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(54) REFRIGERANT CHARGE DETERMINATION DEVICE, AIR CONDITIONING SYSTEM, REFRIGERANT CHARGE DETERMINATION METHOD, AND PROGRAM

(57) A refrigerant amount determination device includes an information acquisition unit (491), a subcooling level regulation unit (492), and a refrigerant amount determination unit (493). The information acquisition unit (491) acquires expansion valve opening-degree information that indicates a degree of opening of an expansion valve subject to determination, the expansion valve being at least either one of an expansion valve in an indoor unit and an expansion valve on a side of a subcooling heat exchanger included in an air conditioning system. The subcooling level regulation unit (492) increases a subcooling level of an outdoor heat exchanger included in the air conditioning system. The refrigerant amount determination unit (493) determines whether or not the refrigerant amount in the air conditioning system is appropriate based on the degree of opening of the expansion valve subject to determination before increasing the subcooling level, and the degree of opening of the expansion valve subject to determination after increasing the subcooling level.

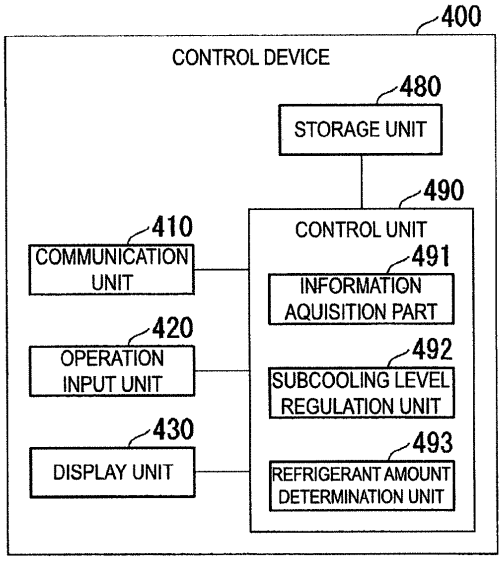

FIG. 3

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Description

Technical Field

[0001] The present invention relates to a refrigerant amount determination device, an air conditioning system, a refrigerant amount determination method, and a program.

[0002] This application claims priority based on JP 2017-036852 filed in Japan on February 28, 2017, of which the contents are incorporated herein by reference.

Background Art

[0003] To operate an air conditioning system efficiently, charging an appropriate amount of refrigerant in the air conditioning system is important. In this regard, PTL 1 discloses a refrigerant charged amount determining method. In the refrigerant charged amount determining method disclosed in Patent Literature 1, an air conditioning system is operated in a cooling cycle and if a degree of opening of an indoor expansion valve and/or a subcooling expansion valve is equal to or larger than a predetermined value, it is determined that the refrigerant charged amount is in a gas low state.

Citation List

Patent Documents

[0004] PTL 1: JP 2008-96051 A

Summary of Invention

Problem to be Solved by the Invention

[0005] According to the refrigerant charged amount determining method disclosed in Patent Literature 1, a gas low state in an air conditioning system can be detected. If such a gas low state in the air conditioning system is detected, the air conditioning system can be operated efficiently by increasing a refrigerant amount in the air conditioning system. It is more preferred that determining whether or not the refrigerant amount in the air conditioning system is appropriate is achieved with higher accuracy.

[0006] The present invention provides a refrigerant amount determination device, an air conditioning system, a refrigerant amount determination method, and a program capable of achieving determination of whether or not a refrigerant amount in an air conditioning system is appropriate with higher accuracy.

Solution to Problem

[0007] According to a first aspect of the present invention, a refrigerant amount determination device includes an information acquisition unit, a subcooling level regulation unit, and a refrigerant amount determination unit. The information acquisition unit acquires expansion valve opening-degree information that indicates a degree of opening of an expansion valve subject to determination, the expansion valve being at least either one of an expansion valve in an indoor unit and an expansion valve on a side of a subcooling heat exchanger included in an air conditioning system. The subcooling level regulation unit increases a subcooling level of an outdoor heat exchanger included in the air conditioning system. The refrigerant amount determination unit determines whether or not a refrigerant amount in the air conditioning system is appropriate based on the degree of opening of the expansion valve subject to determination before increasing the subcooling level and the degree of opening of the expansion valve subject to determination after increasing the subcooling level.

[0008] The refrigerant amount determination device may increase the subcooling level by reducing a degree of opening of an expansion valve on a side of the outdoor heat exchanger included in the air conditioning system.

[0009] The refrigerant amount determination device may determine whether or not a refrigerant amount in the air conditioning system is appropriate further based on the subcooling level before being increased by the subcooling level regulation unit.

[0010] The refrigerant amount determination device may change the subcooling level to a first subcooling level, a second subcooling level that is larger than the first subcooling level, and a third subcooling level that is larger than the second subcooling level, respectively, and determine whether or not a refrigerant amount in the air conditioning system is appropriate based on a degree of opening of the expansion valve subject to determination each for the first subcooling level, the second subcooling level, and the third subcooling level.

[0011] According to a second aspect of the present invention, the air conditioning system includes either one of the refrigerant amount determination devices described above.

[0012] According to a third aspect of the present invention, a refrigerant amount determination method includes a process of increasing a subcooling level of an outdoor heat exchanger included in an air conditioning system, and a process of determining whether or not a refrigerant amount in the air conditioning system is appropriate based on a degree of opening of an expansion valve subject to determination, the expansion valve being at least either one of an expansion valve in an indoor unit and an expansion valve on a side of a subcooling heat exchanger included in the air conditioning system before increasing a subcooling level, and the degree of opening of the expansion valve subject to determination after increasing the subcooling level.

[0013] According to a fourth aspect of the present invention, a program is configured to cause a computer, the computer being configured to control an air conditioning system, to execute a process of increasing a sub-

cooling level of an outdoor heat exchanger included in the air conditioning system; and a process of determining whether or not a refrigerant amount in the air conditioning system is appropriate based on a degree of opening of an expansion valve subject to determination, the expansion valve being at least either one of an expansion valve in an indoor unit and an expansion valve on a side of a subcooling heat exchanger included in the air conditioning system before increasing a subcooling level, and the degree of opening of the expansion valve subject to determination after increasing the subcooling level.

Advantageous Effect of Invention

[0014] According to the refrigerant amount determination device, the air conditioning system, the refrigerant amount determination method, and the program as described above, determining whether or not a refrigerant amount in an air conditioning system is appropriate is achieved with higher accuracy.

Brief Description of Drawings

[0015]

FIG. 1 is an outline block diagram illustrating a functional configuration of an air conditioning system according to an embodiment.

FIG. 2 is an outline configuration diagram illustrating a device configuration of an air conditioning system main body according to the embodiment.

FIG. 3 is an outline block diagram illustrating a functional configuration of a control device according to the embodiment.

FIG. 4 is a diagram illustrating an example criterion used when a refrigerant amount determination unit according to the embodiment determines whether or not a refrigerant amount is appropriate based on data at two subcooling levels.

FIG. 5 is a flowchart illustrating an example procedure in which the control device according to the embodiment determines whether or not a refrigerant amount is appropriate based on data at two subcooling levels.

FIG. 6 is a flowchart illustrating an example procedure in which the control device according to the embodiment increases a subcooling level of an outdoor heat exchanger.

FIG. 7 is a diagram illustrating an example criterion used when a refrigerant amount determination unit according to the embodiment determines whether or not a refrigerant amount is appropriate based on data at three subcooling levels.

FIG. 8 is a flowchart illustrating an example procedure in which the control device according to the embodiment determines whether or not a refrigerant amount is appropriate based on data at three subcooling levels.

Description of Embodiments

[0016] The following describes an embodiment of the present invention, which is not intended to limit the scope of the invention. In addition, not all of combinations of characteristics described in the embodiment are essential for the solution to the problem solved by the invention.

[0017] FIG. 1 is an outline block diagram illustrating a functional configuration of an air conditioning system according to the embodiment. As illustrated in FIG. 1, an air conditioning system 1 includes an air conditioning system main body 100 and a control device 400.

[0018] The air conditioning system main body 100 operates according to control by the control device 400 and regulates inside air temperature subject to temperature regulation. However, the subject for which the air conditioning system main body 100 regulates temperature is not limited to an indoor temperature. For example, like a spot air conditioning system for outdoor use, the air conditioning system main body 100 may regulate air temperature in an outdoor space.

[0019] FIG. 2 is an outline configuration diagram illustrating a device configuration of the air conditioning system main body 100. In an example of FIG. 2, the air conditioning system main body 100 includes an outdoor unit 200 and an indoor unit 300. The outdoor unit 200 includes a compressor 211, an accumulator 212, a four-way valve 221, an outdoor heat exchanger 231, an outdoor-side expansion valve 232, a receiver tank 241, a subcooling heat exchanger 251, a subcooling-side expansion valve 252, a high-pressure-side pressure sensor 291, and an outdoor heat exchanger outlet temperature sensor 292. The indoor unit 300 includes an indoor heat exchanger 311 and an indoor unit-side expansion valve 312.

[0020] FIG. 2 illustrates an example of the air conditioning system main body 100 including a plurality of indoor units 300. However, the air conditioning system main body 100 may include at least one indoor unit 300. The air conditioning system main body 100 may also include at least one outdoor unit 200. In addition, the compressor 211, the accumulator 212, the four-way valve 221, the receiver tank 241, the subcooling heat exchanger 251, and the subcooling-side expansion valve 252 may be installed in a place other than the outdoor unit 200. For example, some or all of the compressor 211, the accumulator 212, the four-way valve 221, the receiver tank 241, the subcooling heat exchanger 251, and the subcooling-side expansion valve 252 may be included in a separate device from the outdoor unit 200, and installed outside of the outdoor unit 200, for example.

[0021] In addition, the air conditioning system 1 may be a system dedicated to cooling. In the example of FIG. 2, the four-way valve 221 switches a cooling cycle and a heating cycle.

[0022] In the cooling cycle, a refrigerant gas compressed in the compressor 211 is introduced to the outdoor heat exchanger 231 via the four-way valve 221. The refrigerant gas introduced to the outdoor heat exchanger

231 dissipates heat by a heat exchange with outside air and then condenses. The refrigerant that has become a fluid by the condensation is introduced to the receiver tank 241 via the outdoor-side expansion valve 232. In the receiver tank 241, an extra amount of the refrigerant is accumulated to correspond any change of operation conditions.

[0023] The refrigerant flown out from the receiver tank 241 is subcooled in the subcooling heat exchanger 251 and then introduced to the indoor unit 300. The subcooling heat exchanger 251 subcools the refrigerant to prevent the refrigerant from evaporating in a piping between the outdoor unit 200 and the indoor unit 300. Specifically, part of the refrigerant fluid flown out from the receiver tank 241 is decompressed by the subcooling-side expansion valve 252. After that, the refrigerant fluid is introduced to the subcooling heat exchanger 251 and then evaporates in the subcooling heat exchanger 251. This evaporating refrigerant exchanges heat with the refrigerant introduced to the indoor unit 300 from the receiver tank 241 via the subcooling heat exchanger 251, and then removes the evaporation heat. Thereby the refrigerant introduced to the indoor unit 300 from the receiver tank 241 via the subcooling heat exchanger 251 is subcooled.

[0024] The refrigerant introduced to the subcooling heat exchanger 251 from the receiver tank 241 via the subcooling-side expansion valve 252 evaporates in the subcooling heat exchanger 251 and becomes a gas. After that, the refrigerant is introduced to the compressor 211 via the accumulator 212 and then compressed.

[0025] However, the subcooling heat exchanger 251 and the subcooling-side expansion valve 252 are not essential for the air conditioning system main body 100. For example, if a distance of the piping between the outdoor unit 200 and the indoor unit 300 is short and the prevention of the refrigerant evaporation is unnecessary, the air conditioning system main body 100 may not include the subcooling heat exchanger 251 and the subcooling-side expansion valve 252.

[0026] The refrigerant introduced to the indoor unit 300 is decompressed by the indoor unit-side expansion valve 312 and then introduced to the indoor heat exchanger 311.

[0027] The refrigerant introduced to the indoor heat exchanger 311 absorbs heat by a heat exchange with inside air and then evaporates. This heat absorption cools the inside air.

[0028] The refrigerant that has become a gas by the evaporation is introduced to the compressor 211 via the four-way valve 221 and the accumulator 212 and then compressed. The accumulator 212 separates the refrigerant introduced to the accumulator 212 itself into a refrigerant fluid and a refrigerant gas, and introduces only the refrigerant gas to the compressor 211. This aims to prevent reduced capability or malfunction of the compressor 211 due to the refrigerant fluid being introduced to the compressor 211.

[0029] The high-pressure-side pressure sensor 291 is disposed on a piping between the four-way valve 221 and the outdoor heat exchanger 231, and measures a pressure of the refrigerant in the piping. In a cooling cycle, in particular, the high-pressure-side pressure sensor 291 measures a pressure of a high-pressure refrigerant gas compressed in the compressor 211 and then introduced to the outdoor heat exchanger 231 via the four-way valve 221. In this case, based on the pressure measured by the high-pressure-side pressure sensor 291, the information acquisition unit 491 calculates a pressure saturation temperature of the outdoor heat exchanger 231. The outdoor heat exchanger outlet temperature sensor 292 is disposed at an outlet of the outdoor heat exchanger 231, and measures a temperature of the refrigerant flowing out from the outdoor heat exchanger 231.

[0030] The control device 400 controls the air conditioning system main body 100 to regulate a room temperature. In addition, the control device 400 corresponds to an example of the refrigerant amount determination device and determines whether or not an amount of the refrigerant in the air conditioning system 1 is appropriate. The refrigerant amount in the air conditioning system 1 is an amount of the refrigerant charged in the air conditioning system 1. The refrigerant amount in the air conditioning system 1 is also referred to as a refrigerant amount in the air conditioning system main body 100.

[0031] The control device 400 is configured with a computer such as a microcomputer.

[0032] The installation position of the control device 400 is not limited to a specific position. For example, the control device 400 may be installed inside of the outdoor unit 200 or inside of the indoor unit 300. Alternatively, the control device 400 may be included in a separate device from the outdoor unit 200 and the indoor unit 300.

[0033] In addition, the refrigerant amount determination device may be included in a separate device from the control device 400.

[0034] FIG. 3 is an outline block diagram illustrating a functional configuration of the control device 400. As illustrated in FIG. 3, the control device 400 includes a communication unit 410, an operation input unit 420, a display unit 430, a storage unit 480, and a control unit 490. The control unit 490 includes an information acquisition unit 491, a subcooling level regulation unit 492, and a refrigerant amount determination unit 493.

[0035] The communication unit 410 communicates with other equipment. In particular, the communication unit 410 receives a sensor signal indicating a measured pressure value by the high-pressure-side pressure sensor 291, and a sensor signal indicating a measured temperature value by the outdoor heat exchanger outlet temperature sensor 292. In addition, the communication unit 410 transmits control signals for each part of the air conditioning system main body 100.

[0036] The operation input unit 420 includes an input device such as a press button, and receives a user operation. The whole or part of the operation input unit 420

may be disposed on a remote controller.

[0037] The display unit 430 includes a display device such as a liquid crystal panel or lamp, or combination thereof, and displays various information. In particular, the display unit 430 displays determination results of whether or not a refrigerant amount is appropriate. For example, the display unit 430 includes a refrigerant amount excessive alarm lamp indicating that the refrigerant amount is excessive and a refrigerant amount insufficient lamp indicating that the refrigerant amount is insufficient. If the refrigerant amount determination unit 493 determines that the refrigerant amount is excessive, the display unit 430 lights up the refrigerant amount excessive alarm lamp. In addition, if the refrigerant amount determination unit 493 determines that the refrigerant amount is insufficient, the display unit 430 lights up the refrigerant amount insufficient alarm lamp.

[0038] The whole or part of the display unit 430 may be disposed on a remote controller.

[0039] The storage unit 480 stores various information. The storage unit 480 is configured with a storage unit included in the control device 400.

[0040] The control unit 490 controls each part of the control device 400 to execute various processing. The control unit 490 is configured by reading the program from the storage unit 480 and executing the program by a central processing unit (CPU) included in the control device 400.

[0041] The information acquisition unit 491 acquires expansion valve opening-degree information indicating a degree of opening of an expansion valve subject to determination. The expansion valve subject to determination here refers to either one or both of the subcooling-side expansion valve 252 and the indoor unit-side expansion valve 312. The subcooling-side expansion valve 252 corresponds to an expansion valve on the subcooling heat exchanger 251 side. The indoor unit-side expansion valve 312 corresponds to an expansion valve of the indoor unit 300. If the air conditioning system main body 100 includes a plurality of indoor units 300 and the indoor unit-side expansion valve 312 is used as the expansion valve subject to determination, the indoor unit-side expansion valve 312 of all the indoor units 300 may be used as the expansion valve subject to determination, or the indoor unit-side expansion valve 312 of some of the indoor units 300 may be used as the expansion valve subject to determination.

[0042] Furthermore, the information acquisition unit 491 may acquire a command value for a degree of opening of the expansion valve subject to determination as the expansion valve opening-degree information. Furthermore, the information acquisition unit 491 may acquire a measured value for the degree of opening of the expansion valve subject to determination as the expansion valve opening-degree information.

[0043] The subcooling level regulation unit 492 increases a subcooling level of the outdoor heat exchanger 231. The subcooling level of the outdoor heat exchanger 231 here is indicated by a difference in temperature between an outlet temperature of the outdoor heat exchanger 231 and a pressure saturation temperature of the outdoor heat exchanger 231. It is considered that an amount of the refrigerant fluid accumulated in the outdoor heat exchanger 231 increases as the size of the outdoor heat exchanger 231 increases.

[0044] The subcooling level regulation unit 492 increases the subcooling level by reducing the degree of opening of the outdoor-side expansion valve 232. Alternatively, the outdoor unit 200 may include a flow rate regulating valve for regulating the subcooling level in addition to the outdoor-side expansion valve 232 and the subcooling level regulation unit 492 may control a degree of opening of this flow rate regulating valve.

[0045] The refrigerant amount determination unit 493 determines whether or not a refrigerant amount in the air conditioning system 1 is appropriate. Specifically, the refrigerant amount determination unit 493 determines based on the degree of opening of the expansion valve subject to determination before the subcooling level regulation unit 492 increases the subcooling level and the subcooling level of the outdoor heat exchanger 231, and the degree of opening of the expansion valve subject to determination after the subcooling level regulation unit 492 increased the subcooling level. Alternatively, the subcooling level regulation unit 492 may determine, without using information of the subcooling level of the outdoor heat exchanger 231, based on the degree of opening of the expansion valve subject to determination before the subcooling level regulation unit 492 increases the subcooling level, and the degree of opening of the expansion valve subject to determination after the subcooling level regulation unit 492 increased the subcooling level.

[0046] If the expansion valve subject to determination includes a plurality of expansion valves, the refrigerant amount determination unit 493 may determine by using the mean value of the degree of opening of these plurality of valves, or the mode (most frequent value) thereof. Alternatively, the refrigerant amount determination unit 493 may determine based on majority rule whether or not the degree of opening of these plurality of valves each exceed the threshold value.

[0047] FIG. 4 is a diagram illustrating an example criterion used when the refrigerant amount determination unit 493 determines whether or not a refrigerant amount is appropriate based on data at two subcooling levels. In an example of FIG. 4, the refrigerant amount determination unit 493 determines the amount of the refrigerant charged in the air conditioning system main body 100 is appropriate, excessive, or insufficient based on abnormality determination results each for a normal state and after increase of the subcooling level.

[0048] For example, the storage unit 480 preliminarily stores the criterion information indicating the criterion. The refrigerant amount determination unit 493 uses the criterion information to perform determination.

[0049] The normal state here refers to the state before the subcooling level regulation unit 492 increases the subcooling level of the outdoor heat exchanger 231. In other words, the normal state here is the state in which the control to close the outdoor-side expansion valve 232 to increase the subcooling level of the outdoor heat exchanger 231 is not performed. Closing the valve here refers to reducing the degree of opening of the valve.

[0050] The refrigerant amount determination unit 493 determines, in individual abnormality determinations, on either one of determination results of expansion valve opening-degree large, subcooling level large, or abnormality undetected.

[0051] The expansion valve opening-degree large indicates that the degree of opening of the expansion valve subject to determination is larger than a predetermined threshold value. This expansion valve opening-degree large indicates that the refrigerant in the receiver tank 241 is insufficient.

[0052] If the refrigerant in the receiver tank 241 is insufficient because the receiver tank 241 is empty, for example, the refrigerant flowing through the indoor heat exchanger 311 becomes insufficient and a state in which cooling to a target temperature is impossible. Accordingly, the control unit 490 increases the degree of opening of the indoor unit-side expansion valve 312 to increase the refrigerant flowing through the indoor heat exchanger 311. In addition, the control unit 490 increases the degree of opening of the subcooling-side expansion valve 252 in preparation for increase of the refrigerant flowing from one outdoor unit 200 to another outdoor unit 200.

[0053] However, in the state in which the refrigerant in the receiver tank 241 is insufficient, increasing the degree of opening of the indoor unit-side expansion valve 312 does not increase the refrigerant flowing through the indoor heat exchanger 311, therefore, the temperature of the indoor unit-side expansion valve 312 does not reduce. Accordingly, the control unit 490 further increases the degree of opening of the indoor unit-side expansion valve 312 and the degree of opening of the subcooling-side expansion valve 252. In this manner, in the state in which the refrigerant in the receiver tank 241 is insufficient, the control unit 490 increases the degree of opening of the indoor unit-side expansion valve 312 and the degree of opening of the subcooling-side expansion valve 252 more and more. Thereby the degree of opening of the expansion valve subject to determination becomes larger than the threshold value. As described above, the expansion valve subject to determination refers to either one or both of the indoor unit-side expansion valve 312 and the subcooling-side expansion valve 252.

[0054] The subcooling level large indicates that the subcooling level of the outdoor heat exchanger 231 is larger than the predetermined threshold value. This subcooling level large indicates that the refrigerant is overflowing from the receiver tank 241. Overflowing of the refrigerant from the receiver tank 241 here refers to the receiver tank 241 being full and impossible to fully house the refrigerant. If the refrigerant overflows from the receiver tank 241, the overflown refrigerant accumulates in the outdoor heat exchanger 231, thereby increasing the subcooling level of the outdoor heat exchanger 231. The receiver tank 241 determines, if the subcooling level of the outdoor heat exchanger 231 increases and becomes larger than the threshold value, the subcooling level large.

[0055] The abnormality undetected indicates that none of the expansion valve opening-degree large and the subcooling level large is detected.

[0056] In the example of FIG. 4, if the refrigerant amount determination unit 493 determines the abnormality undetected in the abnormality determination in the normal state, and determines the expansion valve opening-degree large in the abnormality determination after increasing the subcooling level, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is appropriate.

[0057] The abnormality determination result after increasing the subcooling level in this case indicates that, in the state in which the refrigerant is intentionally accumulated in the outdoor heat exchanger 231, the refrigerant in the receiver tank 241 is insufficient. From this result, in the normal state in which the refrigerant is not accumulated intentionally in the outdoor heat exchanger 231, even though the refrigerant amount in the receiver tank 241 changes due to any environmental change or the like, it is expected that the refrigerant does not overflow from the receiver tank 241. To acquire appropriate determination results in this case, an increasing amount of the subcooling level increased by the subcooling level regulation unit 492 can be preliminarily regulated.

[0058] In addition, if the refrigerant amount determination unit 493 determines the abnormality undetected or the subcooling level large in the abnormality determination in the normal state, and determines the abnormality undetected in the abnormality determination after increasing the subcooling level, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is excessive.

[0059] If the abnormality determination result in the normal state is the subcooling level large, it is considered that the refrigerant is overflowing from the receiver tank 241. Therefore, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is excessive.

[0060] In addition, if the abnormality determination result after increasing the subcooling level is the abnormality undetected, in the normal state in which the refrigerant is not accumulated intentionally in the outdoor heat exchanger 231, the refrigerant may overflow from the receiver tank 241. Therefore, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main

body 100 is excessive.

[0061] In addition, if the refrigerant amount determination unit 493 determines the expansion valve opening-degree large in the abnormality determination in the normal state, and determines the expansion valve opening-degree large in the abnormality determination after increasing the subcooling level, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is excessive.

[0062] If the abnormality determination result in the normal state is the expansion valve opening-degree large, it is considered that the refrigerant in the receiver tank 241 is insufficient. Therefore, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is insufficient.

[0063] The refrigerant amount determination unit 493 may determine whether or not the refrigerant amount is appropriate based on the processing illustrated in FIG. 5.

[0064] FIG. 5 is a flowchart illustrating an example procedure in which the control device 400 determines whether or not the refrigerant amount is appropriate based on data at two subcooling levels.

Step S101

[0065] The control unit 490 sets an operation mode of the air conditioning system main body 100 to a normal operation mode in the cooling cycle. Based on this setting, the control unit 490 controls the air conditioning system main body 100 to operate in the cooling cycle and in the normal state. As described above, the normal state is the state in which the control to close the outdoor-side expansion valve 232 to increase the subcooling level of the outdoor heat exchanger 231 is not performed.

[0066] After step S101, the processing proceeds to step S102.

Step S102

[0067] The refrigerant amount determination unit 493 performs abnormality determination. The abnormality determination here corresponds to an abnormality determination in the normal state.

[0068] If the abnormality undetected is determined (step S102: abnormality undetected), the processing proceeds to step Sill. If the subcooling level large is determined (step S102: subcooling level large), the processing proceeds to step S131. If the expansion valve opening-degree large is determined (step S102: expansion valve opening-degree large), the processing proceeds to step S141.

Step Sill

[0069] The subcooling level regulation unit 492 increases the subcooling level of the outdoor heat exchanger 231 by closing the outdoor-side expansion valve 232.

[0070] After step Sill, the processing proceeds to step S112.

Step S112

[0071] The refrigerant amount determination unit 493 performs abnormality determination. The abnormality determination here corresponds to an abnormality determination after increasing the subcooling level.

[0072] If the expansion valve opening-degree large is determined (step S121: expansion valve opening-degree large), the processing proceeds to step S121. If either the abnormality undetected is determined or the subcooling level large is determined (step S121: abnormality undetected or the subcooling level large), the processing proceeds to step S131.

Step S121

[0073] The refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is appropriate.

[0074] After step S121, the control device 400 ends the processing illustrated in FIG. 5.

Step S131

[0075] The refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is excessive.

[0076] After step S131, the control device 400 ends the processing illustrated in FIG. 5.

Step S141

[0077] The refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is insufficient.

[0078] After step S141, the control device 400 ends the processing illustrated in FIG. 5.

[0079] FIG. 6 is a flowchart illustrating an example procedure in which the control device 400 increases the subcooling level of the outdoor heat exchanger 231. The control device 400 performs the processing illustrated in FIG. 6 in step Sill in FIG. 5.

Step S201

[0080] The information acquisition unit 491 acquires outdoor heat exchanger outlet temperature information from the outdoor heat exchanger outlet temperature sensor 292 via the communication unit 410. The outdoor heat exchanger outlet temperature information is the information indicating a measured temperature value of the outdoor heat exchanger outlet temperature sensor 292. The outdoor heat exchanger outlet temperature in-

formation indicates an outlet temperature of the outdoor heat exchanger 231 in the cooling cycle.

[0081] After step S201, the processing proceeds to step S202.

Step S202

[0082] The information acquisition unit 491 acquires outdoor heat exchanger pressure saturation temperature information from the high-pressure-side pressure sensor 291 via the communication unit 410. The outdoor heat exchanger pressure saturation temperature information is the information calculated from the measured pressure value of the high-pressure-side pressure sensor 291. This outdoor heat exchanger pressure saturation temperature information indicates the pressure saturation temperature in the outdoor heat exchanger 231.

[0083] After step S202, the processing proceeds to step S203.

Step S203

[0084] The information acquisition unit 491 calculates the subcooling level of the outdoor heat exchanger 231. Specifically, the refrigerant amount determination unit 493 calculates a difference between the outlet temperature of the outdoor heat exchanger 231 indicated by the outdoor heat exchanger outlet temperature information and the pressure saturation temperature indicated by the outdoor heat exchanger pressure saturation temperature information.

[0085] After step S203, the processing proceeds to step S204.

Step S204

[0086] The subcooling level regulation unit 492 sets a control target value for controlling the degree of opening of the outdoor-side expansion valve 232 based on the subcooling level acquired in step S203. For example, the subcooling level regulation unit 492 sets a target value for increasing the subcooling level of the outdoor heat exchanger 231 by a predetermined temperature.

[0087] After step S204, the processing proceeds to step S205.

Step S205

[0088] The subcooling level regulation unit 492 controls to reduce the degree of opening of the outdoor-side expansion valve 232. For example, the subcooling level regulation unit 492 reduces the degree of opening of the outdoor-side expansion valve 232 by a predetermined degree of opening.

[0089] After step S205, the processing proceeds to step S206.

Step S206

[0090] The subcooling level regulation unit 492 determines whether or not the target value set in step S204 is reached.

[0091] If the target value is determined to be not reached (step S206: NO), the processing returns to step S205. If the target value is determined to be reached (step S206: YES), the control device 400 ends the processing illustrated in FIG. 6.

[0092] The refrigerant amount determination unit 493 may determine whether or not the refrigerant amount is appropriate based on data at three or more subcooling levels.

[0093] FIG. 7 is a diagram illustrating an example criterion used when the refrigerant amount determination unit 493 determines whether or not the refrigerant amount is appropriate based on data at the three subcooling levels. In an example of FIG. 7, the refrigerant amount determination unit 493 determines the amount of the refrigerant charged in the air conditioning system main body 100 is appropriate, excessive, or insufficient based on abnormality determination results for a first subcooling level, a second subcooling level, and a third subcooling level.

[0094] The first subcooling level is the subcooling level in the normal state. Accordingly, the first subcooling level is the subcooling level in a state in which the control to close the outdoor-side expansion valve 232 to increase the subcooling level of the outdoor heat exchanger 231 is not performed. The second subcooling level is the subcooling level larger than the first subcooling level. The third subcooling level is the subcooling level larger than the second subcooling level.

[0095] In the example of FIG. 7, the subcooling level regulation unit 492 changes the subcooling level of the outdoor heat exchanger 231 to the first subcooling level, the second subcooling level, and the third subcooling level, respectively. The refrigerant amount determination unit 493 determines whether or not the refrigerant amount in the air conditioning system 1 is appropriate based on the degree of opening of the expansion valve subject to determination and the subcooling level of the outdoor heat exchanger 231 each for the first subcooling level, the second subcooling level, and the third subcooling level. Alternatively, the subcooling level regulation unit 492 may determine whether or not the refrigerant amount in the air conditioning system 1 is appropriate based on only the degree of opening of the expansion valve subject to determination. In other words, the subcooling level regulation unit 492 may determine without using the information of the subcooling level of the outdoor heat exchanger 231.

[0096] The example of FIG. 7 differs from the example of FIG. 4 in that the subcooling level regulation unit 492 changes the subcooling level of the outdoor heat exchanger 231 to the three levels, and that the refrigerant amount determination unit 493 determines by using the

criterion illustrated in FIG. 7 instead of using the criterion illustrated in FIG. 4. Others are the same as the example of FIG. 4.

[0097] In the example of FIG. 7, if the refrigerant amount determination unit 493 determines the abnormality undetected in the abnormality determination at the first subcooling level, determines the abnormality undetected in the abnormality determination at the second subcooling level, and determines the expansion valve opening-degree large in the abnormality determination at the third subcooling level, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is appropriate.

[0098] On the other hand, if the refrigerant amount determination unit 493 determines the abnormality undetected or the subcooling level large in the abnormality determination at the first subcooling level, determines the abnormality undetected or the subcooling level large in the abnormality determination at the second subcooling level, and determines the abnormality undetected in the abnormality determination at the third subcooling level, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is excessive.

[0099] In addition, if the refrigerant amount determination unit 493 determines the abnormality undetected or the expansion valve opening-degree large in the abnormality determination at the first subcooling level, determines the expansion valve opening-degree large in the abnormality determination at the second subcooling level, and determines the expansion valve opening-degree large in the abnormality determination at the third subcooling level, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is insufficient.

[0100] In particular, if the refrigerant amount determination unit 493 determines the subcooling level large in the abnormality determination at the first subcooling level, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is excessive in the same manner as described in the example in FIG. 4. In addition, if the refrigerant amount determination unit 493 determines the expansion valve opening-degree large in the abnormality determination at the first subcooling level, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is insufficient in the same manner as described in the example in FIG. 4.

[0101] The second subcooling level is the subcooling level set to distinguish, in particular, between the state in which the refrigerant amount is appropriate and the state in which the refrigerant amount is insufficient. The second subcooling level is set to a subcooling level smaller than the subcooling level after being increased as illustrated in the example in FIG. 4.

[0102] If the refrigerant amount determination unit 493 determines the expansion valve opening-degree large in the abnormality determination at the second subcooling level, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is insufficient in the same manner as the refrigerant amount determination unit 493 determined the expansion valve opening-degree large in the abnormality determination at the first subcooling level.

[0103] The third subcooling level is the subcooling level set to distinguish, in particular, between the state in which the refrigerant amount is appropriate and the state in which the refrigerant amount is excessive. The third subcooling level is set to a subcooling level equal to the subcooling level after being increased as illustrated in the example in FIG. 4.

[0104] If the refrigerant amount determination unit 493 determines the abnormality undetected in the abnormality determination at the third subcooling level, the refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is excessive in the same manner as described in the example in FIG. 4.

[0105] The refrigerant amount determination unit 493 may determine whether or not the refrigerant amount is appropriate based on the processing illustrated in FIG. 8.

[0106] FIG. 8 is a flowchart illustrating an example procedure in which the control device 400 determines whether or not the refrigerant amount is appropriate based on data at three subcooling levels.

[0107] Steps S301 to S302 are the same as steps S101 to S102 illustrated in FIG. 5. The abnormality determination in step S301 corresponds to the abnormality determination at the first subcooling level.

[0108] If the abnormality undetected is determined in step S302 (step S302: abnormality undetected), the processing proceeds to step S311. If the subcooling level large is determined (step S302: subcooling level large), the processing proceeds to step S341. If the expansion valve opening-degree large is determined (step S302: expansion valve opening-degree large), the processing proceeds to step S351.

Step S311

[0109] The subcooling level regulation unit 492 increases the subcooling level of the outdoor heat exchanger 231 by closing the outdoor-side expansion valve 232. The control device 400 performs the processing in step S311 illustrated in FIG. 6, whereby the subcooling level regulation unit 492 increases the subcooling level of the outdoor heat exchanger 231. In step S311, the subcooling level regulation unit 492 sets the subcooling level of the outdoor heat exchanger 231 to the second subcooling level.

[0110] After step S311, the processing proceeds to

step S312.

Step S312

[0111] The refrigerant amount determination unit 493 performs abnormality determination. The abnormality determination here corresponds to the abnormality determination at the second subcooling level.

[0112] If the abnormality undetected is determined (step S312: abnormality undetected), the processing proceeds to step S321. If the subcooling level large is determined (step S312: subcooling level large), the processing proceeds to step S341. If the expansion valve opening-degree large is determined (step S312: expansion valve opening-degree large), the processing proceeds to step S351.

Step S321

[0113] The subcooling level regulation unit 492 increases the subcooling level of the outdoor heat exchanger 231 by closing the outdoor-side expansion valve 232. The control device 400 performs the processing illustrated in FIG. 6 in step S321, whereby the subcooling level regulation unit 492 increases the subcooling level of the outdoor heat exchanger 231. In step S321, the subcooling level regulation unit 492 sets the subcooling level of the outdoor heat exchanger 231 to the third subcooling level.

[0114] After step S321, the processing proceeds to step S322.

Step S322

[0115] The refrigerant amount determination unit 493 performs abnormality determination. The abnormality determination here corresponds to the abnormality determination at the third subcooling level.

[0116] If the expansion valve opening-degree large is determined (step S322: expansion valve opening-degree large), the processing proceeds to step S331. If either the abnormality undetected is determined or the subcooling level large is determined (step S322: abnormality undetected or subcooling level large), the processing proceeds to step S341.

Step S331

[0117] The refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is appropriate.

[0118] After step S331, the control device 400 ends the processing illustrated in FIG. 8.

Step S341

[0119] The refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is excessive.

[0120] After step S341, the control device 400 ends the processing illustrated in FIG. 8.

Step S351

[0121] The refrigerant amount determination unit 493 determines that the amount of the refrigerant charged in the air conditioning system main body 100 is insufficient.

[0122] After step S351, the control device 400 ends the processing illustrated in FIG. 8.

[0123] As described above, the subcooling level regulation unit 492 increases the subcooling level of the outdoor heat exchanger 231. The refrigerant amount determination unit 493 determines whether or not the refrigerant amount in the air conditioning system 1 is appropriate based on the degree of opening of the expansion valve subject to determination before increasing the subcooling level and the degree of opening of the expansion valve subject to determination after increasing the subcooling level.

[0124] If the control device 400 determines whether or not the refrigerant amount in the air conditioning system 1 is appropriate based on only the information in a state in which the subcooling level of the outdoor heat exchanger 231 is not increased, it is impossible to determine how much amount of the refrigerant can be housed by the receiver tank 241 additionally.

[0125] When the control device 400 increases the subcooling level of the outdoor heat exchanger 231, the refrigerant is accumulated intentionally in the outdoor heat exchanger 231, and thus the refrigerant amount in the receiver tank 241 can be reduced. If the determination is performed in this state, the control device 400 can determine whether or not a sufficient amount of the refrigerant can be housed by the receiver tank 241 additionally in a state in which the subcooling level of the outdoor heat exchanger 231 is not increased. Therefore, the control device 400 can determine the possibility of the refrigerant overflowing from the receiver tank 241 when the refrigerant amount in the receiver tank 241 increases due to any environmental change or the like.

[0126] In this respect, the control device 400 can determine whether or not the refrigerant amount in the air conditioning system 1 is appropriate with higher accuracy in comparison with determining based on only the information in a state in which the subcooling level of the outdoor heat exchanger 231 is not increased.

[0127] The subcooling level regulation unit 492 is capable of increasing the subcooling level of the outdoor heat exchanger 231 by reducing the degree of opening of the outdoor-side expansion valve 232.

[0128] In addition, the refrigerant amount determination unit 493 determines whether or not the refrigerant amount in the air conditioning system 1 is appropriate based on the subcooling level of the outdoor heat exchanger 231 before increasing the subcooling level in addition to the degree of opening of the expansion valve

subject to determination.

[0129] This determination enables the refrigerant amount determination unit 493 to determine whether or not the refrigerant amount in the air conditioning system 1 is insufficient.

[0130] In addition, the subcooling level regulation unit 492 changes the subcooling level of the outdoor heat exchanger 231 to the first subcooling level, the second subcooling level, and the third subcooling level, respectively. The refrigerant amount determination unit 493 determines whether or not the refrigerant amount in the air conditioning system 1 is appropriate based on the degree of opening of the expansion valve subject to determination each for the first subcooling level, the second subcooling level, and the third subcooling level.

[0131] When the refrigerant amount in the receiver tank 241 reduces to some extent from the refrigerant amount in the normal state, the refrigerant amount determination unit 493 can determine whether or not the refrigerant amount is sufficient by using information at the second subcooling level. Accordingly, the refrigerant amount determination unit 493 can determine whether or not the refrigerant amount in the air conditioning system 1 is insufficient.

[0132] In addition, by using information at the third subcooling level, the refrigerant amount determination unit 493 can determine whether or not a sufficient amount of the refrigerant can be housed by the receiver tank 241 additionally in a state in which the subcooling level of the outdoor heat exchanger 231 is not increased as described above.

[0133] In this respect, the control device 400 achieves determination of whether or not the refrigerant amount in the air conditioning system 1 is appropriate with still higher accuracy.

[0134] Note that a program for implementing the whole or part of functions of the control unit 490 is recorded in a computer readable recording medium, and a computer system is caused to read and execute the program that is recorded in the recording medium to execute various processes. The "computer system" here includes hardware such as an operating system (OS) and peripheral equipment. In addition, if a world wide web (WWW) system is used, the "computer system" also includes a home page providing environment (or a display environment).

[0135] In addition, the "computer readable recording medium" refers to a portable medium such as a flexible disk, a magneto-optical disk, a read only memory (ROM), and a compact disc read-only memory (CD-ROM), or a storage device such as a hard disk built in a computer system. The above-described program may implement part of the functions as described above, and furthermore, also implement the functions as described above in combination with a program already recorded on the computer system.

[0136] The embodiment of the present invention has been described above in detail with reference to the drawings, but the specific configurations are not limited to the embodiment, and design changes and the like that do not depart from the scope of the present invention are also included.

Industrial Applicability

[0137] The embodiment of the present invention relates to a refrigerant amount determination device that includes an information acquisition unit, a subcooling level regulation unit, and a refrigerant amount determination unit. The information acquisition unit acquires expansion valve opening-degree information that indicates a degree of opening of an expansion valve subject to determination, the expansion valve being at least either one of an expansion valve in an indoor unit and an expansion valve on a side of a subcooling heat exchanger included in an air conditioning system. The subcooling level regulation unit increases a subcooling level of an outdoor heat exchanger included in the air conditioning system. The refrigerant amount determination unit determines whether or not the refrigerant amount in the air conditioning system is appropriate based on the degree of opening of the expansion valve subject to determination before increasing the subcooling level and the degree of opening of the expansion valve subject to determination after increasing the subcooling level.

[0138] According to the embodiment, determining whether or not the refrigerant amount in the air conditioning system is appropriate is achieved with higher accuracy.

Reference Signs List

[0139]

1 Air conditioning system
100 Air conditioning system main body
200 Outdoor unit
211 Compressor
212 Accumulator
221 Four-way valve
231 Outdoor heat exchanger
232 Outdoor-side expansion valve
241 Receiver tank
251 Subcooling heat exchanger
252 Subcooling-side expansion valve
291 High-pressure-side pressure sensor
292 Outdoor heat exchanger outlet temperature sensor
300 Indoor unit
311 Indoor heat exchanger
312 Indoor unit-side expansion valve
400 Control device
410 Communication unit
420 Operation input unit
430 Display unit
480 Storage unit
490 Control unit

491 Information acquisition unit
492 Subcooling level regulation unit
493 Refrigerant amount determination unit

Claims

1. A refrigerant amount determination device comprising:

   an information acquisition unit;
   a subcooling level regulation unit; and
   a refrigerant amount determination unit, wherein
   the information acquisition unit is configured to acquire expansion valve opening-degree information that indicates a degree of opening of an expansion valve subject to determination, the expansion valve being at least either one of an expansion valve in an indoor unit and an expansion valve on a side of a subcooling heat exchanger included in an air conditioning system;
   the subcooling level regulation unit is configured to increase a subcooling level of an outdoor heat exchanger included in the air conditioning system; and
   the refrigerant amount determination unit is configured to determine whether or not a refrigerant amount in the air conditioning system is appropriate based on a degree of opening of the expansion valve subject to determination before increasing the subcooling level and a degree of opening of the expansion valve subject to determination after increasing the subcooling level.

2. The refrigerant amount determination device according to claim 1, wherein
   the subcooling level regulation unit is configured to increase the subcooling level by reducing a degree of opening of an expansion valve on a side of an outdoor heat exchanger included in the air conditioning system.

3. The refrigerant amount determination device according to claim 1 or 2, wherein
   the refrigerant amount determination unit is configured to determine whether or not a refrigerant amount in the air conditioning system is appropriate further based on the subcooling level before being increased by the subcooling level regulation unit.

4. The refrigerant amount determination device according to any one of claims 1 to 3, wherein
   the subcooling level regulation unit is configured to change the subcooling level to a first subcooling level, a second subcooling level that is larger than the first subcooling level, and a third subcooling level that is larger than the second subcooling level, respectively; and
   the refrigerant amount determination unit is configured to determine whether or not a refrigerant amount in the air conditioning system is appropriate based on a degree of opening of the expansion valve subject to determination each for the first subcooling level, the second subcooling level, and the third subcooling level.

5. An air conditioning system comprising the refrigerant amount determination device according to any one of claims 1 to 4.

6. A refrigerant amount determination method comprising:

   increasing a subcooling level of an outdoor heat exchanger included in an air conditioning system; and
   determining whether or not a refrigerant amount in the air conditioning system is appropriate based on a degree of opening of an expansion valve subject to determination, the expansion valve being at least either one of an expansion valve in an indoor unit and an expansion valve on a side of a subcooling heat exchanger included in the air conditioning system before increasing a subcooling level, and the degree of opening of the expansion valve subject to determination after increasing the subcooling level.

7. A program configured to cause a computer, the computer configured to control an air conditioning system, to execute:

   increasing a subcooling level of an outdoor heat exchanger included in the air conditioning system; and
   determining whether or not a refrigerant amount in the air conditioning system is appropriate based on a degree of opening of an expansion valve subject to determination, the expansion valve being at least either one of an expansion valve in an indoor unit and an expansion valve on a side of a subcooling heat exchanger included in the air conditioning system before increasing a subcooling level, and the degree of opening of the expansion valve subject to determination after increasing the subcooling level.

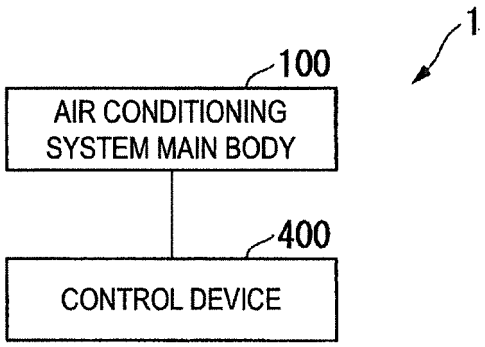

FIG. 1

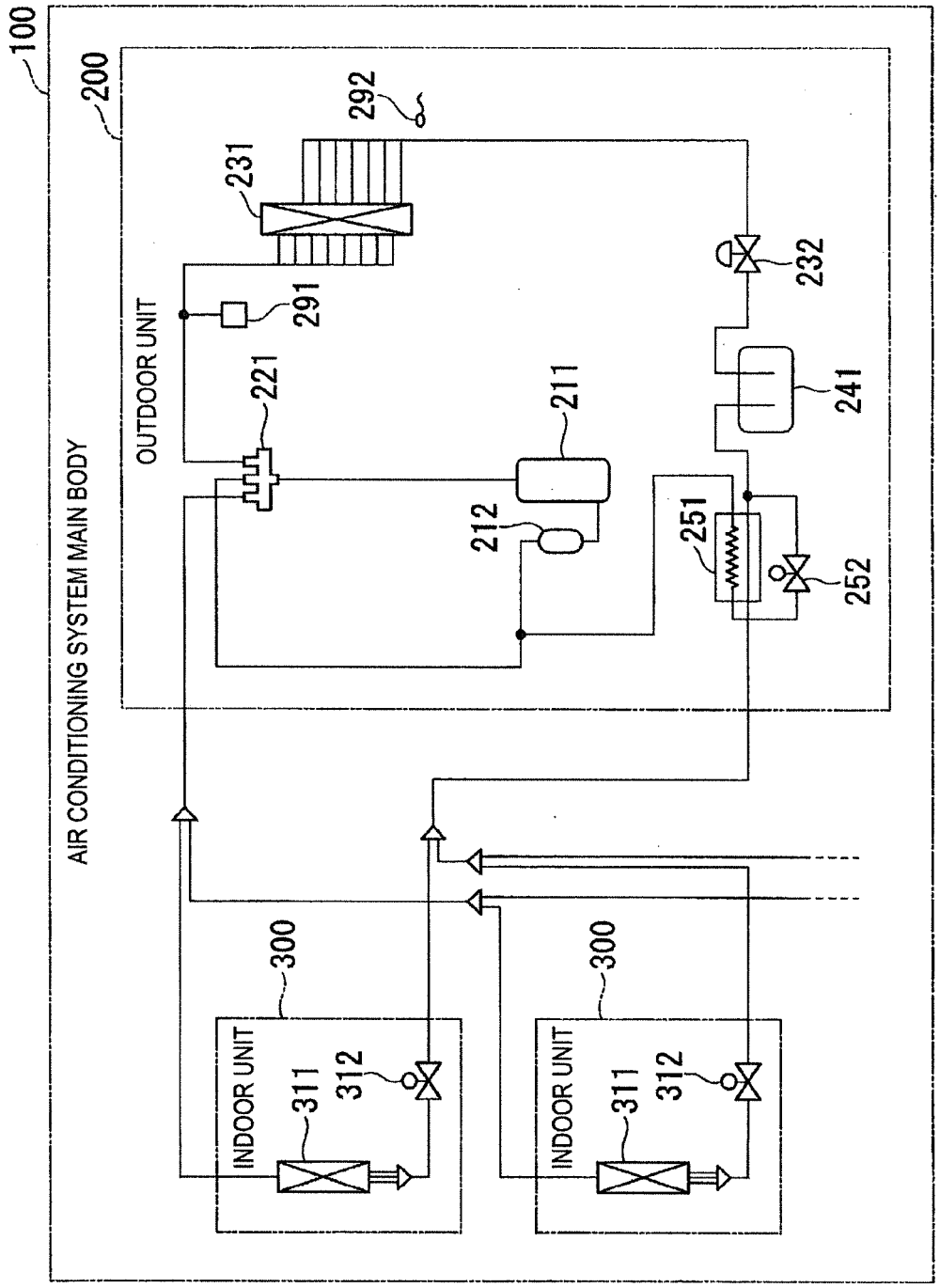
100
AIR CONDITIONING SYSTEM MAIN BODY
200
OUTDOOR UNIT
292
231
291
232
241
221
211
212
251
252
300
INDOOR UNIT
311
312
300
INDOOR UNIT
311
312

FIG. 2

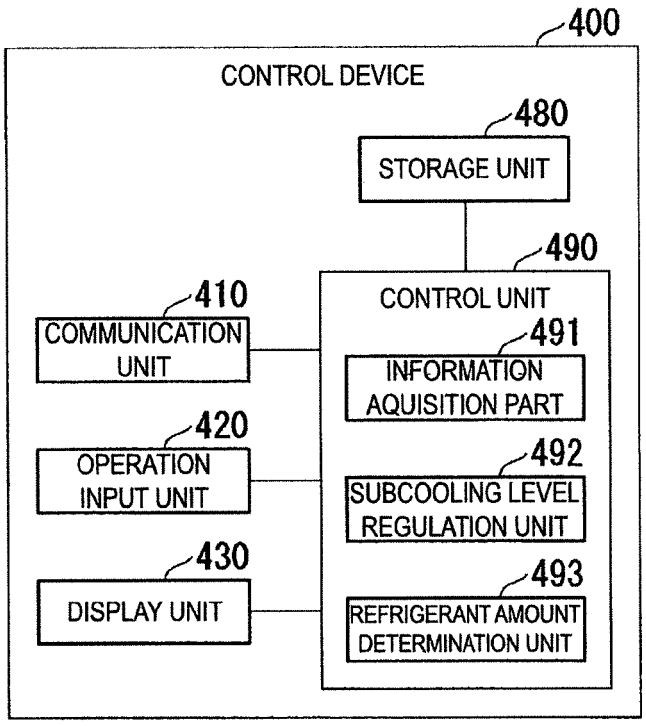

FIG. 3

CONTROL IN DETERMINATION	APPROPRIATE	EXCESSIVE	INSUFFICIENT
NORMAL	ABNORMALITY UNDETECTED	ABNORMALITY UNDETECTED OR SUBCOOLING LEVEL LARGE	EXPANSION VALVE OPENING-DEGREE LARGE
SUBCOOLING LEVEL INCREASED	EXPANSION VALVE OPENING-DEGREE LARGE	ABNORMALITY UNDETECTED	EXPANSION VALVE OPENING-DEGREE LARGE

FIG. 4

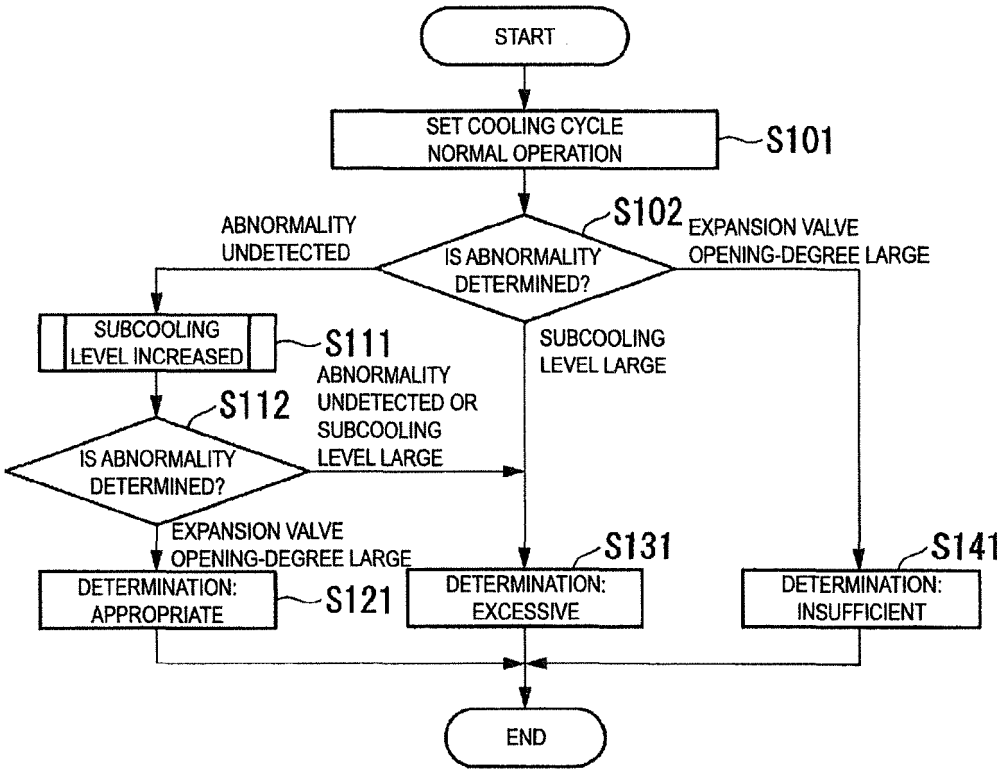
START
SET COOLING CYCLE NORMAL OPERATION
S101
S102
IS ABNORMALITY DETERMINED?
ABNORMALITY UNDETECTED
EXPANSION VALVE OPENING-DEGREE LARGE
SUBCOOLING LEVEL INCREASED
S111
SUBCOOLING LEVEL LARGE
S112
IS ABNORMALITY DETERMINED?
ABNORMALITY UNDETECTED OR SUBCOOLING LEVEL LARGE
EXPANSION VALVE OPENING-DEGREE LARGE
DETERMINATION: APPROPRIATE
S121
DETERMINATION: EXCESSIVE
S131
DETERMINATION: INSUFFICIENT
S141
END

FIG. 5

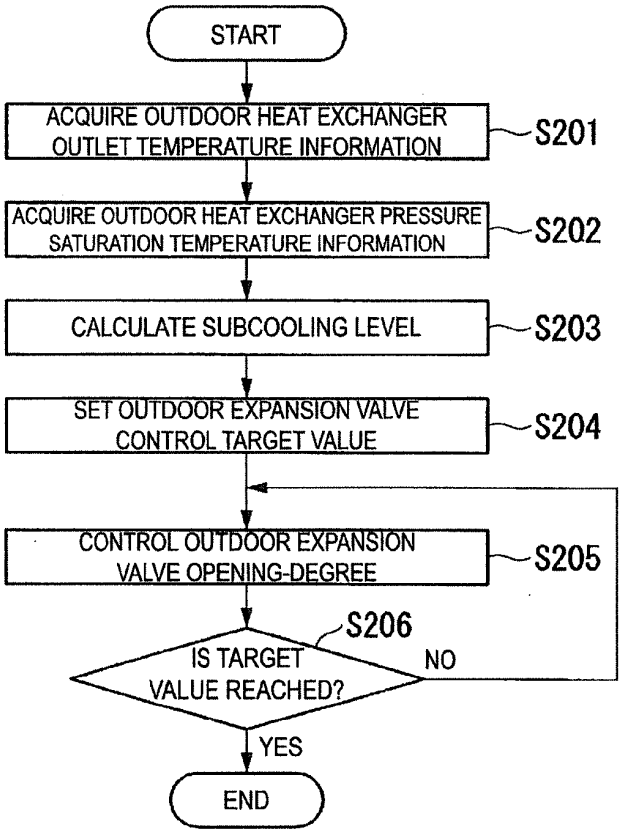

FIG. 6

CONTROL IN DETERMINATION	APPROPRIATE	EXCESSIVE	INSUFFICIENT
NORMAL (FIRST SUBCOOLING LEVEL)	ABNORMALITY UNDETECTED	ABNORMALITY UNDETECTED OR SUBCOOLING LEVEL LARGE	ABNORMALITY UNDETECTED OR EXPANSION VALVE OPENING-DEGREE LARGE
SUBCOOLING LEVEL INCREASED (SECOND SUBCOOLING LEVEL)	ABNORMALITY UNDETECTED	ABNORMALITY UNDETECTED OR SUBCOOLING LEVEL LARGE	EXPANSION VALVE OPENING-DEGREE LARGE
SUBCOOLING LEVEL INCREASED (THIRD SUBCOOLING LEVEL)	EXPANSION VALVE OPENING-DEGREE LARGE	ABNORMALITY UNDETECTED	EXPANSION VALVE OPENING-DEGREE LARGE

FIG. 7

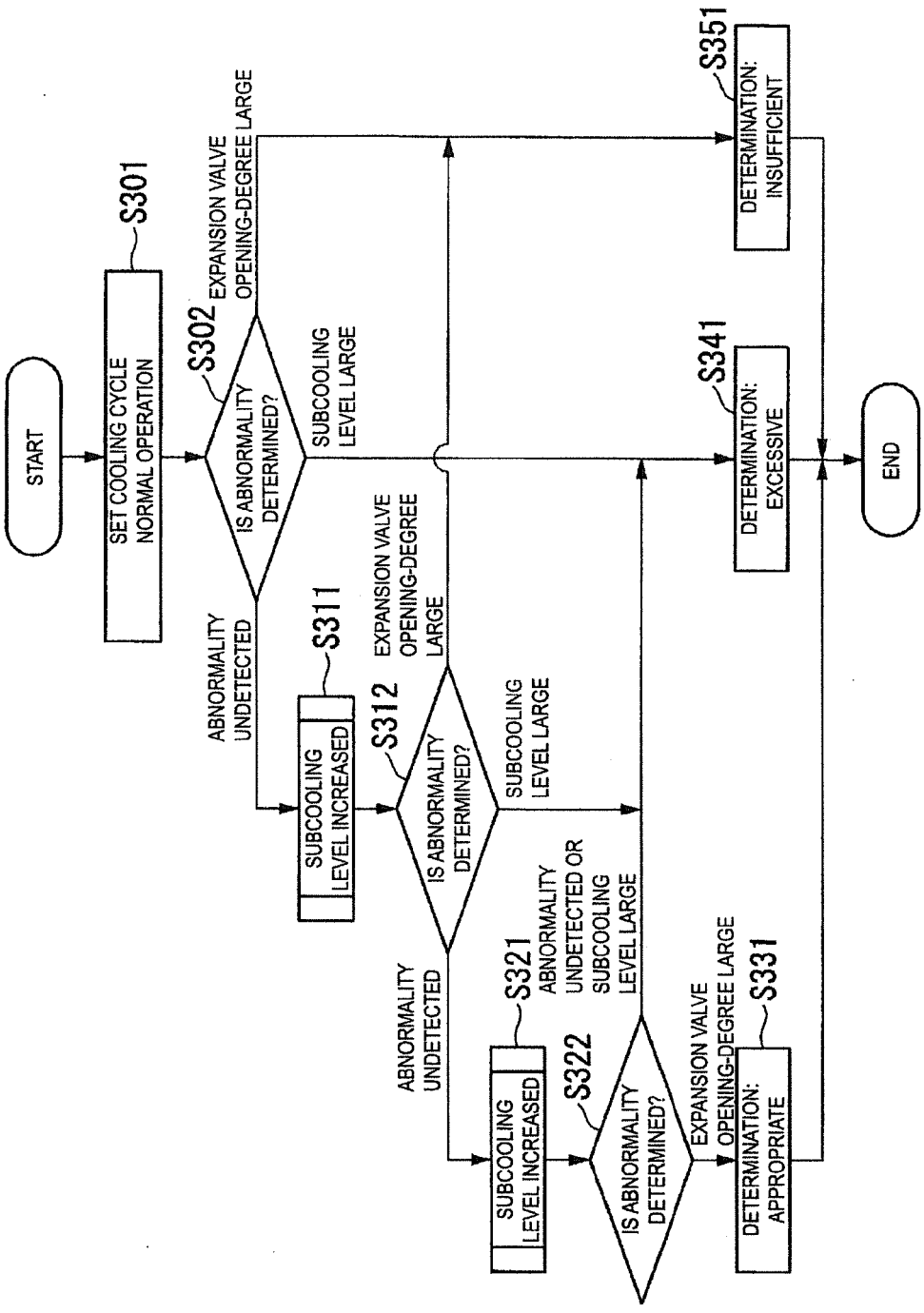
START
SET COOLING CYCLE NORMAL OPERATION
S301
S302
IS ABNORMALITY DETERMINED?
EXPANSION VALVE OPENING-DEGREE LARGE
SUBCOOLING LEVEL LARGE
ABNORMALITY UNDETECTED
S311
SUBCOOLING LEVEL INCREASED
S312
IS ABNORMALITY DETERMINED?
EXPANSION VALVE OPENING-DEGREE LARGE
SUBCOOLING LEVEL LARGE
ABNORMALITY UNDETECTED
S321
SUBCOOLING LEVEL INCREASED
S322
IS ABNORMALITY DETERMINED?
ABNORMALITY UNDETECTED OR SUBCOOLING LEVEL LARGE
EXPANSION VALVE OPENING-DEGREE LARGE
S331
DETERMINATION: APPROPRIATE
S341
DETERMINATION: EXCESSIVE
S351
DETERMINATION: INSUFFICIENT
END

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/003151

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F25B49/02(2006.01)i, F24F11/84(2018.01)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. F25B1/00-7/00, F25B13/00, F25B40/00-49/02, F24F11/84

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)
DWPI(Derwent Innovation), Japio-GPG/FX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2008-96051 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 24 April 2008, abstract, paragraph [0013] (Family: none)	1-7
A	JP 2015-140961 A (DENSO CORP.) 03 August 2015, paragraphs [0035]-[0041], [0046]-[0050], [0059]-[0060], [0072]-[0073], fig. 6 (Family: none)	1-7
A	JP 2016-65660 A (TOSHIBA CARRIER CORPORATION) 28 April 2016, paragraphs [0020]-[0021], [0027], [0032], [0040], fig. 1-2 (Family: none)	1-7
A	EP 2902728 A1 (VAILLANT GMBH) 05 August 2015, abstract, paragraphs [0017]-[0018] & DK 2902728 T	1-7

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 03 April 2018 (03.04.2018)	Date of mailing of the international search report 10 April 2018 (10.04.2018)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/003151

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 2000-266388 A (MITSUBISHI ELECTRIC CORP.) 29 September 2000, paragraph [0095] (Family: none)	1-7
A	JP 2002-257427 A (MITSUBISHI ELECTRIC CORP.) 11 September 2002, paragraphs [0028], [0033] (Family: none)	1-7
A	JP 2015-117853 A (FUJITSU GENERAL LTD.) 25 June 2015, paragraphs [0054]-[0060] (Family: none)	1-7
A	WO 2008/093538 A1 (DAIKIN INDUSTRIES, LTD.) 07 August 2008, paragraphs [0078]-[0079] & US 2010/0024454 A1, paragraphs [0100]-[0101] & EP 2144018 A1 & CN 101657686 A & AU 2008211449 A & KR 10-2009-0115173 A & CN 102080892 A	1-7

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 2017036852 A **[0002]**
- JP 2008096051 A **[0004]**