[0080] For example, the invention may also be configured such that the degree of supercooling of the refrigerant in the outlet of the outdoor heat exchanger 23 is detected by disposing an outdoor heat exchange sensor that can detect the temperature of the refrigerant in the outdoor heat exchanger 23, detecting the condensation temperature value as the saturation temperature value of the refrigerant, and subtracting the refrigerant temperature value detected by the liquid-side temperature sensor 31 from this saturation temperature value of the refrigerant.

(5) Modification 2

[0081] In the present embodiment, as shown in FIG. 5 and in the description thereof, a case where control to switch the refrigerant circuit between the normal operation mode and the refrigerant quantity determination operation mode at certain time intervals is performed has been taken as an example, but the invention is not limited to this.

[0082] For example, instead of the refrigerant circuit being switched by control, the invention may also be configured such that a switch or the like for switching the refrigerant circuit to the refrigerant quantity determination operation mode is disposed in the air conditioning apparatus 1 and such that a serviceman or an installation manager operates the switch or the like on site to thereby

periodically perform the refrigerant leak detection operation.

(9) Other Embodiments

[0083] Embodiment of the present invention have been described above on the basis of the drawings, but the specific configurations thereof are not limited to these embodiments and can be altered in a range that does not depart from the scope of the invention as defined in the appended claims.

[0084] For example, in the embodiment described above, an example has been described where the present invention is applied to an air conditioning apparatus that can switch between heating and cooling, but the invention is not limited to this and is applicable as long as the air conditioning apparatus is a separate type air conditioning apparatus; the present invention may also be applied to pair type air conditioning apparatus and air conditioning apparatus dedicated to cooling.

INDUSTRIAL APPLICABILITY

[0085] By utilizing the present invention, it can be ensured that the adequacy of the quantity of refrigerant with which the inside of a refrigerant circuit is charged can be precisely determined in a separate type air conditioning apparatus where a heat source unit and a utilization unit are interconnected via refrigerant connection pipes.

REFERENCE SIGNS LIST

[0086]

1	Air Conditioning Apparatus	35
2	Outdoor Unit (Heat Source Unit)	
4	Indoor Unit (Utilization Unit)	
6	Liquid Refrigerant Connection Pipe	
7	Gas Refrigerant Connection Pipe	
10	Refrigerant Circuit	40
21	Compressor	
23	Outdoor Heat Exchanger (Heat Source-Side Heat Exchanger)	
27	Outdoor Fan (Cooling Heat Source Adjusting Means)	45
33	Outdoor Expansion Valve (Expansion Mechanism)	
41	Utilization-Side Heat Exchanger	50

Claims

1. An air conditioning apparatus (1) comprising:
 - a refrigerant circuit (10) that includes
 - a heat source unit (2) having a compressor (21) whose operating capacity can be ad-

justed, a heat source-side heat exchanger (23), and cooling heat source adjusting means (27) that can adjust the cooling action of a cooling heat source with respect to the heat source-side heat exchanger, a utilization unit (4) having a utilization-side heat exchanger (41), an expansion mechanism (33), and a liquid refrigerant connection pipe (6) and a gas refrigerant connection pipe (7) that interconnect the heat source unit and the utilization unit, a mode switching means, a detecting means for detecting the degree of supercooling of the refrigerant in the outlet of the heat source-side heat exchanger in a refrigerant quantity determination operation mode, degree of supercooling correcting means, refrigerant quantity adequacy determining means, a controller (8) for performing operation control of the entire air conditioning apparatus,

wherein the cooling heat source adjusting means (27) is a blower fan with a motor that can vary the volume of air it blows towards the heat source-side heat exchanger (23), the refrigerant circuit is capable of performing at least cooling operation where the heat source-side heat exchanger is caused to function as a condenser of refrigerant compressed in the compressor and where the utilization-side heat exchanger is caused to function as an evaporator of the refrigerant condensed in the heat source-side heat exchanger; and the mode switching means is configured to switch an operating state of the refrigerant circuit from a normal operation mode, where control of each device of the heat source unit and the utilization unit is performed according to the operating load of the utilization unit, to the refrigerant quantity determination operation mode, where the cooling operation is performed and the expansion mechanism is controlled such that a degree of superheat of the refrigerant in an outlet of the utilization-side heat exchanger becomes a positive value; and wherein the air conditioning apparatus is configured to perform the refrigerant quantity determination operation mode, wherein the detecting means detects the degree of supercooling of the refrigerant in the outlet of the heat source-side heat exchanger in a state where the air volume of the blower fan (27) has been maximized; and the degree of supercooling correcting means corrects the degree of supercooling value by dividing the degree of supercooling value by a difference between a condensation tem-

- perature value in the heat source-side heat exchanger (23) and an outdoor air temperature, which is a temperature of the outdoor air flowing into the inside of the heat source unit (2), to thereby derive a relative degree of supercooling value; and
the refrigerant quantity adequacy determining means performs, as a refrigerant quantity adequacy determination, a determination of the adequacy of the quantity of the refrigerant with which the inside of the refrigerant circuit is charged on the basis of the relative degree of supercooling value.
2. The air conditioning apparatus (1) according to claim 1, wherein the refrigerant quantity adequacy determining means is configured to periodically perform the refrigerant quantity adequacy determination.
3. The air conditioning apparatus (1) according to any of claims 1 or 2, wherein the compressor (21) is driven by a motor (21m) controlled by an inverter and is configured to be operated such that its speed resulting from the motor always becomes a predetermined speed in the refrigerant quantity determination operation mode.
4. A refrigerant quantity determination method of determining,
in an air conditioning apparatus (1) having a refrigerant circuit (10) that includes
- a heat source unit (2) having a compressor (21) whose operating capacity can be adjusted, a heat source-side heat exchanger (23), and cooling heat source adjusting means (27) that can adjust the cooling action of a cooling heat source with respect to the heat source-side heat exchanger,
a utilization unit (4) having a utilization-side heat exchanger (41),
an expansion mechanism (33), and
a liquid refrigerant connection pipe (6) and a gas refrigerant connection pipe (7) that interconnect the heat source unit and the utilization unit,
- wherein the cooling heat source adjusting means (27) is a blower fan that can vary the volume of air it blows towards the heat source-side heat exchanger (23),
with the refrigerant circuit being capable of performing at least cooling operation where the heat source-side heat exchanger is caused to function as a condenser of refrigerant compressed in the compressor and where the utilization-side heat exchanger is caused to function as an evaporator of the refrigerant condensed in the heat source-side heat exchanger, the adequacy of the quantity of the refrigerant inside

the refrigerant circuit, the air conditioning apparatus refrigerant quantity determination method comprising:

a mode switching step of switching an operating state of the refrigerant circuit from a normal operation mode, where control of each device of the heat source unit and the utilization unit is performed according to the operating load of the utilization unit, to a refrigerant quantity determination operation mode, where the cooling operation is performed and the expansion mechanism is controlled such that the degree of superheat of the refrigerant in the outlet of the utilization-side heat exchanger becomes a positive value, and a speed of a motor (27m) of the blower fan (27) becomes a maximum in the refrigerant quantity determination operation mode, such that the air volume of the blower fan (27) becomes a maximum;
a detecting step of detecting the degree of supercooling of the refrigerant in the outlet of the heat source-side heat exchanger in the degree of supercooling in the refrigerant quantity determination operation mode;
a detected value correcting step of correcting the degree of supercooling value in an outlet of the heat source-side heat exchanger (23) by dividing the degree of supercooling value by a difference between a condensation temperature value in the heat source-side heat exchanger (23) and an outdoor air temperature, which is a temperature of the outdoor air flowing into the inside of the heat source unit (2), to thereby derive a relative degree of supercooling value; and
a refrigerant quantity adequacy determining step of performing a determination of the adequacy of the quantity of the refrigerant with which the inside of the refrigerant circuit is charged on the basis of the relative degree of supercooling value in the refrigerant quantity determination operation mode.

Patentansprüche

1. Klimaanlageeinrichtung (1), umfassend:

einen Kältemittelkreislauf (10), der beinhaltet eine Wärmequelleneinheit (2), die einen Kompressor (21), dessen Betriebskapazität angepasst werden kann, einen wärmequellenseitigen Wärmetauscher (23) und ein kühlendes Wärmequellenanpassungsmittel (27) aufweist, das die Kühlwirkung einer kühlenden Wärmequelle in Bezug auf den wärmequellenseitigen Wärmetauscher anpassen kann,
eine Nutzungseinheit (4), die eine nutzungssei-

tigen Wärmetauscher (41) aufweist, einen Ausdehnungsmechanismus (33) und ein Flüssigkältemittelverbindungsrohr (6) und ein Gaskältemittelverbindungsrohr (7), die die Wärmequelleneinheit und die Nutzungseinheit verbinden, ein Moduswechsellmittel, ein Erfassungsmittel zum Erfassen des Unterkühlungsgrads des Kältemittels in dem Auslass des wärmequellenseitigen Wärmetauschers in einem Kältemittelmengenermittlungsbetriebsmodus, Unterkühlungsgradkorrekturmittel, Kältemittelmengeneignungsermittlungsmittel, eine Steuerung (8) zum Durchführen von Betriebssteuerung der gesamten Klimaanlageeinrichtung, wobei das kühlende Wärmequellenanpassungsmittel (27) ein Gebläselüfter mit einem Motor ist, der das Luftvolumen variieren kann, das er zu dem wärmequellenseitigen Wärmetauscher (23) bläst, der Kältemittelkreislauf im Stande ist, mindestens Kühlbetrieb durchzuführen, wo der wärmequellenseitige Wärmetauscher veranlasst ist, als ein Kondensator eines Kältemittels zu fungieren, das in dem Kompressor komprimiert wird, und wo der nutzungsseitige Wärmetauscher veranlasst ist, als ein Verdampfer des Kältemittels zu fungieren, das in dem wärmequellenseitigen Wärmetauscher kondensiert ist; und das Moduswechsellmittel konfiguriert ist, einen Betriebszustand des Kältemittelkreislaufs von einem Normalbetriebsmodus, wo Steuerung von jeder Vorrichtung der Wärmequelleneinheit und der Nutzungseinheit gemäß der Betriebslast der Nutzungseinheit durchgeführt wird, zu dem Kältemittelmengenermittlungsbetriebsmodus zu wechseln, wo der Kühlbetrieb durchgeführt wird und der Ausdehnungsmechanismus so gesteuert wird, dass ein Überhitzungsgrad des Kältemittels in einem Auslass des nutzungsseitigen Wärmetauschers ein positiver Wert wird; und wobei die Klimaanlageeinrichtung konfiguriert ist, den Kältemittelmengenermittlungsbetriebsmodus durchzuführen, wobei das Erfassungsmittel den Unterkühlungsgrad des Kältemittels in dem Auslass des wärmequellenseitigen Wärmetauschers in einem Zustand erfasst, wo das Luftvolumen des Gebläselüfters (27) maximiert wurde; und das Unterkühlungsgradkorrekturmittel den Unterkühlungsgradwert korrigiert, indem der Unterkühlungsgradwert durch eine Differenz zwischen einem Kondensationstemperaturwert in dem wärmequellenseitigen Wärmetauscher (23) und einer Außenlufttemperatur, die eine Temperatur der Außenluft ist, die in das Innere der Wärmequelleneinheit (2) strömt, geteilt wird, um dadurch einen relativen Unterkühlungsgrad-

wert abzuleiten; und das Kältemittelmengeneignungsermittlungsmittel als eine Kältemittelmengeneignungsermittlung eine Ermittlung der Eignung der Menge des Kältemittels, mit dem das Innere des Kältemittelkreislaufs beladen ist, auf der Basis des relativen Unterkühlungsgradwerts durchführt.

2. Klimaanlageeinrichtung (1) nach Anspruch 1, wobei das Kältemittelmengeneignungsermittlungsmittel konfiguriert ist, periodisch die Kältemittelmengeneignungsermittlung durchzuführen.
3. Klimaanlageeinrichtung (1) nach einem der Ansprüche 1 oder 2, wobei der Kompressor (21) von einem Motor (21m) durch einen Inverter angetrieben wird und konfiguriert ist, so betrieben zu werden, dass seine Geschwindigkeit, die von dem Motor resultiert, immer eine vorgegebene Geschwindigkeit in dem Kältemittelmengenermittlungsbetriebsmodus wird.
4. Kältemittelmengenermittlungsverfahren zur Ermittlung, in einer Klimaanlageeinrichtung (1), die einen Kältemittelkreislauf (10) aufweist, der beinhaltet eine Wärmequelleneinheit (2), die einen Kompressor (21), dessen Betriebskapazität angepasst werden kann, einen wärmequellenseitigen Wärmetauscher (23) und kühlendes Wärmequellenanpassungsmittel (27) aufweist, das die Kühlwirkung einer kühlenden Wärmequelle in Bezug auf den wärmequellenseitigen Wärmetauscher anpassen kann, eine Nutzungseinheit (4), die einen nutzungsseitigen Wärmetauscher (41) aufweist, einen Ausdehnungsmechanismus (33) und ein Flüssigkältemittelverbindungsrohr (6) und ein Gaskältemittelverbindungsrohr (7), die die Wärmequelleneinheit und die Nutzungseinheit verbinden, wobei das kühlende Wärmequellenanpassungsmittel (27) ein Gebläselüfter ist, der das Luftvolumen variieren kann, das er zu dem wärmequellenseitigen Wärmetauscher (23) bläst, wobei der Kältemittelkreislauf im Stande ist, mindestens Kühlbetrieb durchzuführen, wo der wärmequellenseitige Wärmetauscher veranlasst ist, als ein Kondensator von Kältemittel zu fungieren, das in dem Kompressor komprimiert ist, und wo der nutzungsseitige Wärmetauscher veranlasst ist, als ein Verdampfer des Kältemittels zu fungieren, das in dem wärmequellenseitigen Wärmetauscher kondensiert ist, die Eignung der Menge des Kältemittels innerhalb des Kältemittelkreislaufs, wobei das Klimaanlageeinrichtungs-Kältemittelmengenermittlungsverfahren umfasst:

einen Moduswechselschritt zum Wechseln ei-

nes Betriebszustands des Kältemittelkreislaufs von einem Normalbetriebsmodus, wo Steuerung jeder Vorrichtung der Wärmequelleneinheit und der Nutzungseinheit gemäß der Betriebslast der Nutzungseinheit durchgeführt ist, zu einem Kältemittelmengenermittlungsbetriebsmodus, wo der Kühlbetrieb durchgeführt ist und der Ausdehnungsmechanismus so gesteuert ist, dass der Überhitzungsgrad des Kältemittels in dem Auslass des nutzungsseitigen Wärmetauschers ein positiver Wert wird und eine Geschwindigkeit eines Motors (27m) des Gebläselüfters (27) in dem Kältemittelmengenermittlungsbetriebsmodus ein Maximum wird, so dass das Luftvolumen des Gebläselüfters (27) ein Maximum wird;

einen Erfassungsschritt zur Erfassung des Unterkühlungsgrads des Kältemittels in dem Auslass des wärmequellenseitigen Wärmetauschers in dem Unterkühlungsgrad in dem Kältemittelmengenermittlungsbetriebsmodus;

einen erfassten Wertkorrekturschritt zur Korrektur des Unterkühlungsgrads in einem Auslass des wärmequellenseitigen Wärmetauschers (23), indem der Unterkühlungsgradwert durch eine Differenz zwischen einem Kondensationstemperaturwert in dem wärmequellenseitigen Wärmetauscher (23) und einer Außenlufttemperatur, die eine Temperatur der Außenluft ist, die in das Innere der Wärmequelleneinheit (2) strömt, dividiert wird, um dadurch einen relativen Unterkühlungsgradwert abzuleiten; und

einen Kältemittelmengeneignungsermittlungsschritt zum Durchführen einer Ermittlung der Eignung der Menge des Kältemittels mit dem das Innere des Kältemittelkreislaufs beladen ist, auf der Basis des relativen Unterkühlungswertgrads in dem Kältemittelmengenermittlungsbetriebsschritt.

Revendications

1. Appareil de climatisation d'air (1) comprenant :

un circuit de réfrigérant (10) qui inclut

une unité source de chaleur (2) présentant un compresseur (21) dont la capacité de fonctionnement peut être ajustée, un échangeur de chaleur côté source de chaleur (23), et un moyen d'ajustement de source de chaleur de refroidissement (27) qui peut ajuster l'action de refroidissement d'une source de chaleur de refroidissement par rapport à l'échangeur de chaleur côté source de chaleur,

une unité d'utilisation (4) présentant un

échangeur de chaleur côté utilisation (41), un mécanisme de détente (33), et un tube de liaison de réfrigérant liquide (6) et un tube de liaison de réfrigérant gazeux (7) qui relie l'unité source de chaleur et l'unité d'utilisation, un moyen de commutation de mode, un moyen de détection pour détecter le degré de surrefroidissement du réfrigérant dans la sortie de l'échangeur de chaleur côté source de chaleur dans un mode de fonctionnement de détermination de quantité de réfrigérant, un moyen de correction de degré de surrefroidissement, un moyen de détermination d'adéquation de quantité de réfrigérant, un dispositif de commande (8) pour effectuer une commande de fonctionnement de l'ensemble de l'appareil de climatisation d'air,

dans lequel le moyen d'ajustement de source de chaleur de refroidissement (27) est un ventilateur de soufflante avec un moteur qui peut faire varier le volume d'air qu'il souffle vers l'échangeur de chaleur côté source de chaleur (23),

le circuit de réfrigérant est capable d'effectuer au moins une opération de refroidissement où l'échangeur de chaleur côté source de chaleur est amené à fonctionner comme un condenseur de réfrigérant comprimé dans le compresseur et où l'échangeur de chaleur côté utilisation est amené à fonctionner comme un évaporateur du réfrigérant condensé dans l'échangeur de chaleur côté source de chaleur ;

et le moyen de commutation de mode est configuré pour commuter un état de fonctionnement du circuit de réfrigérant depuis un mode de fonctionnement normal, où une commande de chaque dispositif de l'unité source de chaleur et de l'unité d'utilisation est effectuée selon la charge d'exploitation de l'unité d'utilisation, au mode de fonctionnement de détermination de quantité de réfrigérant, où l'opération de refroidissement est effectuée et le mécanisme de détente est commandé de sorte qu'un degré de surchauffe du réfrigérant dans une sortie de l'échangeur de chaleur côté utilisation devienne une valeur positive ;

et dans lequel l'appareil de climatisation d'air est configuré pour effectuer le mode de fonctionnement de détermination de quantité de réfrigérant, dans lequel le moyen de détection détecte le degré de surrefroidissement du réfrigérant dans la sortie de l'échangeur de chaleur côté source de chaleur dans un état où le volume d'air du ventilateur de soufflante (27) a été maximisé ;

et le moyen de correction de degré de surrefroi-

- dissement corrige la valeur de degré de surre-
froidissement en divisant la valeur de degré de
surrefroidissement par une différence entre une
valeur de température de condensation dans
l'échangeur de chaleur côté source de chaleur 5
(23) et une température d'air extérieur, qui est
une température de l'air extérieur circulant dans
l'intérieur de l'unité source de chaleur (2), pour
ainsi dériver une valeur de degré de surrefroi-
dissement relative ; et
le moyen de détermination d'adéquation de
quantité de réfrigérant effectue, en tant que dé-
termination d'adéquation de quantité de réfrigé-
rant, une détermination de l'adéquation de la
quantité du réfrigérant avec laquelle l'intérieur
du circuit de réfrigérant est chargé sur la base
de la valeur de degré de surrefroidissement re-
lative.
2. Appareil de climatisation d'air (1) selon la revendication 1, dans lequel le moyen de détermination d'adéquation de quantité de réfrigérant est configuré pour effectuer périodiquement la détermination d'adéquation de quantité de réfrigérant. 20
3. Appareil de climatisation d'air (1) selon l'une quelconque des revendications 1 ou 2, dans lequel le compresseur (21) est entraîné par un moteur (21m) commandé par un onduleur et est configuré pour être exploité de sorte que sa vitesse résultant du 25
moteur devienne toujours une vitesse prédéterminée dans le mode de fonctionnement de détermination de quantité de réfrigérant. 30
4. Procédé de détermination de quantité de réfrigérant consistant à déterminer, 35
dans un appareil de climatisation d'air (1) présentant un circuit de réfrigérant (10) qui inclut
- une unité source de chaleur (2) présentant un compresseur (21) dont la capacité de fonctionnement peut être ajustée, un échangeur de chaleur côté source de chaleur (23), et un moyen d'ajustement de source de chaleur de refroidissement (27) qui peut ajuster l'action de refroidissement d'une source de chaleur de refroidissement par rapport à l'échangeur de chaleur côté source de chaleur, 40
une unité d'utilisation (4) présentant un échangeur de chaleur côté utilisation (41), 45
un mécanisme de détente (33), et
un tube de liaison de réfrigérant liquide (6) et un tube de liaison de réfrigérant gazeux (7) qui relie l'unité source de chaleur et l'unité d'utilisation, 50
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- dans lequel le moyen d'ajustement de source de chaleur de refroidissement (27) est un ventilateur de

soufflante qui peut faire varier le volume d'air qu'il souffle vers l'échangeur de chaleur côté source de chaleur (23),
avec le circuit de réfrigérant étant capable d'effectuer au moins une opération de refroidissement où l'échangeur de chaleur côté source de chaleur est amené à fonctionner comme un condenseur de réfrigérant comprimé dans le compresseur et où l'échangeur de chaleur côté utilisation est amené à fonctionner comme un évaporateur du réfrigérant condensé dans l'échangeur de chaleur côté source de chaleur,
l'adéquation de la quantité du réfrigérant à l'intérieur du circuit de réfrigérant, le procédé de détermination de quantité de réfrigérant dans l'appareil de climatisation d'air comprenant :

une étape de commutation de mode consistant à commuter un état de fonctionnement du circuit de réfrigérant depuis un mode de fonctionnement normal, où une commande de chaque dispositif de l'unité source de chaleur et de l'unité d'utilisation est effectuée selon la charge d'exploitation de l'unité d'utilisation, à un mode de fonctionnement de détermination de quantité de réfrigérant, où l'opération de refroidissement est effectuée et le mécanisme de détente est commandé de sorte que le degré de surchauffe du réfrigérant dans la sortie de l'échangeur de chaleur côté utilisation devienne une valeur positive, et une vitesse d'un moteur (27m) du ventilateur de soufflante (27) devienne un maximum dans le mode de fonctionnement de détermination de quantité de réfrigérant, de sorte que le volume d'air du ventilateur de soufflante (27) devienne un maximum ;
une étape de détection consistant à détecter le degré de surrefroidissement du réfrigérant dans la sortie de l'échangeur de chaleur côté source de chaleur dans le degré de surrefroidissement dans le mode de fonctionnement de détermination de quantité de réfrigérant ;
une étape de correction de valeur détectée consistant à corriger la valeur de degré de surrefroidissement dans une sortie de l'échangeur de chaleur côté source de chaleur (23) en divisant la valeur de degré de surrefroidissement par une différence entre une valeur de température de condensation dans l'échangeur de chaleur côté source de chaleur (23) et une température d'air extérieur, qui est une température de l'air extérieur circulant dans l'intérieur de l'unité source de chaleur (2), pour ainsi dériver une valeur de degré de surrefroidissement relative ; et
une étape de détermination d'adéquation de quantité de réfrigérant consistant à effectuer une détermination de l'adéquation de la quantité du réfrigérant avec laquelle l'intérieur du circuit

de réfrigérant est chargé sur la base de la valeur de degré de surrefroidissement relative dans le mode de fonctionnement de détermination de quantité de réfrigérant.

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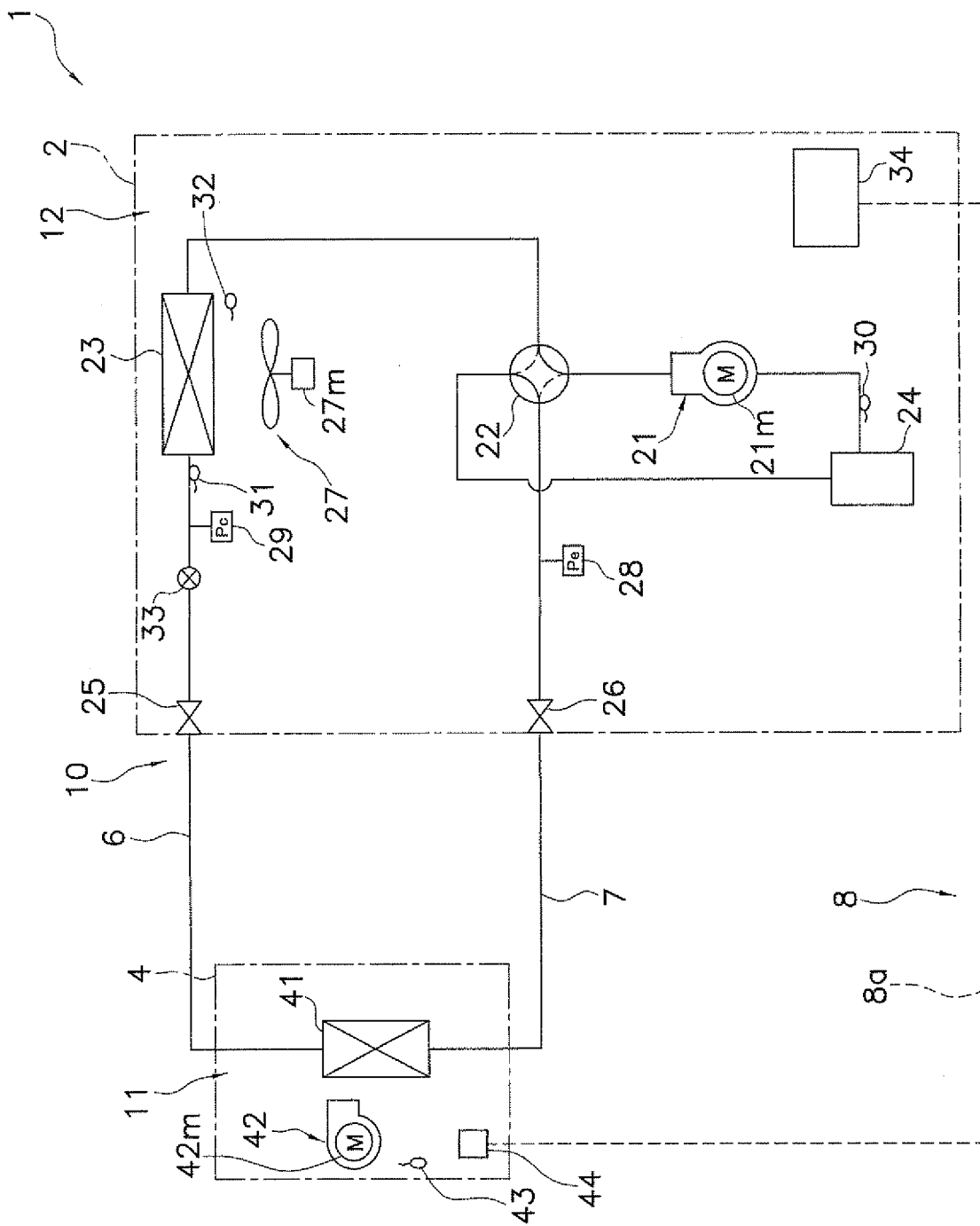


FIG. 1

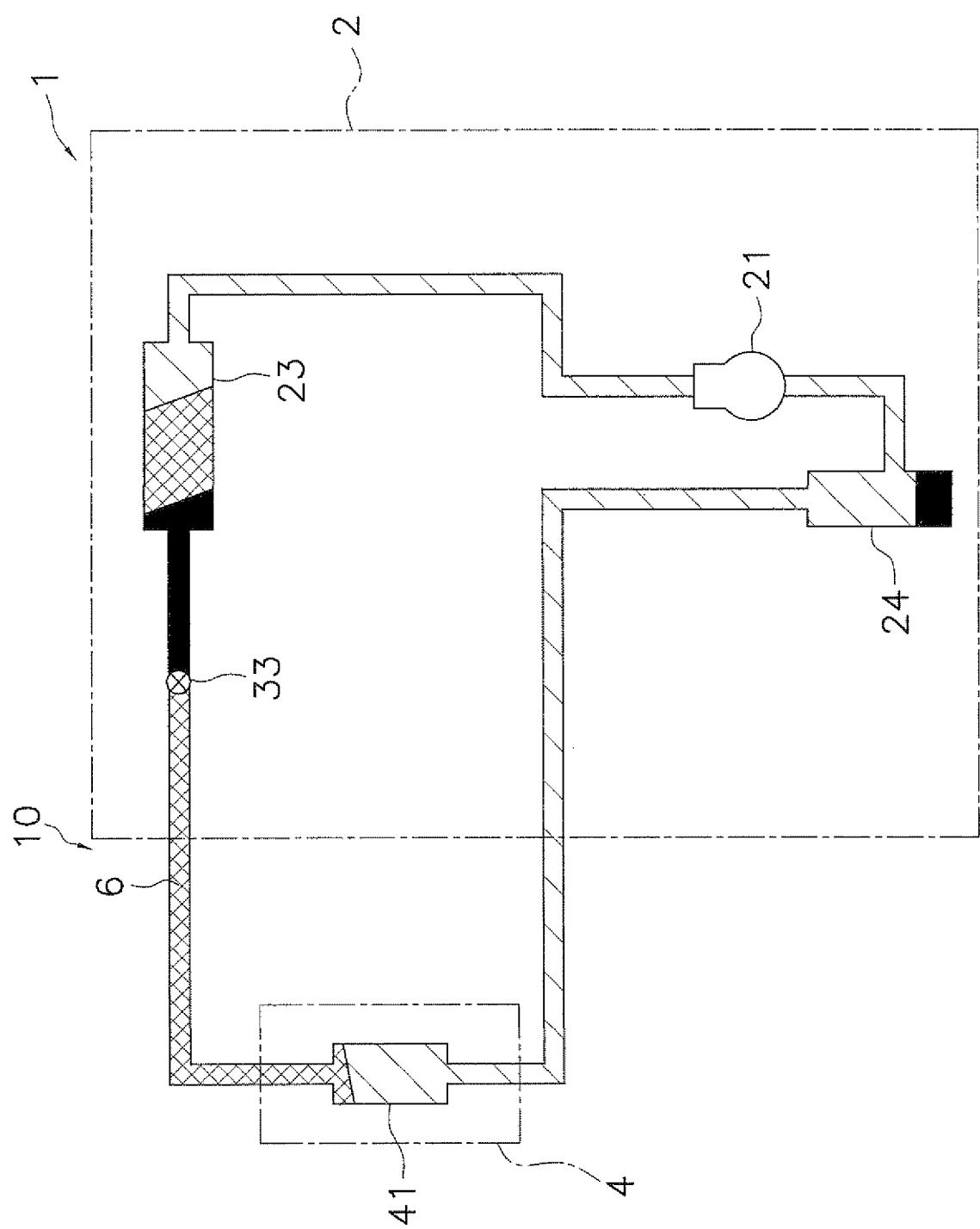


FIG. 2

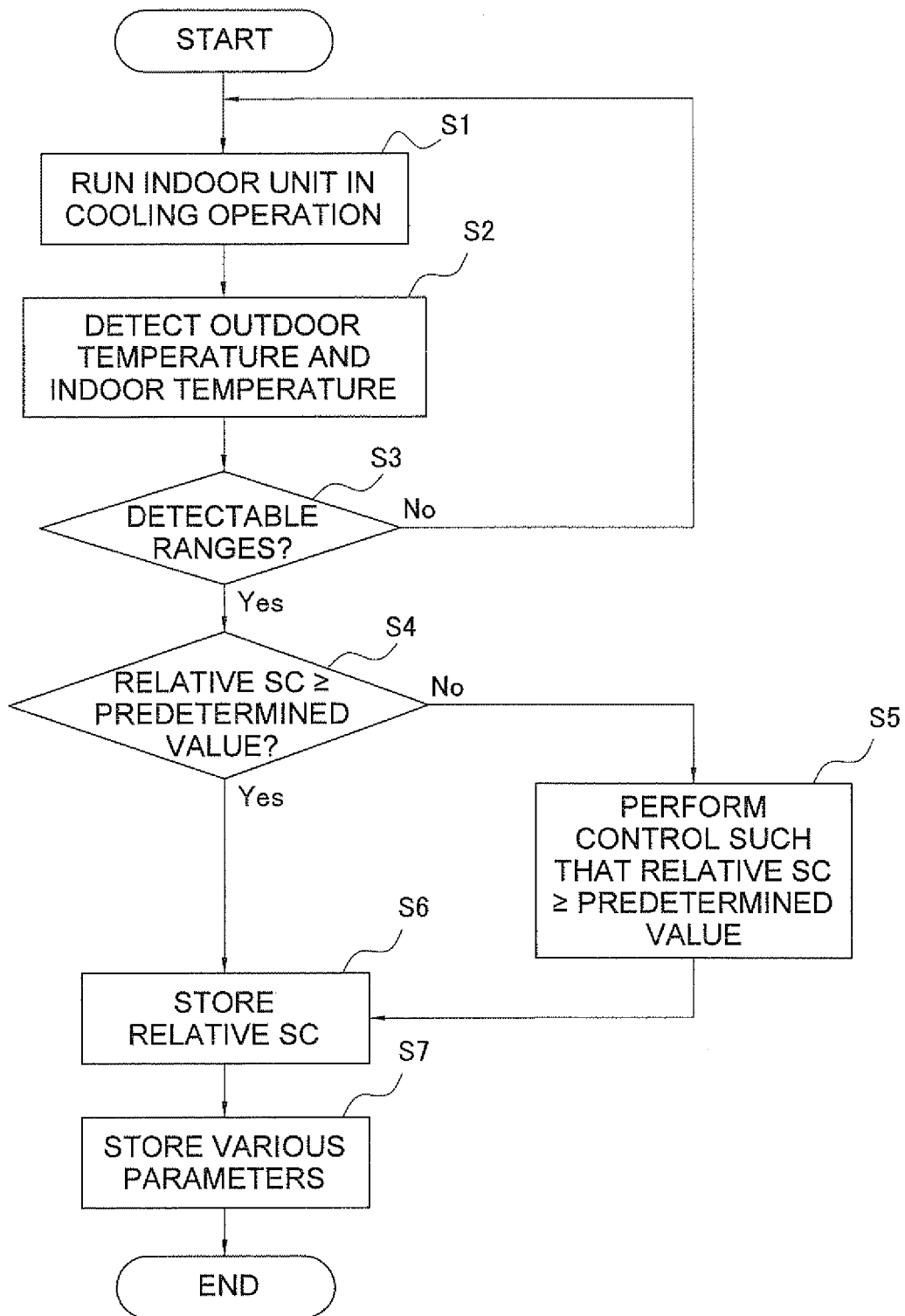


FIG. 3

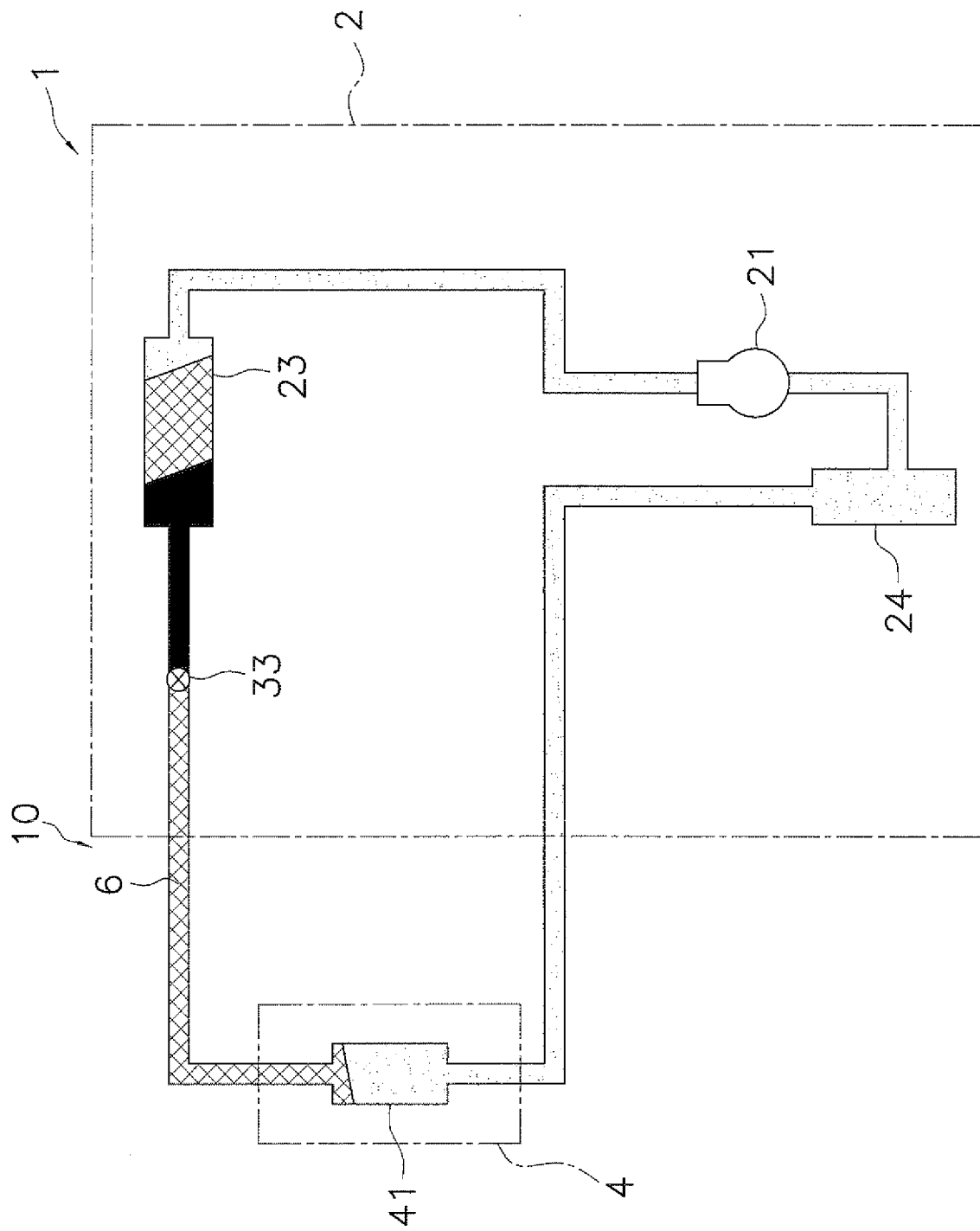


FIG. 4

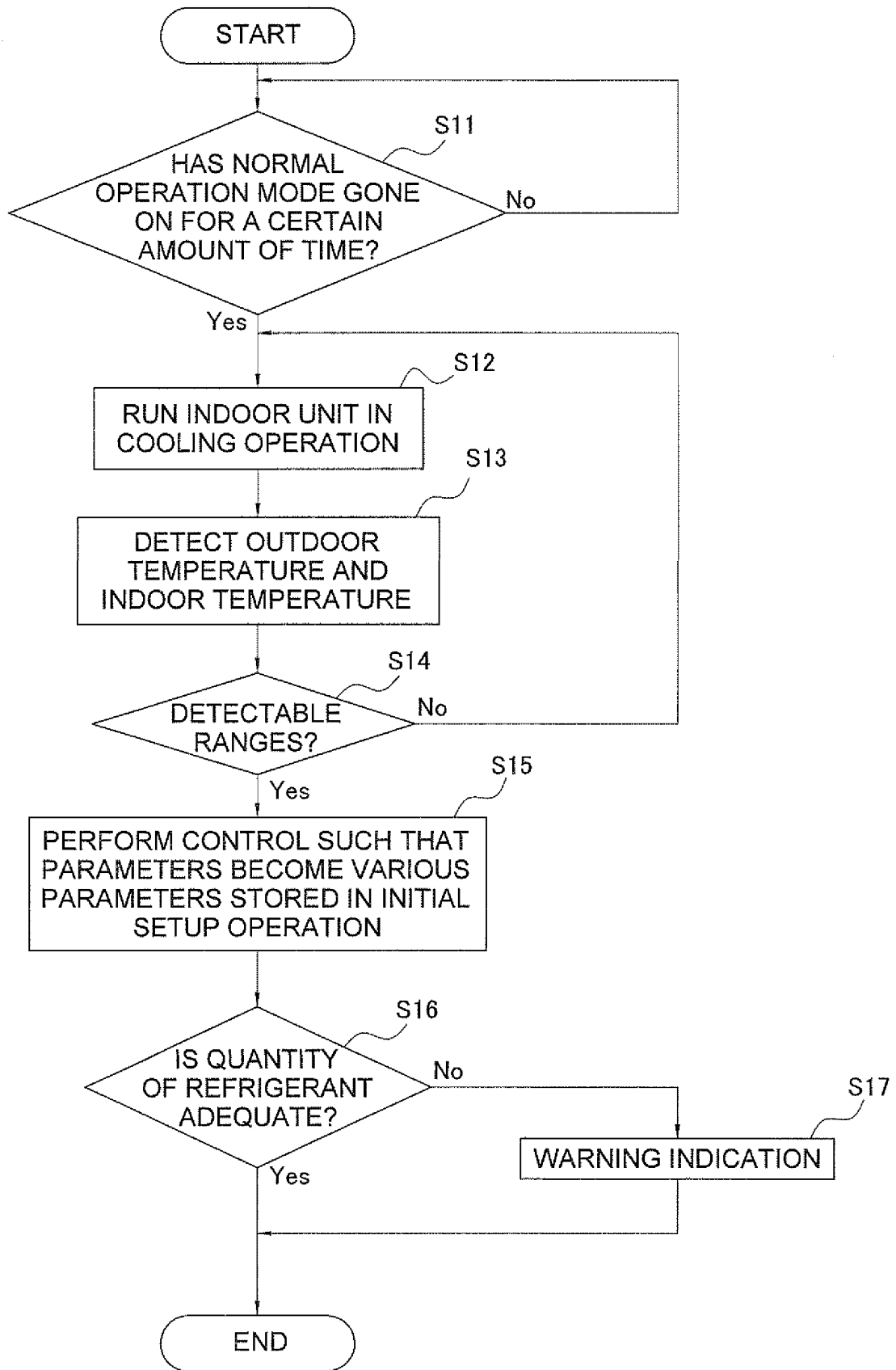


FIG. 5

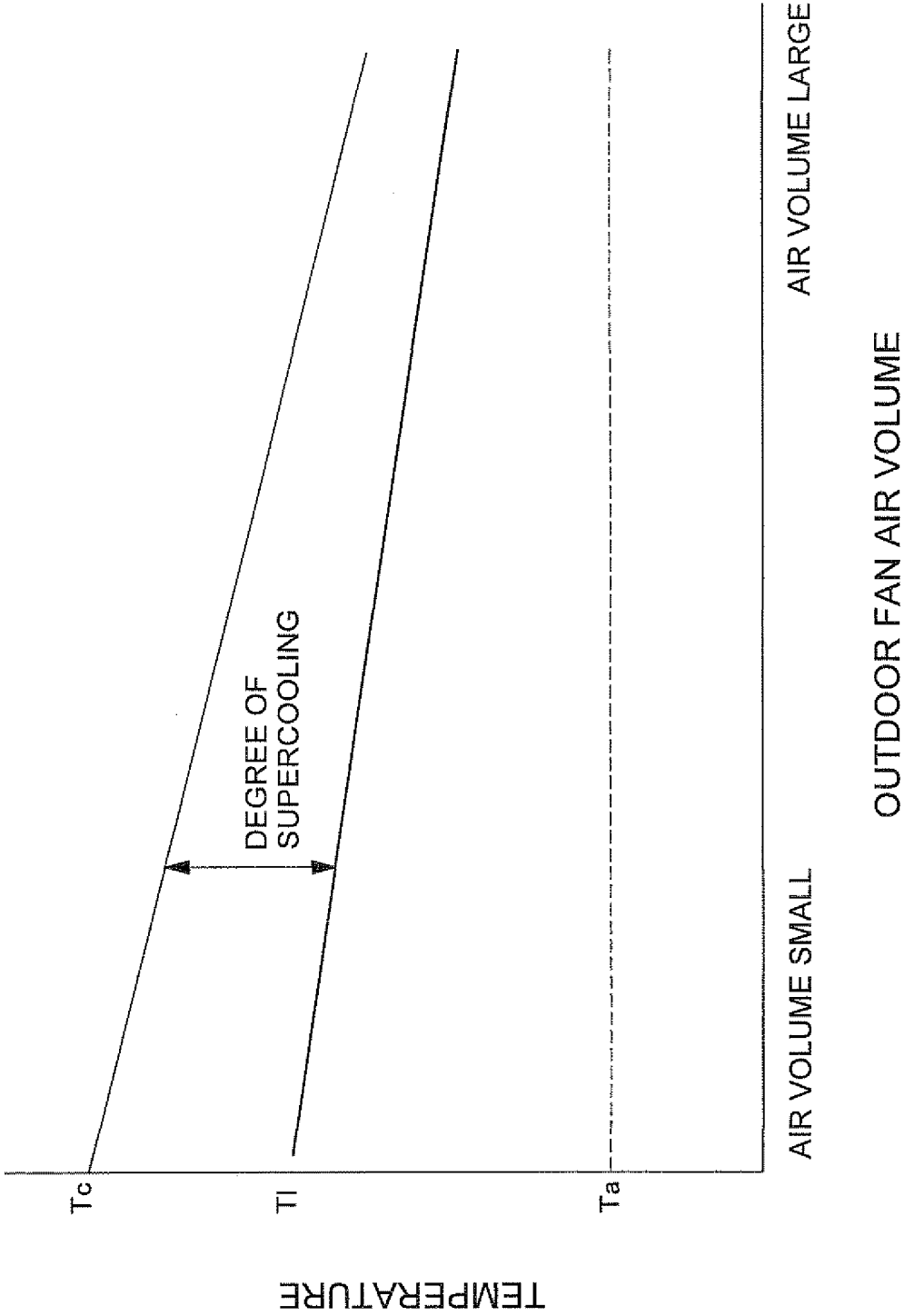


FIG. 6

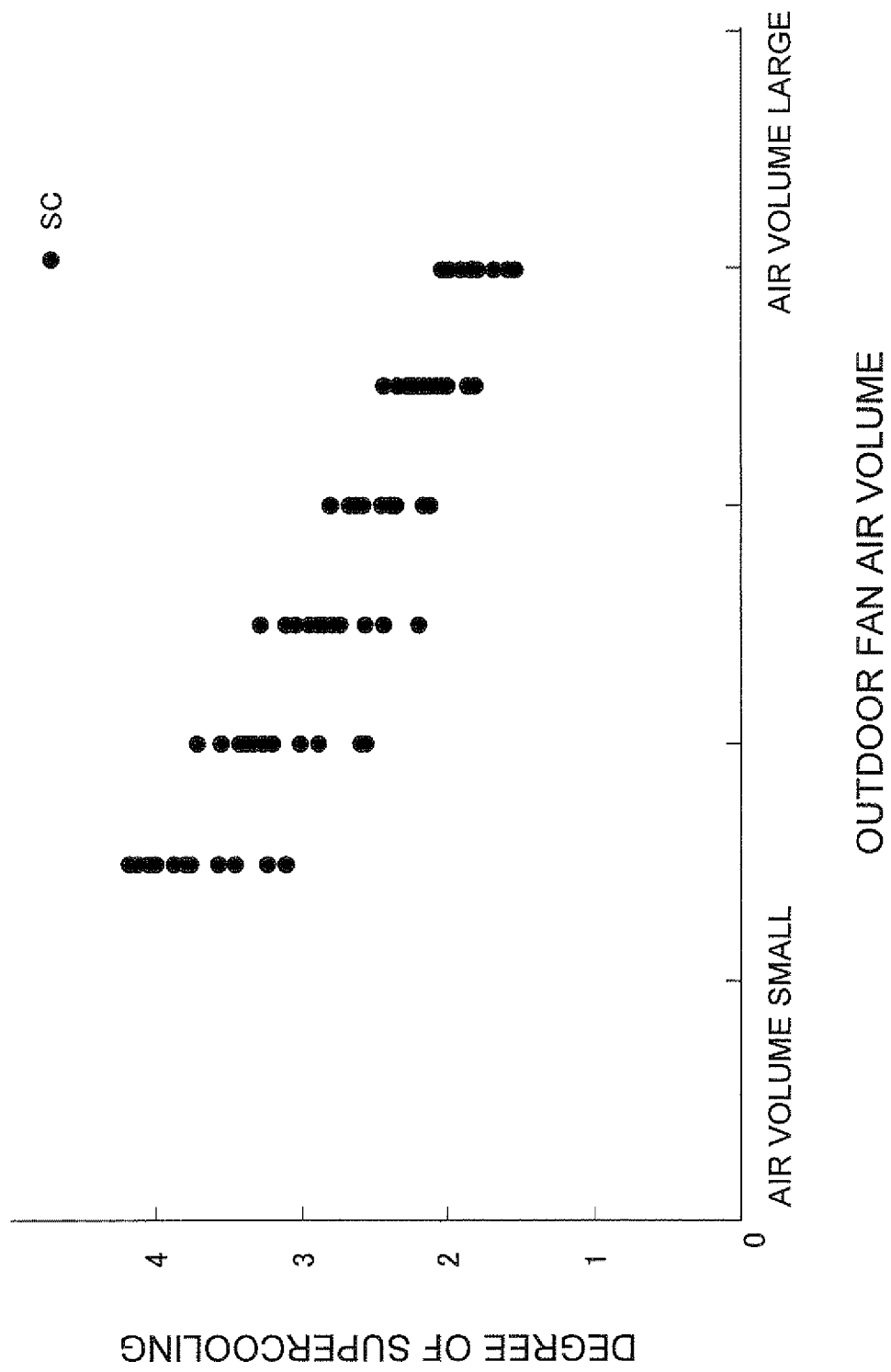


FIG. 7

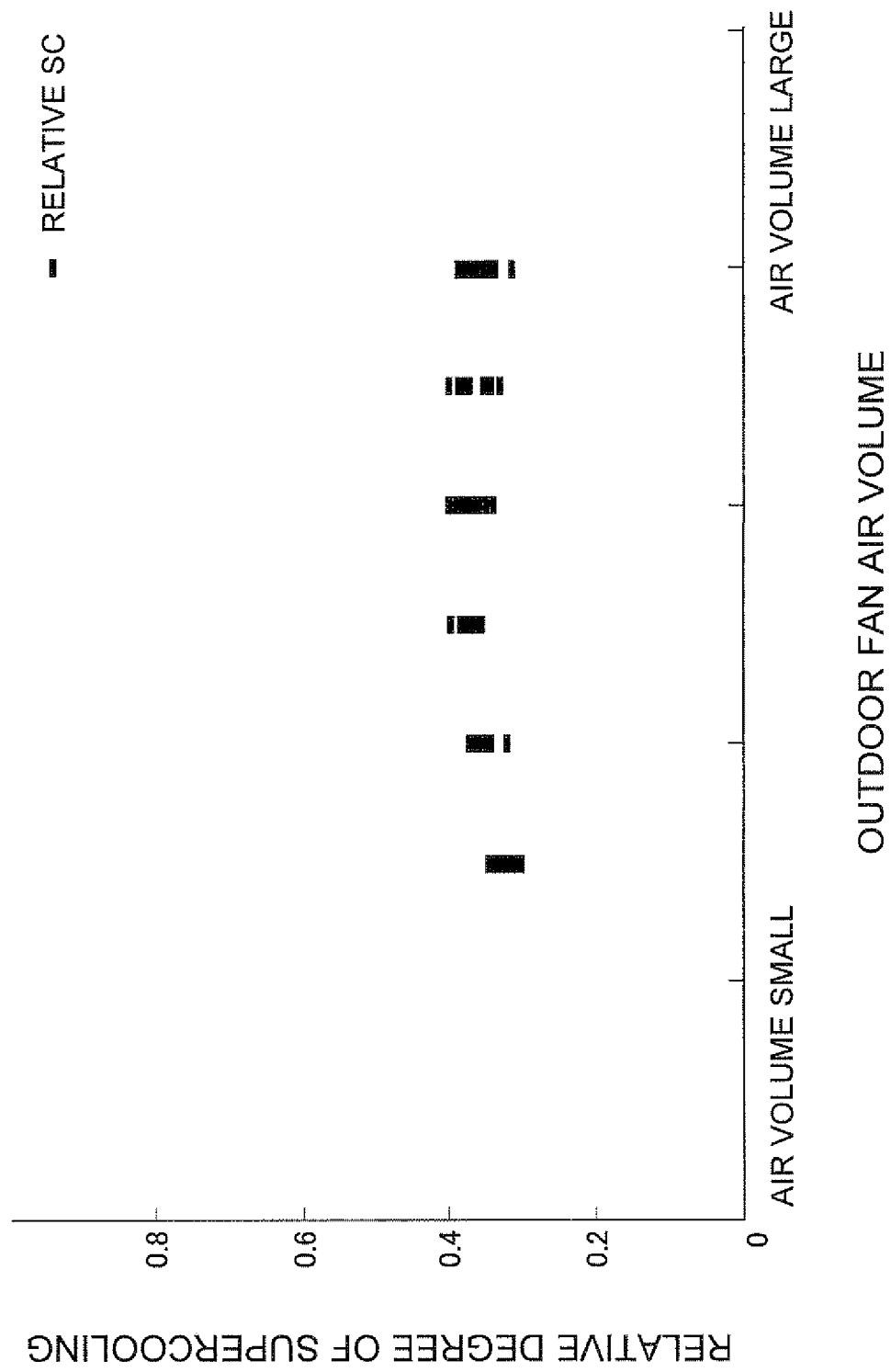


FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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