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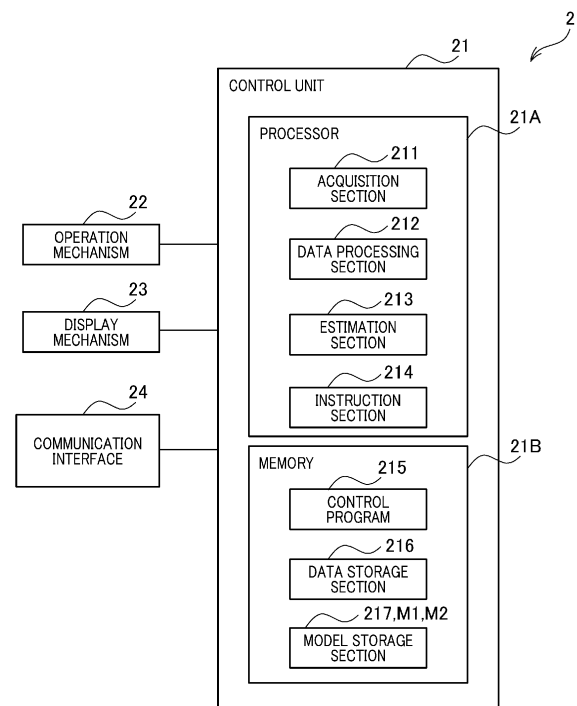
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(54) **AIR CONDITIONING SYSTEM AND METHOD FOR ESTIMATING REFRIGERANT LEAK IN AIR CONDITIONING SYSTEM**

(57) The present disclosure provides an air-conditioning management system that estimates whether or not a refrigerant leak occurs when there is a time frame during which a plurality of indoor units operate in different operation modes. An air-conditioning management system 1 includes a plurality of indoor units 40, an outdoor unit 50, a refrigerant circuit RC that allows a refrigerant to flow between the plurality of indoor units 40 and the outdoor unit 50, and a server device 2, wherein the server device 2 includes an acquisition section 211 that acquires indoor unit data DI on each of the plurality of indoor units 40, a data processing section 212 that performs a cleansing process on the indoor unit data DI, and an estimation section 213 that estimates, based on the indoor unit data DI subjected to the cleansing process, whether or not a refrigerant leak occurs, and the data processing section 212 deletes a portion of the indoor unit data DI corresponding to a time frame during which, of the plurality of indoor units 40, at least one indoor unit 40 performs cooling operation and at least one indoor unit 40 performs heating operation.

FIG.3



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present disclosure relates to an air conditioning system and a method for estimating a refrigerant leak in the air conditioning system.

Description of the Related Art

[0002] Japanese Patent Laid-Open No. 2021-156532 discloses a technique for estimating the amount of a refrigerant contained in an air conditioner, based on operation data on the air conditioner.

[0003] An object of the present disclosure is to provide an air conditioning system that properly estimates whether or not a refrigerant leak occurs in the air conditioning system including a plurality of indoor units when there is a time frame during which the individual indoor units operate in different operation modes.

SUMMARY OF THE INVENTION

[0004] An air conditioning system according to the present disclosure is an air conditioning system including: a plurality of indoor units; an outdoor unit; a refrigerant system that allows a refrigerant to flow between the plurality of indoor units and the outdoor unit; and a management device, wherein the management device includes an acquisition section that acquires operation data on each of the plurality of indoor units, a data processing section that performs a cleansing process on the operation data corresponding to each of the plurality of indoor units, and an estimation section that estimates, based on the operation data subjected to the cleansing process by the data processing section, whether or not a refrigerant leak occurs, and the data processing section deletes a portion of the operation data corresponding to a time frame during which, of the plurality of indoor units, at least one indoor unit performs cooling operation and at least one indoor unit performs heating operation.

[0005] A method for estimating a refrigerant leak in an air conditioning system according to the present disclosure is a method for estimating a refrigerant leak in an air conditioning system in which a plurality of indoor units is connected to refrigerant piping, the method including: an acquisition step of acquiring operation data on each of the plurality of indoor units; a data processing step of performing a cleansing process on the operation data acquired in the acquisition step; and an estimation step of estimating, based on the operation data subjected to the cleansing process, whether or not a refrigerant leak occurs, wherein the data processing step includes deleting a portion of the operation data corresponding to a time frame during which, of the plurality of indoor units, at least one indoor unit performs cooling operation and

at least one indoor unit performs heating operation.

[0006] According to the air conditioning system and the method for estimating a refrigerant leak in the air conditioning system of the present disclosure, it is possible to properly estimate whether or not a refrigerant leak occurs in the air conditioning system including a plurality of indoor units when there is a time frame during which the individual indoor units operate in different operation modes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Figure 1 shows an example of an air-conditioning management system in a present embodiment; Figure 2 shows an example of a refrigerant circuit including an indoor unit and an outdoor unit; Figure 3 shows an example of a configuration of a server device in the present embodiment; Figure 4 is a flowchart showing an example of a process by the server device in the present embodiment; Figure 5 shows an example of a cleansing process by the server device in the present embodiment; Figure 6 shows an example of a configuration of a first air conditioning system according to a first embodiment; Figure 7 shows an example of operation data acquired from the first air conditioning system; Figure 8 shows an example of a consolidation process in the first air conditioning system; Figure 9 shows an example of combined data in the first air conditioning system; Figure 10 shows an example of a configuration of a second air conditioning system according to a second embodiment; Figure 11 shows an example of operation data acquired from the second air conditioning system; and Figure 12 shows an example of combined data in the second air conditioning system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(Findings and the like that underlie the present disclosure)

[0008] Japanese Patent Laid-Open No. 2021-156532 discloses the following technique. Specifically, an air conditioner includes: an outdoor unit including a compressor, an outdoor heat exchanger, and an expansion valve; an indoor unit including an indoor heat exchanger; and a refrigerant circuit formed by the outdoor unit and the indoor unit being connected by refrigerant piping, the refrigerant circuit configured to be filled with a predetermined amount of a refrigerant. The air conditioner includes an estimation model that estimates, by using a current operation state amount of the air conditioner, the

ratio of refrigerant insufficiency to the predetermined amount of the refrigerant contained in the refrigerant circuit, and the estimation model varies according to the ratio of refrigerant insufficiency.

[0009] On the other hand, in air conditioning systems including a plurality of indoor units, operation data on the indoor units to be used to estimate a refrigerant leak varies from indoor unit to indoor unit. Accordingly, there has been a problem that, for example, when the individual indoor units operate in different operation modes, it is difficult for the technique according to Japanese Patent Laid-Open No. 2021-156532 to properly estimate whether or not a refrigerant leak occurs.

[0010] Accordingly, the inventors have found that it can be properly estimated whether or not a refrigerant leak occurs in an air conditioning system including a plurality of indoor units, by deleting operation data corresponding to a time frame during which, of the plurality of indoor units, at least one indoor unit performs cooling operation and at least one indoor unit performs heating operation.

[0011] The present disclosure provides an air conditioning system and a method for estimating a refrigerant leak in the air conditioning system that can properly estimate whether or not a refrigerant leak occurs in the air conditioning system including a plurality of indoor units.

[0012] Hereinafter, embodiments are described in detail with reference to the drawings. However, an unnecessarily detailed description is omitted in some cases. For example, a detailed description of already well-known matters, or a repeated description of the substantially same configurations, is omitted in some cases.

[0013] Note that the accompanying drawings and the following description are provided to help persons skilled in the art fully understand the present disclosure, and it is not intended that the subject matters according to claims are limited by the drawings and the following description.

[1. Configuration of air-conditioning management system]

[0014] Figure 1 shows an example of an air-conditioning management system 1 in a present embodiment. As shown in Figure 1, the air-conditioning management system 1 includes a server device 2, an air conditioning system 3, and a smartphone 6.

[0015] The air-conditioning management system 1 corresponds to "air conditioning system".

[0016] The air-conditioning management system 1 according to the present embodiment includes a first air-conditioning management system 1A according to a first embodiment and a second air-conditioning management system 1B according to a second embodiment.

[0017] The first air-conditioning management system 1A will be further described with reference to Figures 6 to 9.

[0018] The second air-conditioning management system 1B will be further described with reference to Figures

10 to 12.

[0019] First, with reference to Figures 1 to 5, a description is given of components that are common to the first air-conditioning management system 1A according to the first embodiment and the second air-conditioning management system 1B according to the second embodiment.

[0020] The server device 2 is communicably connected to each of a control device 30 of the air conditioning system 3 and the smartphone 6 through a network NW. The network NW is, for example, a WAN (Wide Area Network).

[0021] Although a case is described in which the network NW is a WAN in the present embodiment, the present disclosure is not limited thereto. The network NW may be a LAN (Local Area Network), or may be the Internet.

[0022] The air conditioning system 3 includes the control device 30, indoor unit 40, outdoor unit 50, and a refrigerant circuit RC. The air conditioning system 3 is installed, for example, in an office in a building.

[0023] The indoor unit 40 is disposed, for example, on a ceiling of a room of the office. The indoor unit 40 includes a plurality of indoor units 40. An operation state of each of the plurality of indoor units 40 is set independently. The operation state includes a selected state of operate/stop and an operation state mode. Operation state modes include cooling operation, heating operation, dehumidification operation, and the like.

[0024] Each indoor unit 40 includes an indoor heat exchanger 41. The indoor heat exchanger 41 transfers heat between indoor air and a refrigerant. The air subjected to heat exchange is blown out of an undepicted outlet. When the operation state mode is the cooling operation, the air subjected to heat exchange has a lower temperature than indoor air. When the operation state mode is the heating operation, the air subjected to heat exchange has a higher temperature than indoor air.

[0025] The indoor heat exchanger 41 will be further described with reference to Figure 2.

[0026] In the present embodiment, a case is described in which the indoor unit 40 includes three indoor units 40. For example, the indoor unit 40 includes an indoor unit 40A, an indoor unit 40B, and an indoor unit 40C. The indoor units 40A, 40B, and 40C have approximately the same configurations. Accordingly, in the following description, each of the indoor units 40A, 40B, and 40C is referred to as "indoor unit 40" in some cases where it is not necessary to make a distinction among the indoor units 40A, 40B, and 40C.

[0027] The outdoor unit 50 is disposed, for example, on a balcony outside of the room of the office. The outdoor unit 50 may be disposed, for example, on a rooftop of the building in which the office is located.

[0028] The outdoor unit 50 includes a compressor 51, a four-way valve 52, an outdoor heat exchanger 53, and an expansion valve 54. The compressor 51, the four-way valve 52, the outdoor heat exchanger 53, and the expansion

sion valve 54 will be further described with reference to Figure 2.

[0029] The outdoor unit 50 may include a plurality of outdoor units 50. In the first embodiment, which will be described with reference to Figures 6 to 9, a case is described in which the number of the outdoor units 50 is one. In the second embodiment, which will be described with reference to Figures 10 to 12, a case is described in which the number of the outdoor units 50 is two. The two outdoor units 50 include, for example, an outdoor unit 50A and an outdoor unit 50B. The outdoor units 50A and 50B have approximately the same configurations. Accordingly, in the following description, each of the outdoor units 50A and 50B is referred to as "outdoor unit 50" in some cases where it is not necessary to make a distinction between the outdoor units 50A and 50B.

[0030] In the present embodiment, for the first air-conditioning management system 1A according to the first embodiment, the case where the number of the outdoor units 50 is one is described, and for the second air-conditioning management system 1B according to the second embodiment, the case where the number of the outdoor units 50 is two is described. In the second air-conditioning management system 1B according to the second embodiment, the outdoor unit 50 includes the outdoor units 50A and 50B.

[0031] The control device 30 is configured, for example, by using an embedded system or the like equipped with a personal computer and a real-time OS, and controls the indoor unit 40 and the outdoor unit 50. The control device 30 controls the indoor unit 40 and the outdoor unit 50, for example, depending on the operation state mode. The control device 30 controls behavior of the refrigerant circuit RC, which will be described with reference to Figure 2, depending on the operation state mode.

[0032] Moreover, the control device 30 acquires operation data from the indoor unit 40 and the outdoor unit 50 and transmits the operation data to the server device 2. For example, in each predetermined period, the control device 30 acquires operation data from the indoor unit 40 and the outdoor unit 50 and transmits the operation data to the server device 2. The predetermined period is, for example, 10 seconds. The predetermined period may be, for example, one minute.

[0033] Further, the control device 30 causes the indoor unit 40 and the outdoor unit 50 to perform the cooling operation or the heating operation, according to an instruction from the server device 2.

[0034] The server device 2 receives operation data on the indoor unit 40 and the outdoor unit 50 from the control device 30. The server device 2 estimates, based on the operation data on the indoor unit 40 and the outdoor unit 50, whether or not a refrigerant leak occurs. The server device 2 transmits, to the smartphone 6, a result of the estimation of whether or not a refrigerant leak occurs.

[0035] The server device 2 corresponds to an example of "management device".

[0036] The smartphone 6 receives, from the server de-

vice 2, a result of estimation of whether or not a refrigerant leak occurs. For example, the smartphone 6 displays, on a touch panel, the result of estimation of whether or not a refrigerant leak occurs. Note that the smartphone 6 is held by, for example, a manager of the air conditioning system 3. The smartphone 6 may be held by, for example, a user of the air conditioning system 3.

[2. Refrigerant circuit]

[0037] Next, with reference to Figure 2, the refrigerant circuit RC is described. Figure 2 shows an example of the refrigerant circuit RC including the indoor unit 40 and the outdoor unit 50. A solid arrow indicates a direction in which the refrigerant flows when the cooling operation is performed. A dashed arrow indicates a direction in which the refrigerant flows when the heating operation is performed. Note that for the purpose of convenience, Figure 2 describes the refrigerant circuit RC including one indoor unit 40 and one outdoor unit 50.

[0038] The refrigerant circuit RC corresponds to an example of "refrigerant system".

[0039] The indoor unit 40 includes the indoor heat exchanger 41. The outdoor unit 50 includes the compressor 51, the four-way valve 52, the outdoor heat exchanger 53, and the expansion valve 54.

[0040] The compressor 51 compresses the refrigerant. The high-temperature and high-pressure refrigerant compressed by the compressor 51 flows into the four-way valve 52.

[0041] The four-way valve 52 changes a flowing path of the refrigerant. When the cooling operation is performed, the four-way valve 52 supplies the high-temperature and high-pressure refrigerant flowed out of the compressor 51 to the outdoor heat exchanger 53. The refrigerant flowed out of the outdoor heat exchanger 53 is supplied to the indoor heat exchanger 41 after sequentially passing through the outdoor heat exchanger 53 and the expansion valve 54. Then, the four-way valve 52 supplies the refrigerant flowed out of the indoor heat exchanger 41 to the compressor 51. When the heating operation is performed, the four-way valve 52 supplies the high-temperature and high-pressure refrigerant flowed out of the compressor 51 to the indoor heat exchanger 41. The refrigerant flowed out of the indoor heat exchanger 41 is supplied to the outdoor heat exchanger 53 via the expansion valve 54. The four-way valve 52 supplies the refrigerant flowed out of the outdoor heat exchanger 53 to the compressor 51.

[0042] The outdoor heat exchanger 53 transfers heat between outdoor air and the refrigerant.

[0043] The expansion valve 54 decompresses the refrigerant.

[0044] Next, a description is given of the behavior of the refrigerant circuit RC when the cooling operation is performed.

[0045] The compressor 51 compresses the refrigerant and thus creates the high-temperature and high-pres-

sure refrigerant. The high-temperature and high-pressure refrigerant flowed out of the compressor 51 is supplied to the outdoor heat exchanger 53 by the four-way valve 52. The outdoor heat exchanger 53 releases heat of the high-temperature and high-pressure refrigerant into outdoor air and thus condenses the refrigerant. In other words, the outdoor heat exchanger 53 functions as a condenser. The refrigerant condensed at the outdoor heat exchanger 53 is supplied to the expansion valve 54. The expansion valve 54 decompresses the refrigerant. The refrigerant decompressed at the expansion valve 54 is supplied to the indoor heat exchanger 41. The indoor heat exchanger 41 transfers heat between the refrigerant and indoor air and thus evaporates the refrigerant. In other words, the indoor heat exchanger 41 functions as an evaporator. Then, the evaporated refrigerant is supplied to the compressor 51 by the four-way valve 52.

[0046] As described above, when the cooling operation is performed, the outdoor heat exchanger 53 functions as a condenser, and the indoor heat exchanger 41 functions as an evaporator.

[0047] Next, a description is given of the behavior of the refrigerant circuit RC when the heating operation is performed.

[0048] The compressor 51 compresses the refrigerant and thus creates the high-temperature and high-pressure refrigerant. The high-temperature and high-pressure refrigerant flowed out of the compressor 51 is supplied to the indoor heat exchanger 41 by the four-way valve 52. The indoor heat exchanger 41 transfers heat between the refrigerant and indoor air and thus condenses the refrigerant. In other words, the indoor heat exchanger 41 functions as a condenser. The refrigerant condensed at the indoor heat exchanger 41 is supplied to the expansion valve 54. The expansion valve 54 decompresses the refrigerant. The refrigerant decompressed at the expansion valve 54 is supplied to the outdoor heat exchanger 53. The outdoor heat exchanger 53 transfers heat between the low-pressure refrigerant and outdoor air and evaporates the refrigerant by using heat absorbed from outdoor air. In other words, the outdoor heat exchanger 53 functions as an evaporator. The evaporated refrigerant is supplied to the compressor 51 by the four-way valve 52.

[0049] As described above, when the heating operation is performed, the indoor heat exchanger 41 functions as a condenser, and the outdoor heat exchanger 53 functions as an evaporator.

[0050] Next, with reference to Figure 2, an example of sensor arrangement is described.

[0051] A temperature sensor E1, which detects an evaporation saturation temperature LP of the refrigerant when the cooling operation is performed, is disposed at the indoor heat exchanger 41, and a temperature sensor E2 is disposed upstream of the indoor heat exchanger 41 when the cooling operation is performed.

[0052] A temperature sensor DIS1, which detects a temperature of a medium discharged from the compres-

sor 51, is disposed at the compressor 51. Moreover, a current sensor CT1, which detects a primary current supplied to the compressor 51, a current sensor CT2, which detects a secondary current supplied to the compressor 51, and a rotational speed sensor HZ, which detects a rotational speed of the compressor 51, are disposed at the compressor 51. Further, a temperature sensor TS, which detects a refrigerant temperature SCT, is disposed upstream of the compressor 51.

[0053] A temperature sensor OT, which detects an outdoor air temperature, a temperature sensor C2, which detects a temperature inside the outdoor heat exchanger 53, and a temperature sensor C1, which detects a refrigerant temperature at a discharging side of the outdoor heat exchanger 53 when the cooling operation is performed, are disposed at the outdoor heat exchanger 53. The temperature sensor C1 detects a condensation saturation temperature HP of the refrigerant when the cooling operation is performed.

[0054] An opening degree sensor MOV, which detects an opening degree of the expansion valve, is disposed at the expansion valve 54.

[3. Configuration of server device]

[0055] Next, with reference to Figure 3, a configuration of the server device 2 is described. Figure 3 shows an example of the configuration of the server device 2 in the present embodiment. As shown in Figure 3, the server device 2 includes a control unit 21, an operation mechanism 22, a display mechanism 23, and a communication interface 24.

[0056] The control unit 21 includes a processor 21A, such as a CPU (Central Processing Unit) or an MPU (Micro-Processing Unit), and a memory device 21B, such as a ROM (Read Only Memory) or a RAM (Random Access Memory), and controls each part of the server device 2. The memory device 21B stores a control program 215. The memory device 21B may include a magnetic storage device, such as an HDD (Hard Disk Drive), or a semiconductor storage device, such as an SSD (Solid State Drive).

[0057] In the control unit 21, the processor 21A reads the control program 215 stored in the memory device 21B and executes a process. In other words, the control unit 21 executes a process through cooperation between hardware and software.

[0058] The processor 21A may be configured by using a single processor, or may be configured by a plurality of processors functioning as the processor 21A.

[0059] Although the processor 21A controls each part of the server device 2 by executing the control program 215 in the present embodiment, the present disclosure is not limited thereto. For example, the control unit 21 may include an ASIC (Application Specific Integrated Circuit), and the ASIC may execute a process by using packaged functionality. For example, the control unit 21 may include a signal processing circuit, and the signal

processing circuit may execute a process by performing signal processing.

[0060] The operation mechanism 22 includes input means such as a key board and a mouse connected to the server device 2, detects an operation performed on or with the input means by a user, and outputs a detection signal corresponding to the operation to the control unit 21. The control unit 21, based on the input from the operation mechanism 22, executes a process corresponding to the user operation. The user is, for example, a manager of the server device 2.

[0061] The display mechanism 23 includes a plurality of LEDs (Light Emitting Diodes), an LCD (Liquid Crystal Display), or the like, and performs lighting-up of, extinguishing lights on, and blinking of the LEDs in a predetermined form, display of information on the LCD, or the like, in accordance with control by the control unit 21.

[0062] The communication interface 24 includes a connector and an interface circuit and is connected to the control unit 21.

[0063] The communication interface 24 is an interface for communicating with the control device 30, for example, in accordance with the Ethernet(R) standard.

[0064] Moreover, the communication interface 24 is an interface for communicating with the smartphone 6, for example, in accordance with the Ethernet(R) standard. The communication interface 24 communicates with the smartphone 6 through the network NW. The communication interface 24 communicates with the network NW in accordance with the Ethernet(R) standard, and the smartphone 6 communicates with an undepicted relay station deployed in the network NW, for example, in accordance with the Wi-Fi(R) standard.

[0065] Next, a functional configuration of the control unit 21 is described.

[0066] The control unit 21 includes an acquisition section 211, a data processing section 212, an estimation section 213, an instruction section 214, a data storage section 216, and a model storage section 217.

[0067] For example, the processor 21A functions as the acquisition section 211, the data processing section 212, the estimation section 213, and the instruction section 214 by executing the control program 215. For example, the processor 21A causes the memory device 21B to function as the data storage section 216 and the model storage section 217 by executing the control program 215.

[0068] The data storage section 216 stores indoor unit data DI and outdoor unit data DO. The indoor unit data DI includes data indicating an operation state of each indoor unit 40, and detection values of the sensors disposed in each indoor unit 40. The operation state includes the selected state of operate/stop and the operation state mode. The operation state modes include the cooling operation, the heating operation, the dehumidification operation, and the like.

[0069] The outdoor unit data DO includes detection values of the sensors disposed in the outdoor unit 50, or

detection values of the sensors disposed in each of the two outdoor units 50.

[0070] The indoor unit data DI and the outdoor unit data DO are acquired from the control device 30 of the air conditioning system 3 by the acquisition section 211, and stored in the data storage section 216 by the acquisition section 211.

[0071] The indoor unit data DI corresponds to an example of "operation data on a plurality of indoor units".

[0072] The outdoor unit data DO corresponds to an example of "operation data on an outdoor unit".

[0073] Moreover, the data storage section 216 stores consolidated indoor unit data DIV, which is generated as indoor unit data on one virtual indoor unit by consolidating indoor unit data DI1 on the indoor unit 40A, indoor unit data DI2 on the indoor unit 40B, and indoor unit data DI3 on the indoor unit 40C. The consolidated indoor unit data DIV is generated by the data processing section 212 and stored in the data storage section 216 by the data processing section 212.

[0074] The consolidated indoor unit data DIV corresponds to an example of "consolidated operation data".

[0075] Further, the data storage section 216 stores combined data DN, which is generated by combining the consolidated indoor unit data DIV and the outdoor unit data DO. The combined data DN is generated by the data processing section 212 and stored in the data storage section 216 by the data processing section 212.

[0076] The model storage section 217 stores a first estimation model M1 and a second estimation model M2. The first estimation model M1 is generated by using the consolidated indoor unit data DIV and the outdoor unit data DO for a period during which each of the three indoor units 40 performs the cooling operation. In other words, the first estimation model M1 is generated by using the combined data DN in the period during which each of the three indoor units 40 performs the cooling operation.

[0077] The second estimation model M2 is generated by using the consolidated indoor unit data DIV and the outdoor unit data DO for a period during which each of the three indoor units 40 performs the heating operation. In other words, the second estimation model M2 is generated by using the combined data DN in the period during which each of the three indoor units 40 performs the heating operation.

[0078] Note that each of the first estimation model M1 and the second estimation model M2 is generated, for example, by using logistic regression analysis.

[0079] In the present embodiment, a case is described in which the first estimation model M1 and the second estimation model M2 are generated beforehand and are stored in the model storage section 217 beforehand. Note that the first estimation model M1 is generated, for example, by using a large quantity of the consolidated indoor unit data DIV and the outdoor unit data DO (so-called big data) for a period during which the cooling operation is performed in various air conditioning systems 3 including the first air conditioning system 3A, which will

be described with reference to Figure 6, and the second air conditioning system 3B, which will be described with reference to Figure 10. The second estimation model M2 is generated, for example, by using a large quantity of the consolidated indoor unit data DIV and the outdoor unit data DO (so-called big data) for a period during which the heating operation is performed in various air conditioning systems 3 including the first air conditioning system 3A, which will be described with reference to Figure 6, and the second air conditioning system 3B, which will be described with reference to Figure 10.

[0080] The acquisition section 211 acquires the indoor unit data DI on each of the three indoor units 40. For example, the acquisition section 211 acquires the indoor unit data DI1 from the indoor unit 40A, acquires the indoor unit data DI2 from the indoor unit 40B, and acquires the indoor unit data DI3 from the indoor unit 40C.

[0081] In the present embodiment, the acquisition section 211 acquires the indoor unit data DI via the control device 30. In other words, the control device 30 acquires the indoor unit data DI on each of the three indoor units 40. The control device 30 transmits the acquired indoor unit data DI to the server device 2. The acquisition section 211 acquires the indoor unit data DI by receiving the indoor unit data DI from the control device 30.

[0082] The acquisition section 211 acquires the outdoor unit data DO from the outdoor unit 50. In the present embodiment, the acquisition section 211 acquires the outdoor unit data DO via the control device 30. In other words, the control device 30 acquires the outdoor unit data DO from the outdoor unit 50. The control device 30 transmits the acquired outdoor unit data DO to the server device 2. The acquisition section 211 acquires the outdoor unit data DO by receiving the outdoor unit data DO from the control device 30.

[0083] The data processing section 212 executes a following process on the indoor unit data DI and the outdoor unit data DO for a predetermined period PA. The predetermined period PA is, for example, one hour. The predetermined period PA may be, for example, 30 minutes. In the present embodiment, a case is described in which the predetermined period PA is one hour.

[0084] The predetermined period PA corresponds to an example of "time frame".

[0085] For example, when the predetermined period PA is a period between 09:00 and 10:00, the indoor unit data DI for the predetermined period PA is, for example, the indoor unit data DI that is acquired by the control device 30 from the indoor units 40 at times between 09:00 and 10:00. The outdoor unit data DO for the predetermined period PA is the outdoor unit data DO that is acquired by the control device 30 from the outdoor unit 50 at times between 09:00 and 10:00.

[0086] Based on the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, the data processing section 212 determines, for each predetermined period PA, whether or not the three indoor units 40 are in a "cooling-heating mixed state". The "cooling-

heating mixed state" indicates that, of the three indoor units 40, at least one indoor unit 40 is performing the cooling operation and at least one indoor unit 40 is performing the heating operation.

[0087] When it is determined that the indoor units 40 are in the "cooling-heating mixed state", the data processing section 212 deletes the indoor unit data DI1, the indoor unit data DI2, the indoor unit data DI3, and the outdoor unit data DO corresponding to the predetermined period PA.

[0088] Note that in the present embodiment, for the purpose of convenience, the process of deleting the indoor unit data DI and the outdoor unit data DO corresponding to a predetermined period PA when it is determined that the indoor units 40 are in the "cooling-heating mixed state", is described as part of a cleansing process.

[0089] When each of the three indoor units 40 performs the cooling operation, the data processing section 212 determines that the state of the indoor units 40 is a cooling operation state and thus determines that the state of the indoor units 40 is not the cooling-heating mixed state. When each of the three indoor units 40 performs the heating operation, the data processing section 212 determines that the state of the indoor units 40 is a heating operation state and thus determines that the state of the indoor units 40 is not the cooling-heating mixed state.

[0090] Moreover, the data processing section 212 performs the following cleansing process on the indoor unit data DI and the outdoor unit data DO in a first period P1.

[0091] The first period P1 is a target period for which the estimation section 213 estimates whether or not a refrigerant leak occurs. In other words, the estimation section 213 estimates whether or not a refrigerant leak occurs, based on the indoor unit data DI and the outdoor unit data DO in the first period P1. The first period P1 is, for example, three hours. The first period P1 may be, for example, four hours. Note that the first period P1 is longer than the predetermined period PA. For example, the first period P1 is an integral multiple that is two or more times the predetermined period PA. The first period P1 is, for example, three times the predetermined period PA. In the present embodiment, a case is described in which the first period P1 is three hours.

[0092] In the present embodiment, the "cleansing process" is a process of deleting operation data that is inappropriate for operation data to be used when the estimation section 213 estimates whether or not a refrigerant leak occurs. Note that the operation data to be deleted is at least one of the indoor unit data DI and the outdoor unit data DO. In other words, the operation data to be deleted is at least one of the indoor unit data DI1, the indoor unit data DI2, the indoor unit data DI3, and the outdoor unit data DO.

[0093] The data processing section 212 deletes the indoor unit data DI corresponding to an indoor unit 40, of the three indoor units 40, that performs the cooling operation for a time period that is equal to or longer than a first time length H1 and performs the heating operation

for a time period that is equal to or longer than the first time length H1 during the first period P1.

[0094] The first time length H1 is shorter than a half of the first period P1. The first time length H1 is, for example, one hour. The first time length H1 may be, for example,

[0095] For example, when the time period for which the indoor unit 40A performs the cooling operation is the first time length H1 or more and the time period for which the indoor unit 40A performs the heating operation is the first time length H1 or more in the first period P1, the data processing section 212 deletes the indoor unit data D11 corresponding to the first period P1.

[0096] For example, when the time period for which the indoor unit 40B performs the cooling operation is the first time length H1 or more and the time period for which the indoor unit 40B performs the heating operation is the first time length H1 or more in the first period P1, the data processing section 212 deletes the indoor unit data D12 corresponding to the first period P1.

[0097] For example, when the time period for which the indoor unit 40C performs the cooling operation is the first time length H1 or more and the time period for which the indoor unit 40C performs the heating operation is the first time length H1 or more in the first period P1, the data processing section 212 deletes the indoor unit data D13 corresponding to the first period P1.

[0098] Moreover, in the indoor unit data DI corresponding to an indoor unit 40, of the three indoor units 40, that performs the cooling operation for a time period that is equal to or longer than a second time length H2 and performs the heating operation for a time period that is not more than a third time length H3, which is shorter than the second time length, during the first period P1, the data processing section 212 deletes a portion of the indoor unit data DI corresponding to the time period for which the heating operation is performed.

[0099] The second time length H2 is shorter than the first period P1. The second time length H2 is, for example, two hours. The second time length H2 may be, for example, 1.5 hours.

[0100] The third time length H3 is shorter than the second time length H2. The third time length H3 is shorter than a half of the first period P1. The third time length H3 is, for example, one hour. The third time length H3 may be, for example, 0.5 hours.

[0101] For example, when the time period for which the indoor unit 40A performs the cooling operation is the second time length H2 or more and the time period for which the indoor unit 40A performs the heating operation is not more than the third time length H3, which is shorter than the second time length, in the first period P1, the data processing section 212 deletes the indoor unit data D11 corresponding to the time period for which the heating operation is performed.

[0102] For example, when the time period for which the indoor unit 40B performs the cooling operation is the second time length H2 or more and the time period for

which the indoor unit 40B performs the heating operation is not more than the third time length H3, which is shorter than the second time length, in the first period P1, the data processing section 212 deletes the indoor unit data D12 corresponding to the time period for which the heating operation is performed.

[0103] For example, when the time period for which the indoor unit 40C performs the cooling operation is the second time length H2 or more and the time period for which the indoor unit 40C performs the heating operation is not more than the third time length H3, which is shorter than the second time length, in the first period P1, the data processing section 212 deletes the indoor unit data D13 corresponding to the time period for which the heating operation is performed.

[0104] Further, in the indoor unit data DI corresponding to an indoor unit 40, of the three indoor units 40, that performs the heating operation for a time period that is equal to or longer than the second time length H2 and performs the cooling operation for a time period that is not more than the third time length, which is shorter than the second time length, during the first period P1, the data processing section 212 deletes a portion of the indoor unit data DI corresponding to the time period for which the cooling operation is performed.

[0105] For example, when the time period for which the indoor unit 40A performs the heating operation is the second time length H2 or more and the time period for which the indoor unit 40A performs the cooling operation is not more than the third time length, which is shorter than the second time length, in the first period P1, the data processing section 212 deletes the indoor unit data D11 corresponding to the time period for which the cooling operation is performed.

[0106] For example, when the time period for which the indoor unit 40B performs the heating operation is the second time length H2 or more and the time period for which the indoor unit 40B performs the cooling operation is not more than the third time length, which is shorter than the second time length, in the first period P1, the data processing section 212 deletes the indoor unit data D12 corresponding to the time period for which the cooling operation is performed.

[0107] For example, when the time period for which the indoor unit 40C performs the heating operation is the second time length H2 or more and the time period for which the indoor unit 40C performs the cooling operation is not more than the third time length, which is shorter than the second time length, in the first period P1, the data processing section 212 deletes the indoor unit data D13 corresponding to the time period for which the cooling operation is performed.

[0108] The cleansing process will be further described with reference to Figure 5.

[0109] Furthermore, the data processing section 212 generates the consolidated indoor unit data DIV when each of the three indoor units 40 performs the cooling operation, or when each of the three indoor units 40 per-

forms the heating operation. In other words, the data processing section 212 generates the consolidated indoor unit data DIV, which is operation data on one virtual indoor unit, by consolidating the indoor unit data DI on the three indoor units 40.

[0110] The data processing section 212 generates the consolidated indoor unit data DIV when, of the three indoor units 40, each of two indoor units 40 performs the cooling operation and the other one stops operating. In other words, the data processing section 212 generates the consolidated indoor unit data DIV, which is operation data on one virtual indoor unit, by consolidating the indoor unit data DI on the two indoor units 40 that perform the cooling operation.

[0111] The data processing section 212 generates the consolidated indoor unit data DIV when, of the three indoor units 40, each of two indoor units 40 performs the heating operation and the other one stops operating. In other words, the data processing section 212 generates the consolidated indoor unit data DIV, which is operation data on one virtual indoor unit, by consolidating the indoor unit data DI on the two indoor units 40 that perform the heating operation.

[0112] Note that in the following description, for the purpose of convenience, a case is described in which each of the three indoor units 40 performs the cooling operation, or in which each of the three indoor units 40 performs the heating operation.

[0113] A method of consolidating three pieces of the indoor unit data DI is, for example, averaging. In other words, the data processing section 212 generates the consolidated indoor unit data DIV by averaging detection values of a sensor S on the same date and time included in the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, respectively.

[0114] For example, a description is given of a method of generating the consolidated indoor unit data DIV corresponding to the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3 that are detected on March 1, 2023 at 09:00:00. The indoor unit data DI1 includes a detection value S1 of the sensor S, the indoor unit data DI2 includes a detection value S2 of the sensor S, and the indoor unit data DI3 includes a detection value S3 of the sensor S. The data processing section 212 obtains a detection value SV of the sensor S in the consolidated indoor unit data DIV, as in a following expression (1).

$$SV = (S1 + S2 + S3)/3 \quad (1)$$

[0115] Although the data processing section 212 generates the detection value SV in the consolidated indoor unit data DIV by calculating the average of the detection values S1, S2, and S3 in the present embodiment, the present disclosure is not limited thereto.

[0116] For example, the data processing section 212 may generate the detection value SV in the consolidated

indoor unit data DIV by calculating at least one of the maximum value or the minimum value of the detection values S1, S2, and S3. For example, the data processing section 212 may generate the detection value SV in the consolidated indoor unit data DIV by calculating the variance of the detection values S1, S2, and S3. The data processing section 212 may generate the detection value SV in the consolidated indoor unit data DIV by calculating at least one of the largest amount of change or the smallest amount of change in the detection values S1, S2, and S3. The largest amount of change is the largest one of the amounts of change from the previous detection values. The smallest amount of change is the smallest one of the amounts of change from the previous detection values.

[0117] For example, the data processing section 212 may generate a value that most frequently appears among the detection values S1, S2, and S3, that is, the most frequent value, for the detection value SV in the consolidated indoor unit data DIV.

[0118] The data processing section 212 generates the combined data DN by combining the consolidated indoor unit data DIV and the outdoor unit data DO. For example, the data processing section 212 generates the combined data DN by putting together pieces of data included in the consolidated indoor unit data DIV and pieces of data included in outdoor unit data DO into data on a detected-on-the-same-date-and-time basis.

[0119] Note that when the outdoor unit 50 includes the outdoor units 50A and 50B, the data processing section 212 generates combined data DN1 and combined data DN2, as described below.

[0120] The data processing section 212 generates the combined data DN1 by combining the consolidated indoor unit data DIV and outdoor unit data DO1 on the outdoor unit 50A. For example, the data processing section 212 generates the combined data DN1 by putting together pieces of data included in the consolidated indoor unit data DIV and pieces of data included in the outdoor unit data DO1 into data on a detected-on-the-same-date-and-time basis.

[0121] The data processing section 212 generates the combined data DN2 by combining the consolidated indoor unit data DIV and outdoor unit data DO2 on the outdoor unit 50B. For example, the data processing section 212 generates the combined data DN2 by putting together pieces of data included in the consolidated indoor unit data DIV and pieces of data included in the outdoor unit data DO2 into data on a detected-on-the-same-date-and-time basis.

[0122] The estimation section 213 estimates whether or not a refrigerant leak occurs, by using the consolidated indoor unit data DIV and the outdoor unit data DO. The estimation section 213 estimates whether or not a refrigerant leak occurs, for example, by using the combined data DN.

[0123] For example, in each first period P1, the estimation section 213 estimates whether or not a refrigerant

leak occurs, by using the combined data DN. For example, in the first period P1 between 09:00 and 12:00, the estimation section 213 estimates whether or not a refrigerant leak occurs, for a first time. For example, in the first period P1 between 12:00 and 15:00, the estimation section 213 estimates whether or not a refrigerant leak occurs, for a second time. For example, in the first period P1 between 15:00 and 18:00, the estimation section 213 estimates whether or not a refrigerant leak occurs, for a third time. In other words, the estimation section 213 estimates whether or not a refrigerant leak occurs, three times a day.

[0124] Note that a period from 09:00 until 18:00 is, for example, working hours of a user who works at the office where the indoor units 40 are installed. In other words, the estimation section 213 estimates whether or not a refrigerant leak occurs in each first period P1, depending on working hours of a user who works at the office where the indoor units 40 are installed.

[0125] When each of the three indoor units 40 performs the cooling operation, the estimation section 213 estimates whether or not a refrigerant leak occurs, by using the first estimation model M1. When each of the three indoor units 40 performs the heating operation, the estimation section 213 estimates whether or not a refrigerant leak occurs, by using the second estimation model M2. The first estimation model M1 and the second estimation model M2 are stored beforehand in the model storage section 217.

[0126] The estimation section 213 does not estimate whether or not a refrigerant leak occurs, in a time frame for which the indoor unit data DI subjected to the cleansing process is the indoor unit data DI on a predetermined number NA of indoor units 40 or fewer, of the three indoor units 40.

[0127] The predetermined number NA is, for example, one. In other words, the estimation section 213 does not estimate whether or not a refrigerant leak occurs in a time frame for which the indoor unit data DI subjected to the cleansing process is the indoor unit data DI on one or fewer indoor units 40, of the three indoor units 40. In other words, the estimation section 213 performs estimation of whether or not a refrigerant leak occurs in a time frame for which the indoor unit data DI subjected to the cleansing process is the indoor unit data DI on two or more indoor units 40, of the three indoor units 40.

[0128] When the outdoor unit 50 includes the outdoor units 50A and 50B, the estimation section 213 executes a following process. Specifically, the estimation section 213 estimates whether or not a refrigerant leak occurs in the outdoor unit 50A, by using the consolidated indoor unit data DIV and the outdoor unit data DO1. The estimation section 213 estimates whether or not a refrigerant leak occurs in the outdoor unit 50A, for example, by using the combined data DN1.

[0129] The estimation section 213 estimates whether or not a refrigerant leak occurs in the outdoor unit 50B, by using the consolidated indoor unit data DIV and the

outdoor unit data DO2. The estimation section 213 estimates whether or not a refrigerant leak occurs in the outdoor unit 50B, for example, by using the combined data DN2.

[0130] When it is determined that a refrigerant leak occurs in the outdoor unit 50A or the outdoor unit 50B, the estimation section 213 estimates that a refrigerant leak occurs in the air conditioning system 3.

[0131] The estimation section 213 informs the smartphone 6 of a result of the estimation by the estimation section 213, that is, that a refrigerant leak occurs or does not occur. For example, each time it is estimated whether or not a refrigerant leak occurs, the estimation section 213 informs the smartphone 6 that a refrigerant leak occurs or does not occur. For example, the estimation section 213 may inform the smartphone 6 that a refrigerant leak occurs only when it is estimated that a refrigerant leak occurs in the air conditioning system 3.

[0132] When the estimation section 213 does not perform estimation of whether or not a refrigerant leak occurs for a second period P2 that is longer than the first period P1, the instruction section 214 causes each of the three indoor units 40 to perform the cooling operation or the heating operation.

[0133] The second period P2 is shorter than 24 hours. The second period P2 is, for example, nine hours. The second period P2 is, for example, 12 hours. The second period P2 is an integral multiple that is two or more times the first period P1. In the present embodiment, the second period P2 is nine hours. In other words, the second period P2 is three times the first period P1.

[0134] The instruction section 214 causes each of the three indoor units 40 to perform the cooling operation or the heating operation for a period that is equal to or longer than the first period P1. The period that is equal to or longer than the first period P1 is, for example, three hours. The period that is equal to or longer than the first period P1 may be, for example, four hours. For example, the instruction section 214 causes each of the three indoor units 40 to perform the cooling operation or the heating operation during a time frame in the middle of the night or early morning. The time frame in the middle of the night or early morning is, for example, a time frame from midnight until 06:00.

[0135] When the previous estimation of whether or not a refrigerant leak occurs by the estimation section 213 is performed by using the consolidated indoor unit data DIV on the cooling operation, the instruction section 214 causes each of the three indoor units 40 to perform the cooling operation. When the previous estimation of whether or not a refrigerant leak occurs by the estimation section 213 is performed by using the consolidated indoor unit data DIV on the heating operation, the instruction section 214 causes each of the three indoor units 40 to perform the heating operation.

[0136] The estimation section 213 estimates whether or not a refrigerant leak occurs, by using the consolidated indoor unit data DIV and the outdoor unit data DO2 cor-

responding to the cooling operation or the heating operation performed in response to an instruction from the instruction section 214. The estimation section 213 informs the smartphone 6 of a result of the estimation by the estimation section 213, that is, that a refrigerant leak occurs or does not occur.

[4. Process by control unit]

[0137] Next, with reference to Figure 4, a process by the control unit 21 of the server device 2 is described. Figure 4 is a flowchart showing an example of the process by the control unit 21 in the present embodiment.

[0138] As shown in Figure 4, first, in step S101, the acquisition section 211 acquires indoor unit data DI and outdoor unit data DO from the control device 30. The acquisition section 211 stores the indoor unit data DI and the outdoor unit data DO in the data storage section 216. Note that the indoor unit data DI includes indoor unit data DI1, indoor unit data DI2, and indoor unit data DI3.

[0139] Next, in step S103, the data processing section 212 determines, based on the indoor unit data DI, whether or not the indoor units 40 are in the "cooling-heating mixed state". The "cooling-heating mixed state" indicates that, of the three indoor units 40, at least one indoor unit 40 is performing the cooling operation and at least one indoor unit 40 is performing the heating operation. When the data processing section 212 determines that the indoor units 40 are in the "cooling-heating mixed state" (step S103; YES), the data processing section 212 discards the indoor unit data DI and the outdoor unit data DO acquired in step S101. Thereafter, the process returns to step S101. When the data processing section 212 determines that the indoor units 40 are not in the "cooling-heating mixed state" (step S103; NO), the process proceeds to step S105.

[0140] Next, in step S105, the data processing section 212 performs a "data check" of the indoor unit data DI and the outdoor unit data DO. The "data check" is a process of determining whether or not data included in the indoor unit data DI and the outdoor unit data DO follows a preset data format. For example, when there is data that is determined not to follow the preset data format, the data processing section 212 deletes data on a date and time on which the data is included.

[0141] Next, in step S107, the data processing section 212 performs the "cleansing process" on the indoor unit data DI. The "cleansing process" in the present embodiment is a process of deleting operation data that is inappropriate for operation data to be used when the estimation section 213 estimates whether or not a refrigerant leak occurs.

[0142] For example, the data processing section 212 deletes the indoor unit data DI corresponding to an indoor unit 40, of the three indoor units 40, that performs the cooling operation for a time period that is equal to or longer than the first time length H1 and performs the heating operation for a time period that is equal to or longer

than the first time length H1 during the first period P1.

[0143] For example, in the indoor unit data DI corresponding to an indoor unit 40, of the three indoor units 40, that performs the cooling operation for a time period that is equal to or longer than the second time length H2 and performs the heating operation for a time period that is not more than the third time length H3, which is shorter than the second time length, during the first period P1, the data processing section 212 deletes a portion of the indoor unit data DI corresponding to the time period for which the heating operation is performed.

[0144] For example, in the indoor unit data DI corresponding to an indoor unit 40, of the three indoor units 40, that performs the heating operation for a time period that is equal to or longer than the second time length H2 and performs the cooling operation for a time period that is not more than the third time length, which is shorter than the second time length, during the first period P1, the data processing section 212 delete a portion of the indoor unit data DI corresponding to the time period for which the cooling operation is performed.

[0145] Next, in step S109, the data processing section 212 generates consolidated indoor unit data DIV, which is operation data on one virtual indoor unit, from the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3. Moreover, the data processing section 212 generates combined data DN by combining the consolidated indoor unit data DIV and the outdoor unit data DO.

[0146] Next, in step S111, the data processing section 212 generates a parameter using results of detection by two or more sensors S included in the combined data DN, and adds the generated parameter to the combined data DN. The parameter includes, for example, a compressor suction superheat degree TP. The compressor suction superheat degree TP is defined by a following expression (2).

$$TP = SCT - LP \quad (2)$$

[0147] Here, the refrigerant temperature SCT is the refrigerant temperature of an upstream side of the compressor 51, and is detected by the temperature sensor TS shown in Figure 2. The evaporation saturation temperature LP is the evaporation saturation temperature of the refrigerant, and is detected by the temperature sensor E2 shown in Figure 2 when the cooling operation is performed and is detected by the temperature sensor C2 when the heating operation is performed.

[0148] Next, in step S113, the estimation section 213 determines whether or not the first period P1 has elapsed since a time point when the acquisition section 211 started acquiring the indoor unit data DI and the outdoor unit data DO, or a preset time point. The time point when the acquisition section 211 started acquiring the indoor unit data DI and the outdoor unit data DO is, for example, 09:00. The preset time points are, for example, 12:00 and 15:00. When the estimation section 213 determines

that the first period P1 has not elapsed (step S113; NO), the process returns to step S101. When the estimation section 213 determines that the first period P1 has elapsed (step S113; YES), the process proceeds to step S115.

[0149] In step S115, the estimation section 213 determines whether or not it is possible to estimate, by using the combined data DN generated in step S109, whether or not a refrigerant leak occurs. For example, when time periods corresponding to the usable indoor unit data DI3 and outdoor unit data DO included in the combined data DN are less than a threshold time length TA, it is determined that it is not possible to estimate whether or not a refrigerant leak occurs. For example, when the time periods corresponding to the usable indoor unit data DI3 and outdoor unit data DO included in the combined data DN are the threshold time length TA or more, it is determined that it is possible to estimate whether or not a refrigerant leak occurs. The threshold time length TA is, for example, one hour. The usable indoor unit data DI3 and outdoor unit data DO are, for example, data without missing data or the like.

[0150] When the estimation section 213 determines that it is not possible to estimate whether or not a refrigerant leak occurs (step S115; NO), the process proceeds to step S121. When the estimation section 213 determines that it is possible to estimate whether or not a refrigerant leak occurs (step S115; YES), the process proceeds to step S117.

[0151] In step S117, the estimation section 213 estimates whether or not a refrigerant leak occurs, by using the combined data DN. When each of the three indoor units 40 performs the cooling operation, the estimation section 213 estimates whether or not a refrigerant leak occurs, by using the first estimation model M1. When each of the three indoor units 40 performs the heating operation, the estimation section 213 estimates whether or not a refrigerant leak occurs, by using the second estimation model M2.

[0152] Next, in step S119, the estimation section 213 informs the smartphone 6 of a result of the estimation of whether or not a refrigerant leak occurs. Thereafter, the process returns to step S101.

[0153] When the determination of the estimation section 213 in step S115 is "NO", in step S121, the instruction section 214 determines whether or not the second period P2 has elapsed since the time point when the acquisition section 211 started acquiring the indoor unit data DI and the outdoor unit data DO. The time point when the acquisition section 211 started acquiring the indoor unit data DI and the outdoor unit data DO is, for example, 09:00.

[0154] When the instruction section 214 determines that the second period P2 has not elapsed (step S121; NO), the process returns to step S101. When the instruction section 214 determines that the second period P2 has elapsed (step S121; YES), the process proceeds to step S123.

[0155] In step S123, the instruction section 214 deter-

mines whether or not the estimation section 213 has completed performing estimation of whether or not a refrigerant leak occurs. In other words, the instruction section 214 determines whether or not the estimation section 213 performed, during the second period P2, estimation of whether or not a refrigerant leak occurs.

[0156] When the instruction section 214 determines that the estimation section 213 has completed performing estimation of whether or not a refrigerant leak occurs (step S123; YES), the process returns to step S101. When the instruction section 214 determines that the estimation section 213 has not completed performing estimation of whether or not a refrigerant leak occurs (step S123; NO), the process proceeds to step S125.

[0157] In step S125, the instruction section 214 causes each of the three indoor units 40 to perform the cooling operation or the heating operation. In other words, the instruction section 214 forces each of the three indoor units 40 to operate. Thereafter, the process returns to step S101.

[0158] Step S101 corresponds to an example of "acquisition step". Step S103 and step S107 correspond to an example of "data processing step". Step S117 corresponds to an example of "estimation step".

[5. Example of cleansing process]

[0159] Next, with reference to Figure 5, an example of the cleansing process is described. Figure 5 shows an example of the cleansing process by the server device 2 in the present embodiment.

[0160] Figure 5 shows changes in the operation state of the indoor unit 40A during the first period P1. The operation state includes the selected state of operate/stop and the operation state mode. The selected state of operate/stop is shown at the top of Figure 5. In the selected state of operate/stop, "1" indicates an "operate" state, and "0" indicates a "stop" state.

[0161] The operation state mode is shown in the middle of Figure 5. In the operation state mode, "1" indicates the cooling operation, "2" indicates the heating operation, and "5" indicates the dehumidification operation. In the present embodiment, the dehumidification operation is assumed to be part of the cooling operation.

[0162] A horizontal axis indicating time T is shown at the bottom of Figure 5. A period from time T11 until time T16, which goes from the left to the right of Figure 5, corresponds to the first period P1. The first period P1 is, for example, three hours.

[0163] As shown in Figure 5, during a period between time T11 and time T12, the selected state of operate/stop is "1" indicating the "operate" state, and the operation state mode is "5" indicating the dehumidification operation. At time T12, the operation state mode changes from "5" indicating the dehumidification operation to "1" indicating the cooling operation.

[0164] During a period between time T12 and time T13, the selected state of operate/stop is "1" indicating the

"operate" state, and the operation state mode is "1" indicating the cooling operation. At time T13, the selected state of operate/stop changes from "1" indicating the "operate" state to "0" indicating the "stop" state.

[0165] During a period between time T13 and time T14, the selected state of operate/stop is "0" indicating the "stop" state, and the operation state mode is "1" indicating the cooling operation. At time T14, the selected state of operate/stop changes from "0" indicating the "stop" state to "1" indicating the "operate" state.

[0166] During a period between time T14 and time T15, the selected state of operate/stop is "1" indicating the "operate" state, and the operation state mode is "1" indicating the cooling operation. At time T15, the operation state mode changes from "1" indicating the cooling operation to "2" indicating the heating operation.

[0167] During a period between time T15 and time T16, the selected state of operate/stop is "1" indicating the "operate" state, and the operation state mode is "2" indicating the heating operation.

[0168] When the selected state of operate/stop and the operation state mode change as shown in Figure 5, the indoor unit 40A is in the "stop" state during the period between time T13 and time T14, and usable data for the indoor unit data DI1 therefore cannot be acquired. Accordingly, the data processing section 212 deletes a portion of the indoor unit data DI1 corresponding to the period PD1 between time T13 and time T14.

[0169] The cooling operation is performed during a period between time T11 and time T13 and the period between time T14 and time T15. The total time period for which the cooling operation is performed is, for example, the second time length H2 or more. The second time length H2 is, for example, two hours. The heating operation is performed during the period between time T15 and time T16. The time period for which the heating operation is performed is the third time length H3 or less. The third time length H3 is, for example, one hour.

[0170] In other words, in the first period P1 shown in Figure 5, the time period for which the cooling operation is performed is the second time length H2 or more, and the time period for which the heating operation is performed is the third time length H3 or less. Accordingly, the data processing section 212 deletes a portion of the indoor unit data DI1 corresponding to the period PD2 between time T15 and time T16 during which the heating operation is performed.

[6. First embodiment]

[0171] Next, with reference to Figures 6 to 9, the first air-conditioning management system 1A according to the first embodiment is described. The first air-conditioning management system 1A according to the first embodiment includes the first air conditioning system 3A as the air conditioning system 3. Figure 6 shows an example of a configuration of the first air conditioning system 3A according to the first embodiment.

[0172] As shown in Figure 6, the first air conditioning system 3A includes three indoor units 40 and one outdoor unit 50A. The three indoor units 40 include the indoor unit 40A, the indoor unit 40B, and the indoor unit 40C.

[0173] Each of the indoor units 40A, 40B, and 40C and the outdoor unit 50A are configured in such a manner that the refrigerant can flow therebetween through refrigerant piping, as described with reference to Figure 2. In other words, the indoor units 40A, 40B, and 40C and the outdoor unit 50A constitute one refrigerant circuit RC.

[0174] Next, with reference to Figure 7, indoor unit data DI and outdoor unit data DO are described. Figure 7 shows an example of operation data DA acquired from the first air conditioning system 3A.

[0175] As shown in Figure 7, the operation data DA includes indoor unit data DI1, indoor unit data DI2, indoor unit data DI3, and outdoor unit data DO. The indoor unit data DI1, the indoor unit data DI2, the indoor unit data DI3, and the outdoor unit data DO are acquired by the acquisition section 211 from the control device 30 of the first air conditioning system 3A. The indoor unit data DI1 is operation data on the indoor unit 40A. The indoor unit data DI2 is operation data on the indoor unit 40B. The indoor unit data DI3 is operation data on the indoor unit 40C. The outdoor unit data DO is operation data on the outdoor unit 50A.

[0176] Each of the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3 has the same configuration as the others. In each of the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, values of detection date and time, such as detection date and time T1, detection date and time T2, detection date and time T3, are stated in the up-down direction of Figure 7. Moreover, detection items in each of the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3 are stated in Figure 7. The detection items include items indicating the operation state of each of the indoor units 40A, 40B, and 40C, and detection values of sensors S disposed in each of the indoor units 40A, 40B, and 40C.

[0177] The items indicating the operation state of each of the indoor units 40A, 40B, and 40C include the operate/stop state and the operation state mode. The operation state modes include the cooling operation, the heating operation, the dehumidification operation, and the like. For values of the operate/stop state, for example, "0" indicates "stop" and "1" indicates "operate". For values of the operation state mode, for example, "1" indicates the cooling operation, and "2" indicates the heating operation.

[0178] The detection values of the sensors S disposed in each of the indoor units 40A, 40B, and 40C include detection values of the temperature sensor E1 and the temperature sensor E2 shown in Figure 2. The temperature sensor E1 is disposed at the indoor heat exchanger 41 and detects the evaporation saturation temperature LP of the refrigerant when the cooling operation is performed. The temperature sensor E2 is disposed up-

stream of the indoor heat exchanger 41 when the cooling operation is performed.

[0179] In the outdoor unit data DO, values of detection date and time, such as detection date and time T1, detection date and time T2, detection date and time T3, are stated in the up-down direction of Figure 7. In the outdoor unit data DO, detection items are stated in the right-left direction of Figure 7. The detection items include detection values of sensors S disposed in the outdoor unit 50A.

[0180] The detection values of the sensors S disposed in the outdoor unit 50A include the refrigerant temperature SCT and the condensation saturation temperature HP. The refrigerant temperature SCT is detected by the temperature sensor TS shown in Figure 2. The temperature sensor TS is disposed upstream of the compressor 51. The condensation saturation temperature HP is detected, for example, by the temperature sensor C1 shown in Figure 2. The temperature sensor C1 is disposed on an outlet side of the outdoor heat exchanger 53.

[0181] Next, with reference to Figure 8, a process of generating consolidated indoor unit data DIV by the data processing section 212 is described. Figure 8 shows an example of a consolidation process in the first air conditioning system.

[0182] A left side of Figure 8 shows an example of the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3. The indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3 shown in Figure 8 are the same as the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3 shown in Figure 7, respectively.

[0183] The data processing section 212 generates the consolidated indoor unit data DIV, which is operation data on one virtual indoor unit, by consolidating the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3.

[0184] In each of the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, the detection items are stated in the right-left direction of Figure 8. The detection items include the items indicating the operation state of each of the indoor units 40A, 40B, and 40C, and the detection values of the sensors S disposed in each of the indoor units 40A, 40B, and 40C.

[0185] The items indicating the operation state of each of the indoor units 40A, 40B, and 40C include the operate/stop state and the operation state mode. The operation state modes include the cooling operation, the heating operation, the dehumidification operation, and the like. For values of the operate/stop state, for example, "0" indicates "stop", and "1" indicates "operate". For values of the operation state mode, for example, "1" indicates the cooling operation, and "2" indicates the heating operation.

[0186] As shown in Figure 8, in each of the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, the value of the operate/stop state is "1", indicating that each of the indoor units 40A, 40B, and 40C is in the "operate" state. In each of the indoor unit data

DI1, the indoor unit data DI2, and the indoor unit data DI3, the value of the operation state mode is "1", indicating that the operation state mode of each of the indoor units 40A, 40B, and 40C is the cooling operation.

[0187] Accordingly, in the consolidated indoor unit data DIV, the value of the operate/stop state is "1", and the value of the operation state mode is "1".

[0188] Moreover, the detection values of the sensors S disposed in each of the indoor units 40A, 40B, and 40C include detection values of the temperature sensor E1 and the temperature sensor E2 shown in Figure 2. The data processing section 212 generates the consolidated indoor unit data DIV by averaging the detection value of each sensor S on each same detection date and time included in each of the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3.

[0189] In other words, the data processing section 212 calculates the detection value of the temperature sensor E1 included in the consolidated indoor unit data DIV, by averaging the detection values of the temperature sensor E1 on each same detection date and time included in the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, respectively.

[0190] For example, the data processing section 212 calculates the detection value of the temperature sensor E1 on the detection date and time T1 included in the consolidated indoor unit data DIV, by averaging the detection values of the temperature sensor E1 on the detection date and time T1 included in the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, respectively. For example, the data processing section 212 calculates the detection value of the temperature sensor E1 on the detection date and time T2 included in the consolidated indoor unit data DIV, by averaging the detection values of the temperature sensor E1 on the detection date and time T2 included in the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, respectively. For example, the data processing section 212 calculates the detection value of the temperature sensor E1 on the detection date and time T3 included in the consolidated indoor unit data DIV, by averaging the detection values of the temperature sensor E1 on the detection date and time T3 included in the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, respectively.

[0191] The data processing section 212 calculates the detection value of the temperature sensor E2 included in the consolidated indoor unit data DIV, by averaging the detection values of the temperature sensor E2 on each same detection date and time included in the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, respectively.

[0192] For example, the data processing section 212 calculates the detection value of the temperature sensor E2 on the detection date and time T1 included in the consolidated indoor unit data DIV, by averaging the detection values of the temperature sensor E2 on the detection date and time T1 included in the indoor unit data

DI1, the indoor unit data DI2, and the indoor unit data DI3, respectively. For example, the data processing section 212 calculates the detection value of the temperature sensor E2 on the detection date and time T2 included in the consolidated indoor unit data DIV, by averaging the detection values of the temperature sensor E2 on the detection date and time T2 included in the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, respectively. For example, the data processing section 212 calculates the detection value of the temperature sensor E2 on the detection date and time T3 included in the consolidated indoor unit data DIV, by averaging the detection values of the temperature sensor E2 on the detection date and time T3 included in the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3, respectively.

[0193] Thus, the data processing section 212 generates the consolidated indoor unit data DIV shown in a right side of Figure 8.

[0194] Next, with reference to Figure 9, a process of generating combined data DN by the data processing section 212 is described. Figure 9 shows an example of the combined data DN in the first air conditioning system 3A.

[0195] The data processing section 212 generates the combined data DN by combining the consolidated indoor unit data DIV shown in Figure 8 and the outdoor unit data DO shown in Figure 7.

[0196] The values of detection date and time correspond between the consolidated indoor unit data DIV and the outdoor unit data DO. Accordingly, the data processing section 212 generates the combined data DN by combining the values of the detection items included in the outdoor unit data DO with the values of the items indicating the operation state and the values of the detection items included in the consolidated indoor unit data DIV, in association with each value of detection date and time.

[0197] In the combined data DN, values of detection date and time, such as detection date and time T1, detection date and time T2, detection date and time T3, are stated in the up-down direction of Figure 9. In the combined data DN, detection items are stated in the right-left direction of Figure 9. The detection items include the detection items included in the outdoor unit data DO, and the items indicating the operation state and the detection items included in the consolidated indoor unit data DIV. The detection items included in the outdoor unit data DO include the refrigerant temperature SCT and the condensation saturation temperature HP. The items indicating the operation state included in the consolidated indoor unit data DIV include the operate/stop state and the operation state mode. The detection items included in the consolidated indoor unit data DIV include the detection value of the temperature sensor E1 and the detection value of the temperature sensor E2.

[0198] Thus, the data processing section 212 generates the combined data DN shown in Figure 9. The combined data DN corresponds to an example of operation

data DB supplied to the estimation section 213.

[7. Second embodiment]

5 [0199] Next, with reference to Figures 10 to 12, the second air-conditioning management system 1B according to the second embodiment is described. The second air-conditioning management system 1B includes the second air conditioning system 3B as the air conditioning system 3. Figure 10 shows an example of a configuration of the second air conditioning system 3B according to the second embodiment.

10 [0200] As shown in Figure 10, the second air conditioning system 3B includes three indoor units 40 and two outdoor units 50. The three indoor units 40 include the indoor unit 40A, the indoor unit 40B, and the indoor unit 40C. The two outdoor units 50 include the outdoor unit 50A and the outdoor unit 50B.

15 [0201] Each of the indoor units 40A, 40B, and 40C and each of the outdoor units 50A and 50B are configured in such a manner that the refrigerant can flow therebetween through refrigerant piping, as described with reference to Figure 2. In other words, the indoor units 40A, 40B, and 40C and the outdoor units 50A and 50B constitute one refrigerant circuit RC.

20 [0202] Next, with reference to Figure 11, indoor unit data DI and outdoor unit data DO are described. Figure 11 shows an example of operation data DA acquired from the second air conditioning system 3B.

25 [0203] As shown in Figure 11, the operation data DA includes indoor unit data DI1, indoor unit data DI2, indoor unit data DI3, outdoor unit data DO1, and outdoor unit data DO2. The indoor unit data DI1, the indoor unit data DI2, the indoor unit data DI3, the outdoor unit data DO1, and the outdoor unit data DO2 are acquired by the acquisition section 211 from the control device 30 of the second air conditioning system 3B. The indoor unit data DI1 is operation data on the indoor unit 40A. The indoor unit data DI2 is operation data on the indoor unit 40B. The indoor unit data DI3 is operation data on the indoor unit 40C. The outdoor unit data DO1 is operation data on the outdoor unit 50A. The outdoor unit data DO2 is operation data on the outdoor unit 50B.

30 [0204] Each of the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3 has the same configuration as the others. Since the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3 are the same as the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3 shown in Figure 7, respectively, a description thereof is omitted.

35 [0205] In the outdoor unit data DO1, values of detection date and time, such as detection date and time T1, detection date and time T2, detection date and time T3, are stated in the up-down direction of Figure 11. In the outdoor unit data DO1, detection items are stated in the right-left direction of Figure 11. The detection items include detection values of sensors S disposed in the outdoor unit 50A. The detection values of the sensors S disposed

in the outdoor unit 50A are the same as the detection values of the sensors S disposed in the outdoor unit 50A described with reference to Figure 7.

[0206] The data processing section 212 generates consolidated indoor unit data DIV, which is operation data on one virtual indoor unit, by consolidating the indoor unit data DI1, the indoor unit data DI2, and the indoor unit data DI3 shown in Figure 11. Since a method of generating the consolidated indoor unit data DIV is the same as the method of generating the consolidated indoor unit data DIV described with reference to Figure 8, a description thereof is omitted here.

[0207] Next, with reference to Figure 12, a process of generating combined data DN by the data processing section 212 is described. Figure 12 shows an example of the combined data DN in the second air conditioning system 3B.

[0208] The data processing section 212 generates combined data DN1 by combining the consolidated indoor unit data DIV and the outdoor unit data DO1 shown in Figure 11. Moreover, the data processing section 212 generates combined data DN2 by combining the consolidated indoor unit data DIV and the outdoor unit data DO2 shown in Figure 11.

[0209] The values of detection date and time correspond between the consolidated indoor unit data DIV and each of the outdoor unit data DO1 and the outdoor unit data DO2. Accordingly, the data processing section 212 generates the combined data DN1 by combining the values of the detection items included in the outdoor unit data DO1 with the values of the items indicating the operation state and the values of the detection items included in the consolidated indoor unit data DIV, in association with each value of detection date and time. Moreover, the data processing section 212 generates the combined data DN2 by combining the values of the detection items included in the outdoor unit data DO2 with the values of the items indicating the operation state and the values of the detection items included in the consolidated indoor unit data DIV, in association with each value of detection date and time.

[0210] In the combined data DN1, values of detection date and time, such as detection date and time T1, detection date and time T2, detection date and time T3, are stated in the up-down direction of Figure 12. In the combined data DN1, detection items are stated in the right-left direction of Figure 12. The detection items include the detection items included in the outdoor unit data DO1, and the items indicating the operation state and the detection items included in the consolidated indoor unit data DIV. The detection items included in the outdoor unit data DO1 include the refrigerant temperature SCT and the condensation saturation temperature HP. The items indicating the operation state included in the consolidated indoor unit data DIV include the operate/stop state and the operation state mode. The detection items included in the consolidated indoor unit data DIV include the detection value of the temperature sensor E1 and the de-

tection value of the temperature sensor E2.

[0211] In the combined data DN1, values of detection date and time, such as detection date and time T1, detection date and time T2, detection date and time T3, are stated in the up-down direction of Figure 12. In the combined data DN1, detection items are stated in the right-left direction of Figure 12. The detection items include the detection items included in the outdoor unit data DO1, and the items indicating the operation state and the detection items included in the consolidated indoor unit data DIV.

[0212] In the combined data DN2, values of detection date and time, such as detection date and time T1, detection date and time T2, detection date and time T3, are stated in the up-down direction of Figure 12. In the combined data DN2, detection items are stated in the right-left direction of Figure 12. The detection items include the detection items included in the outdoor unit data DO2, and the items indicating the operation state and the detection items included in the consolidated indoor unit data DIV.

[0213] Thus, the data processing section 212 generates the combined data DN shown in Figure 12. The combined data DN includes the combined data DN1 and the combined data DN2. The combined data DN corresponds to an example of operation data DB supplied to the estimation section 213.

[8. Advantageous effects and the like]

[0214] As described above, the air-conditioning management system 1 includes: the plurality of indoor units 40; the outdoor unit 50; the refrigerant circuit RC that allows the refrigerant to flow between the plurality of indoor units 40 and the outdoor unit 50; and the server device 2, wherein the server device 2 includes the acquisition section 211 that acquires indoor unit data DI on each of the plurality of indoor units 40, the data processing section 212 that performs the cleansing process on the indoor unit data DI corresponding to each of the plurality of indoor units 40, and the estimation section 213 that estimates, based on the indoor unit data DI subjected to the cleansing process by the data processing section 212, whether or not a refrigerant leak occurs, and the data processing section 212 deletes a portion of the indoor unit data DI corresponding to a time frame during which, of the plurality of indoor units 40, at least one indoor unit 40 performs the cooling operation and at least one other indoor unit 40 performs the heating operation.

[0215] According to the air-conditioning management system 1, a portion of the indoor unit data DI is deleted that corresponds to a time frame during which, of the plurality of indoor units 40, at least one indoor unit 40 performs the cooling operation and at least one other indoor unit 40 performs the heating operation.

[0216] By comparison, if it is estimated whether or not a refrigerant leak occurs by using such a portion of the indoor unit data DI corresponding to a time frame during

which at least one indoor unit 40 performs the cooling operation and at least one other indoor unit 40 performs the heating operation, there is a possibility that proper estimation is not performed. According to the air-conditioning management system 1, it is possible to restrain estimating whether or not a refrigerant leak occurs by using the portion of the indoor unit data DI corresponding to the time frame during which at least one indoor unit 40 performs the cooling operation and at least one indoor unit 40 performs the heating operation. Accordingly, when there is a time frame during which the plurality of indoor units 40 operate in different operation modes, it is possible to properly estimate whether or not a refrigerant leak occurs.

[0217] Moreover, in the air-conditioning management system 1, the number of the plurality of indoor units 40 is three or more, and the estimation section 213 does not perform estimation of whether or not a refrigerant leak occurs in a time frame for which the indoor unit data DI subjected to the cleansing process by the data processing section 212 is the indoor unit data DI on a predetermined number NA of indoor units 40 or fewer, of the three or more indoor units 40.

[0218] According to such a configuration, the number of the plurality of indoor units 40 is three or more, and estimation of whether or not a refrigerant leak occurs is not performed in a time frame for which the indoor unit data DI subjected to the cleansing process is the indoor unit data DI on the predetermined number NA of indoor units 40 or fewer, of the three or more indoor units 40.

[0219] Accordingly, by appropriately setting the predetermined number NA, it is possible to restrain estimating whether or not a refrigerant leak occurs by using inappropriate indoor unit data DI. Accordingly, it is possible to properly estimate whether or not a refrigerant leak occurs.

[0220] In the air-conditioning management system 1, the estimation section 213 estimates whether or not a refrigerant leak occurs in each first period P1, and the data processing section 212 deletes the indoor unit data DI corresponding to an indoor unit 40, of the plurality of indoor units 40, that performs the cooling operation for a time period that is equal to or longer than the first time length H1 and performs the heating operation for a time period that is equal to or longer than the first time length H1 during the first period P1.

[0221] According to such a configuration, it is estimated whether or not a refrigerant leak occurs in each first period P1, and the indoor unit data DI corresponding to an indoor unit 40, of the plurality of indoor units 40, that performs the cooling operation for a time period that is equal to or longer than the first time length H1 and performs the heating operation for a time period that is equal to or longer than the first time length H1 during the first period P1.

[0222] Accordingly, by appropriately setting the first time length H1, it is possible to restrain estimating whether or not a refrigerant leak occurs by using inappropriate

indoor unit data DI. Accordingly, it is possible to properly estimate whether or not a refrigerant leak occurs.

[0223] In the air-conditioning management system 1, in the indoor unit data DI corresponding to an indoor unit 40, of the plurality of indoor units 40, that performs the cooling operation for a time period that is equal to or longer than the second time length H2 and performs the heating operation for a time period that is not more than the third time length H3, which is shorter than the second time length H2, during the first period, the data processing section 212 deletes a portion of the indoor unit data DI corresponding to the time period for which the heating operation is performed, and in the indoor unit data DI corresponding to an indoor unit 40, of the plurality of indoor units 40, that performs the heating operation for a time period that is equal to or longer than the second time length H2 and performs the cooling operation for a time period that is not more than the third time length H3 during the first period P1, the data processing section 212 deletes a portion of the indoor unit data DI corresponding to the time period for which the cooling operation is performed.

[0224] According to such a configuration, in the indoor unit data DI corresponding to an indoor unit 40, of the plurality of indoor units 40, that performs the cooling operation for a time period that is equal to or longer than the second time length H2 and performs the heating operation for a time period that is not more than the third time length H3, which is shorter than the second time length H2, during the first period P1, a portion of the indoor unit data DI is deleted that corresponds to the time period for which the heating operation is performed, and in the indoor unit data DI corresponding to an indoor unit 40, of the plurality of indoor units 40, that performs the heating operation for a time period that is equal to or longer than the second time length H2 and performs the cooling operation for a time period that is not more than the third time length H3 during the first period P1, a portion of the indoor unit data DI is deleted that corresponds to the time period for which the cooling operation is performed.

[0225] Accordingly, by appropriately setting the second time length H2 and the third time length H3, it is possible to restrain estimating whether or not a refrigerant leak occurs by using inappropriate indoor unit data DI. Accordingly, it is possible to properly estimate whether or not a refrigerant leak occurs.

[0226] In the air-conditioning management system 1, the estimation section 213 estimates whether or not a refrigerant leak occurs in each first period P1, and the instruction section 214 is further included that causes each of the plurality of indoor units 40 to perform the cooling operation or the heating operation when the estimation section 213 does not perform estimation of whether or not a refrigerant leak occurs for the second period P2 that is longer than the first period P1.

[0227] According to such a configuration, it is estimated whether or not a refrigerant leak occurs in each first

period P1, and when estimation of whether or not a refrigerant leak occurs is not performed for the second period P2 that is longer than the first period P1, each of the plurality of indoor units 40 is caused to perform the cooling operation or the heating operation.

[0228] Accordingly, by setting the second period P2 to an appropriate period, estimation of whether or not a refrigerant leak occurs can be reliably performed, for example, at least once a day. Accordingly, user convenience can be enhanced.

[0229] In the air-conditioning management system 1, the estimation section 213 estimates whether or not a refrigerant leak occurs by using the first estimation model M1 when each of the plurality of indoor units 40 performs the cooling operation, and estimates whether or not a refrigerant leak occurs by using the second estimation model M2, which is different from the first estimation model M1, when each of the plurality of indoor units 40 performs the heating operation.

[0230] According to such a configuration, when each of the plurality of indoor units 40 performs the cooling operation, it is estimated whether or not a refrigerant leak occurs by using the first estimation model M1, and when each of the plurality of indoor units 40 performs the heating operation, it is estimated whether or not a refrigerant leak occurs by using the second estimation model M2, which is different from the first estimation model M1.

[0231] Accordingly, by appropriately configuring the first estimation model M1 and the second estimation model M2, it is possible to properly estimate whether or not a refrigerant leak occurs.

[0232] In the air-conditioning management system 1, the first estimation model M1 is generated by using the consolidated indoor unit data DIV and the outdoor unit data DO for a period during which each of the plurality of indoor units 40 performs the cooling operation, and the second estimation model M2 is generated by using the consolidated indoor unit data DIV and the outdoor unit data DO for a period during which each of the plurality of indoor units 40 performs the heating operation.

[0233] According to such a configuration, the first estimation model M1 is generated by using the consolidated indoor unit data DIV and the outdoor unit data DO for a period during which each of the plurality of indoor units 40 performs the cooling operation, and the second estimation model M2 is generated by using the consolidated indoor unit data DIV and the outdoor unit data DO for a period during which each of the plurality of indoor units 40 performs the heating operation.

[0234] Accordingly, the first estimation model M1 and the second estimation model M2 can be appropriately generated.

[0235] In the air-conditioning management system 1, the data processing section 212 generates consolidated indoor unit data DIV by consolidating the respective indoor unit data DI corresponding to the plurality of indoor units 40, and the estimation section 213 estimates, based on the consolidated indoor unit data DIV, whether or not

a refrigerant leak occurs.

[0236] According to such a configuration, the consolidated indoor unit data DIV is generated by consolidating the respective indoor unit data DI corresponding to the plurality of indoor units 40, and it is estimated whether or not a refrigerant leak occurs, based on the consolidated indoor unit data DIV.

[0237] Accordingly, when a plurality of indoor units 40 is included, it is also possible to properly estimate whether or not a refrigerant leak occurs, based on the consolidated indoor unit data DIV.

[0238] A method for estimating a refrigerant leak in the air-conditioning management system 1 is a method for estimating a refrigerant leak in the air conditioning system 1 in which the plurality of indoor units 40 is connected to refrigerant piping, the method including: an acquisition step of acquiring indoor unit data DI on each of the plurality of indoor units 40; a data processing step of performing the cleansing process on the indoor unit data DI corresponding to each of the plurality of indoor units 40; and an estimation step of estimating, based on the indoor unit data DI subjected to the cleansing process, whether or not a refrigerant leak occurs, wherein the data processing step includes deleting a portion of the indoor unit data DI corresponding to a time frame during which, of the plurality of indoor units 40, at least one indoor unit 40 performs the cooling operation and at least one indoor unit 40 performs the heating operation.

[0239] According to the method for estimating a refrigerant leak in the air-conditioning management system 1, operation and effects similar to those of the air-conditioning management system 1 are brought about.

[9. Other embodiments]

[0240] As described above, the embodiments are described as illustrative examples disclosed in the present application. However, the techniques of the present disclosure is not limited to such embodiments, and can also be applied to embodiments in which a change, a substitution, an addition, an omission, or the like is made. It is also possible to configure a new embodiment by combining any of the constituent elements described in the embodiments.

[0241] Accordingly, other embodiments are illustrated below.

[0242] Although a case is described in which the indoor unit 40 includes three indoor units 40 in the present embodiment, the present disclosure is not limited thereto. The indoor unit 40 may include two indoor units 40. The indoor unit 40 may include four or more indoor units 40.

[0243] Although a case is described in which the number of the outdoor units 50 is one or two in the present embodiment, the present disclosure is not limited thereto. The outdoor unit 50 may include, for example, three or more outdoor units 50.

[0244] Although a case is described in which the "management device" is the server device 2 in the present

embodiment, the present disclosure is not limited thereto. The "management device" may be, for example, the control device 30. The "management device" may be, for example, a central management device installed in a building. The "management device" may be a personal computer, a tablet terminal, a smartphone, a computing service provided in a cloud environment, or the like communicably connected to the control device 30.

[0245] Although a case is described in which the server device 2 transmits a result of estimation of whether or not a refrigerant leak occurs to the smartphone 6 in the present embodiment, the present disclosure is not limited thereto. The server device 2 may transmit a result of estimation of whether or not a refrigerant leak occurs to, for example, a personal computer, a tablet terminal, or the like.

[0246] Although a case is described in which each of the first estimation model M1 and the second estimation model M2 is generated by using logistic regression analysis in the present embodiment, the present disclosure is not limited thereto. Each of the first estimation model M1 and the second estimation model M2 may be generated, for example, through machine learning, such as deep learning, by using the consolidated indoor unit data DIV and the outdoor unit data DO.

[0247] Note that when an indoor unit 40 is performing the dehumidification operation, the indoor unit 40 may be treated as if performing the cooling operation. The reason is that the indoor heat exchanger 41 is caused to function as an evaporator also when the dehumidification operation is performed.

[0248] Among the plurality of indoor units 40, indoor units 40 in the same operation state may be consolidated. For example, when the indoor units 40A, 40B, and 40C are included and when the indoor units 40A and 40B are in the state of cooling operation and the indoor unit 40C is in the state of stopping operating, operation data on the indoor unit 40A and operation data on the indoor unit 40B are consolidated. In such a case, the refrigerant leak estimation may be configured not to be performed in a time frame in which the number of indoor units 40 in the same operation state is a predetermined value or smaller. For example, in an air conditioning system 3 including five indoor units 40, when there are only two indoor units 40 that are in the same operation state and the other indoor units 40 are in the state of stopping operating, the refrigerant leak estimation is not performed because there is a possibility that the operation data is not operation data reflecting the whole air conditioning system 3.

[0249] The present invention is not only to estimate whether or not a refrigerant leak occurs, but also can estimate a refrigerant filling rate (for example, 80%).

[0250] Moreover, in order to facilitate the understanding of the process by the control unit 21, for example, each step unit of operation shown in Figure 4 is formed by dividing the process according to main process contents, and the present invention is not limited by a method of division into or names of process units. The process

may be divided into more step units, according to process contents. The process may be divided in such a manner that one step unit includes further more sub-processes. Moreover, order of the steps may be interchanged as appropriate without interfering with the gist of the present invention.

[0251] The air-conditioning management system 1 can be implemented by causing the processor 21A included in the control unit 21 to execute the control program 215. The control program 215 can also be recorded on a recording medium in such a manner as to be readable by a computer. For the recording medium, a magnetic or optical recording medium or a semiconductor memory device can be used.

[0252] Specifically, examples include a flexible disk, an HDD, a CD-ROM (Compact Disk Read Only Memory), a DVD, Blu-ray(R) Disc, a magneto-optical disk, a flash memory, a removable recording medium such as a card recording medium, or a fixed recording medium, and the like. The recording medium may be a non-volatile storage device, such as RAM or ROM, that is an internal storage device included in the control unit 21.

[0253] The method for estimating a refrigerant leak in the air-conditioning management system 1 can also be implemented by storing the control program 215 in another server device or the like, and downloading the control program 215 into the control unit 21 from the other server device.

[0254] Note that since the embodiments are to illustrate the techniques of the present disclosure, various changes, substitutions, additions, omissions, and the like can be made within the scope of claims or the scope of equivalents thereto.

(Supplements)

[0255] (Technique 1) An air conditioning system including: a plurality of indoor units; an outdoor unit; a refrigerant system that allows a refrigerant to flow between the plurality of indoor units and the outdoor unit; and a management device, wherein the management device includes an acquisition section that acquires operation data on each of the plurality of indoor units, a data processing section that performs a cleansing process on the operation data corresponding to each of the plurality of indoor units, and an estimation section that estimates, based on the operation data subjected to the cleansing process by the data processing section, whether or not a refrigerant leak occurs, and the data processing section deletes a portion of the operation data corresponding to a time frame during which, of the plurality of indoor units, at least one indoor unit performs cooling operation and at least one indoor unit performs heating operation.

[0256] With such a configuration, it is possible to restrain estimating whether or not a refrigerant leak occurs by using operation data corresponding to a time frame during which at least one indoor unit performs the cooling operation and at least one indoor unit performs the heat-

ing operation. Accordingly, when there is a time frame during which the plurality of indoor units operate in different operation modes, it is possible to properly estimate whether or not a refrigerant leak occurs.

[0257] (Technique 2) The air conditioning system according to technique 1, wherein the number of the plurality of indoor units is three or more, and the estimation section does not perform estimation of whether or not a refrigerant leak occurs in a time frame for which the operation data subjected to the cleansing process by the data processing section is the operation data on a predetermined number of indoor units or fewer, of the three or more indoor units.

[0258] With such a configuration, by appropriately setting the predetermined number, it is possible to restrain estimating whether or not a refrigerant leak occurs by using inappropriate operation data on an indoor unit. Accordingly, it is possible to properly estimate whether or not a refrigerant leak occurs.

[0259] (Technique 3) The air conditioning system according to technique 1 or 2, wherein the estimation section estimates whether or not a refrigerant leak occurs in each first period, and the data processing section deletes the operation data corresponding to an indoor unit, of the plurality of indoor units, that performs the cooling operation for a time period that is equal to or longer than a first time length and performs the heating operation for a time period that is equal to or longer than the first time length during the first period.

[0260] With such a configuration, by appropriately setting the first time length, it is possible to restrain estimating whether or not a refrigerant leak occurs by using inappropriate operation data on an indoor unit. Accordingly, it is possible to properly estimate whether or not a refrigerant leak occurs.

[0261] (Technique 4) The air conditioning system according to technique 3, wherein in the operation data corresponding to an indoor unit, of the plurality of indoor units, that performs the cooling operation for a time period that is equal to or longer than a second time length and performs the heating operation for a time period that is equal to or shorter than a third time length during the first period, the third time length being shorter than the second time length, the data processing section deletes a portion of the operation data corresponding to the time period for which the heating operation is performed, and in the operation data corresponding to an indoor unit, of the plurality of indoor units, that performs the heating operation for a time period that is equal to or longer than the second time length and performs the cooling operation for a time period that is equal to or shorter than the third time length during the first period, the data processing section deletes a portion of the operation data corresponding to the time period for which the cooling operation is performed.

[0262] With such a configuration, by appropriately setting the second time length and the third time length, it is possible to restrain estimating whether or not a refrigerant

leak occurs by using inappropriate operation data on an indoor unit. Accordingly, it is possible to properly estimate whether or not a refrigerant leak occurs.

[0263] (Technique 5) The air conditioning system according to any one of techniques 1 to 4, wherein the estimation section estimates whether or not a refrigerant leak occurs in each first period, and an instruction section is further included that causes each of the plurality of indoor units to perform the cooling operation or the heating operation when the estimation section does not perform, for a second period, estimation of whether or not a refrigerant leak occurs, the second period being longer than the first period.

[0264] With such a configuration, by setting the second period to an appropriate period, estimation of whether or not a refrigerant leak occurs can be reliably performed, for example, at least once a day. Accordingly, user convenience can be enhanced.

[0265] (Technique 6) The air conditioning system according to any one of techniques 1 to 5, wherein the estimation section estimates whether or not a refrigerant leak occurs by using a first estimation model when each of the plurality of indoor units performs the cooling operation, and estimates whether or not a refrigerant leak occurs by using a second estimation model when each of the plurality of indoor units performs the heating operation, the second estimation model being different from the first estimation model.

[0266] With such a configuration, by appropriately configuring the first estimation model and the second estimation model, it is possible to properly estimate whether or not a refrigerant leak occurs.

[0267] (Technique 7) The air conditioning system according to technique 6, wherein the first estimation model is generated by using the operation data on the plurality of indoor units and operation data on the outdoor unit for a period during which each of the plurality of indoor units performs the cooling operation, and the second estimation model is generated by using the operation data on the plurality of indoor units and the operation data on the outdoor unit for a period during which each of the plurality of indoor units performs the heating operation.

[0268] With such a configuration, the first estimation model and the second estimation model can be appropriately generated.

[0269] (Technique 8) The air conditioning system according to any one of techniques 1 to 7, wherein the data processing section generates consolidated operation data by consolidating the respective operation data corresponding to the plurality of indoor units, the consolidated operation data being operation data on one virtual indoor unit, and the estimation section estimates, based on the consolidated operation data, whether or not a refrigerant leak occurs.

[0270] With such a configuration, when a plurality of indoor units is included, it is also possible to properly estimate whether or not a refrigerant leak occurs, based on the consolidated operation data.

[0271] (Technique 9) A method for estimating a refrigerant leak in an air conditioning system in which a plurality of indoor units is connected to refrigerant piping, the method including: an acquisition step of acquiring operation data on each of the plurality of indoor units; a data processing step of performing a cleansing process on the operation data acquired in the acquisition step; and an estimation step of estimating, based on the operation data subjected to the cleansing process, whether or not a refrigerant leak occurs, wherein the data processing step includes deleting a portion of the operation data corresponding to a time frame during which, of the plurality of indoor units, at least one indoor unit performs cooling operation and at least one indoor unit performs heating operation.

[0272] With such a configuration, operation and effects similar to those of the air conditioning system according to technique 1 are brought about.

INDUSTRIAL APPLICABILITY

[0273] As described above, the air conditioning system and the method for estimating a refrigerant leak in the air conditioning system according to the present disclosure can be used for purposes of estimating whether or not a refrigerant leak occurs in an air conditioning system including a plurality of indoor units.

REFERENCE SIGNS LIST

[0274]

1 Air-conditioning management system (air conditioning system)

1A First air-conditioning management system

1B Second air-conditioning management system

2 Server device (management device)

3 Air conditioning system

3A First air conditioning system

3B Second air conditioning system

6 Smartphone

21 Control unit

21A Processor

21B Memory device

30 Control device

40, 40A, 40B, 40C Indoor unit

50, 50A, 50B Outdoor unit

211 Acquisition section

212 Data processing section

213 Estimation section

214 Instruction section

215 Control program

216 Data storage section

217 Model storage section

DI, DI1, DI2, DI3 Indoor unit data (operation data on indoor unit)

DIV Consolidated indoor unit data (consolidated operation data)

DN, DN1, DN2 Combined data

DO, DO1, DO2 Outdoor unit data (operation data on outdoor unit)

H1 First time length

H2 Second time length

H3 Third time length

M1 First estimation model

M2 Second estimation model

NA Predetermined number

P1 First period

P2 Second period

PA Predetermined period

RC Refrigerant circuit (refrigerant system)

Claims

1. An air conditioning system **characterized by** comprising:

a plurality of indoor units (40);
an outdoor unit (50);
a refrigerant system (RC) configured to allow a refrigerant to flow between the plurality of indoor units and the outdoor unit; and
a management device (2), wherein
the management device includes

an acquisition section (211) configured to acquire operation data (DI) on each of the plurality of indoor units,
a data processing section (212) configured to perform a cleansing process on the operation data corresponding to each of the plurality of indoor units, and
an estimation section (213) configured to estimate, based on the operation data subjected to the cleansing process by the data processing section, whether or not a refrigerant leak occurs, and

the data processing section deletes a portion of the operation data corresponding to a time frame during which, of the plurality of indoor units, at least one indoor unit performs cooling operation and at least one indoor unit performs heating operation.

2. The air conditioning system according to claim 1, wherein

the number of the plurality of indoor units is three or more, and

the estimation section does not perform estimation of whether or not a refrigerant leak occurs in a time frame for which the operation data subjected to the cleansing process by the data processing section is the operation data on a

- predetermined number (NA) of indoor units or fewer, of the three or more indoor units.
3. The air conditioning system according to claim 1, wherein
- the estimation section estimates whether or not a refrigerant leak occurs in each first period (P1), and
- the data processing section deletes the operation data corresponding to an indoor unit, of the plurality of indoor units, that performs the cooling operation for a time period that is equal to or longer than a first time length (H1) and performs the heating operation for a time period that is equal to or longer than the first time length during the first period.
4. The air conditioning system according to claim 3, wherein
- in the operation data corresponding to an indoor unit, of the plurality of indoor units, that performs the cooling operation for a time period that is equal to or longer than a second time length (H2) and performs the heating operation for a time period that is equal to or shorter than a third time length (H3) during the first period, the third time length being shorter than the second time length, the data processing section deletes a portion of the operation data corresponding to the time period for which the heating operation is performed, and
- in the operation data corresponding to an indoor unit, of the plurality of indoor units, that performs the heating operation for a time period that is equal to or longer than the second time length and performs the cooling operation for a time period that is equal to or shorter than the third time length during the first period, the data processing section deletes a portion of the operation data corresponding to the time period for which the cooling operation is performed.
5. The air conditioning system according to any one of claims 1 to 4, wherein
- the estimation section estimates whether or not a refrigerant leak occurs in each first period, and an instruction section (214) is further included that is configured to cause each of the plurality of indoor units to perform the cooling operation or the heating operation when the estimation section does not perform, for a second period (P2), estimation of whether or not a refrigerant leak occurs, the second period being longer than the first period.
6. The air conditioning system according to claim 1, wherein the estimation section estimates whether or not a refrigerant leak occurs by using a first estimation model (M1) when each of the plurality of indoor units performs the cooling operation, and estimates whether or not a refrigerant leak occurs by using a second estimation model (M2) when each of the plurality of indoor units performs the heating operation, the second estimation model being different from the first estimation model.
7. The air conditioning system according to claim 6, wherein
- the first estimation model is generated by using the operation data on the plurality of indoor units and operation data on the outdoor unit for a period during which each of the plurality of indoor units performs the cooling operation, and the second estimation model is generated by using the operation data on the plurality of indoor units and the operation data on the outdoor unit for a period during which each of the plurality of indoor units performs the heating operation.
8. The air conditioning system according to claim 1, wherein
- the data processing section generates consolidated operation data (DIV) by consolidating the respective operation data corresponding to the plurality of indoor units, the consolidated operation data being operation data on one virtual indoor unit, and
- the estimation section estimates, based on the consolidated operation data, whether or not a refrigerant leak occurs.
9. A method for estimating a refrigerant leak in an air conditioning system (3), the air conditioning system including a plurality of indoor units (40), an outdoor unit (50), a refrigerant system (RC) that allows a refrigerant to flow between the plurality of indoor units and the outdoor unit, and a management device (2), the method **characterized by** comprising:
- by the management device,
- an acquisition step of acquiring operation data (DI) on each of the plurality of indoor units;
- a data processing step of performing a cleansing process on the operation data acquired in the acquisition step; and
- an estimation step of estimating, based on the operation data subjected to the cleansing process, whether or not a refrigerant leak occurs, wherein the data processing step includes deleting a portion of the operation data corresponding to a time frame during which, of the plurality

of indoor units, at least one indoor unit performs cooling operation and at least one indoor unit performs heating operation.

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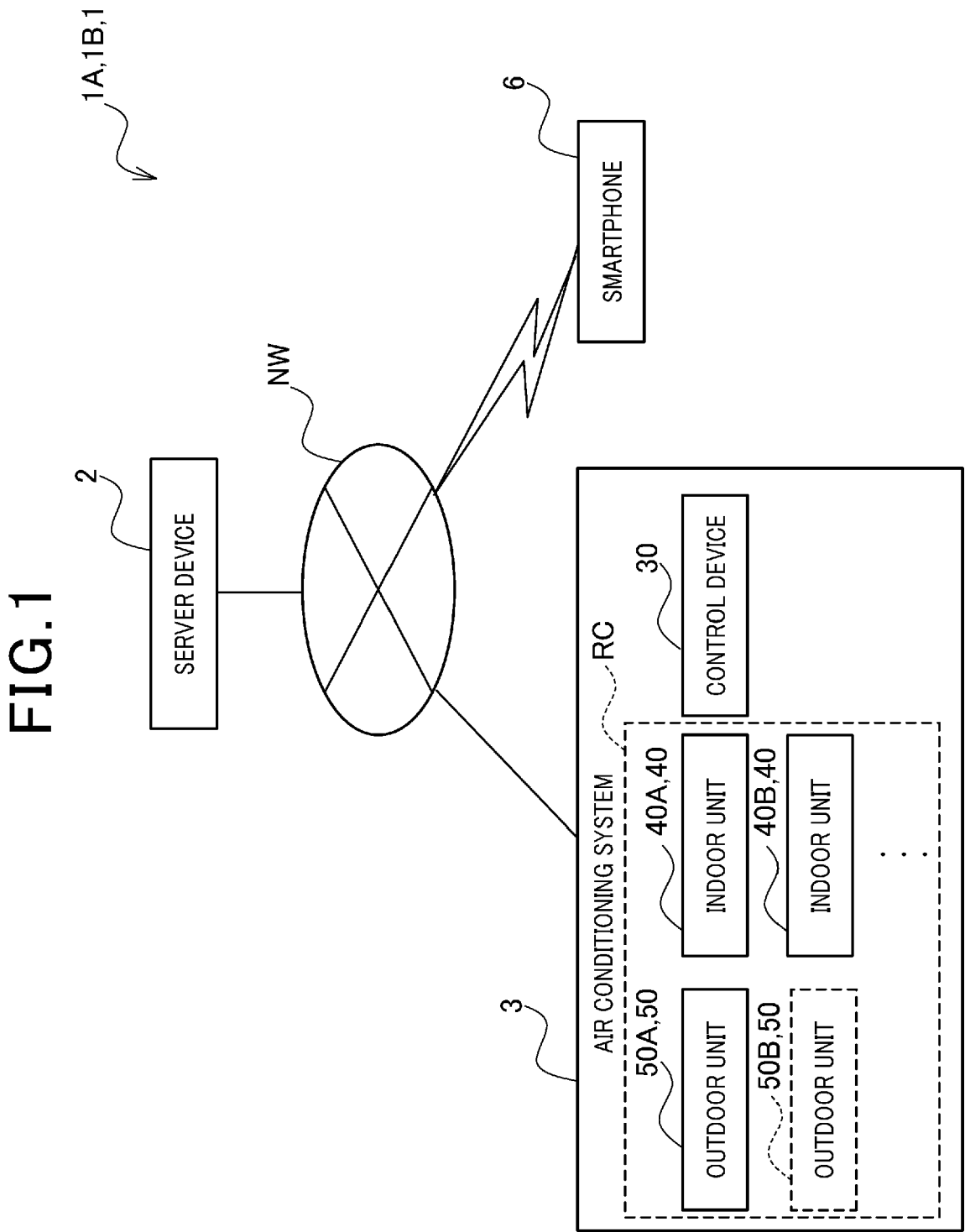


FIG.2

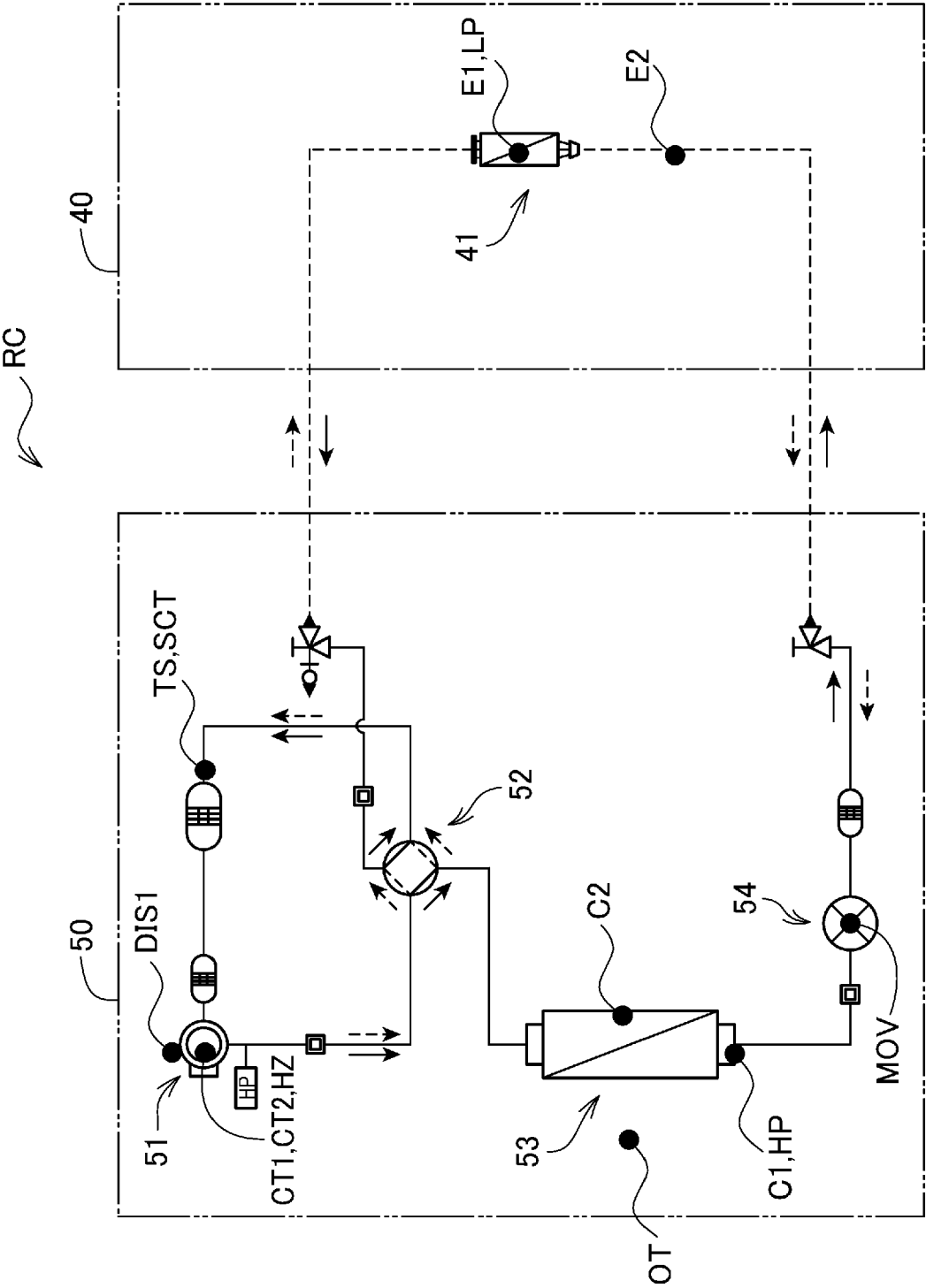


FIG.3

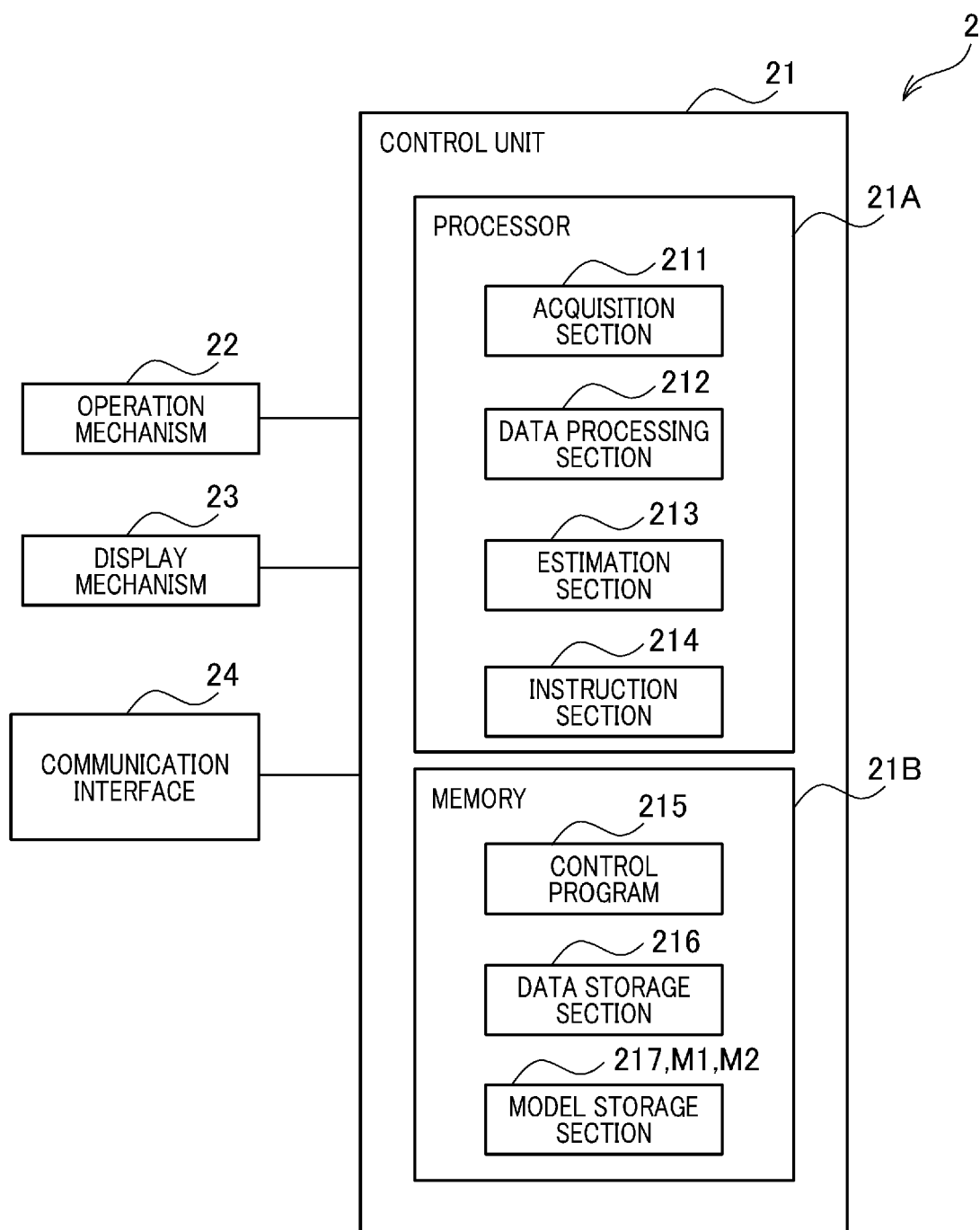


FIG.4

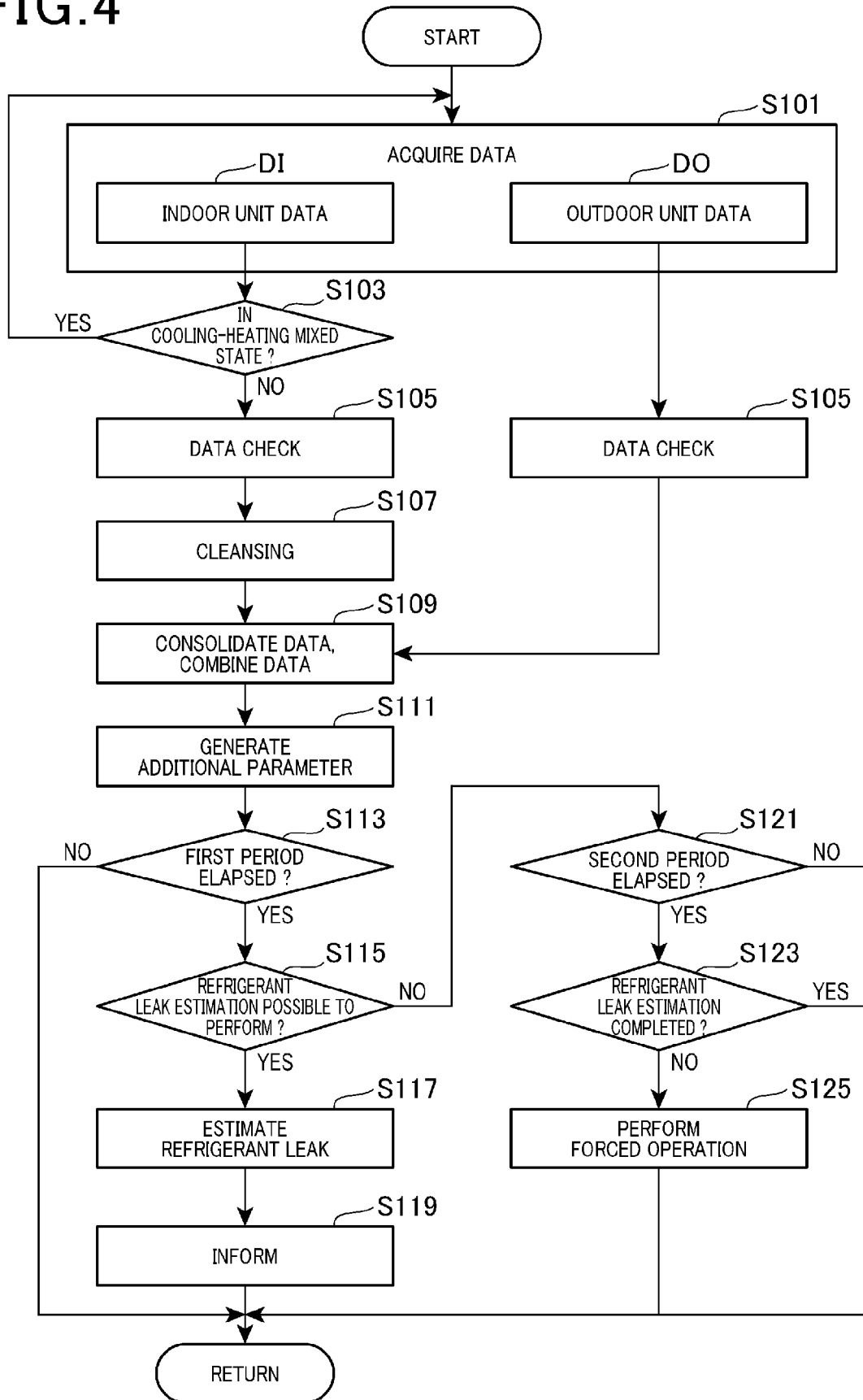


FIG.5

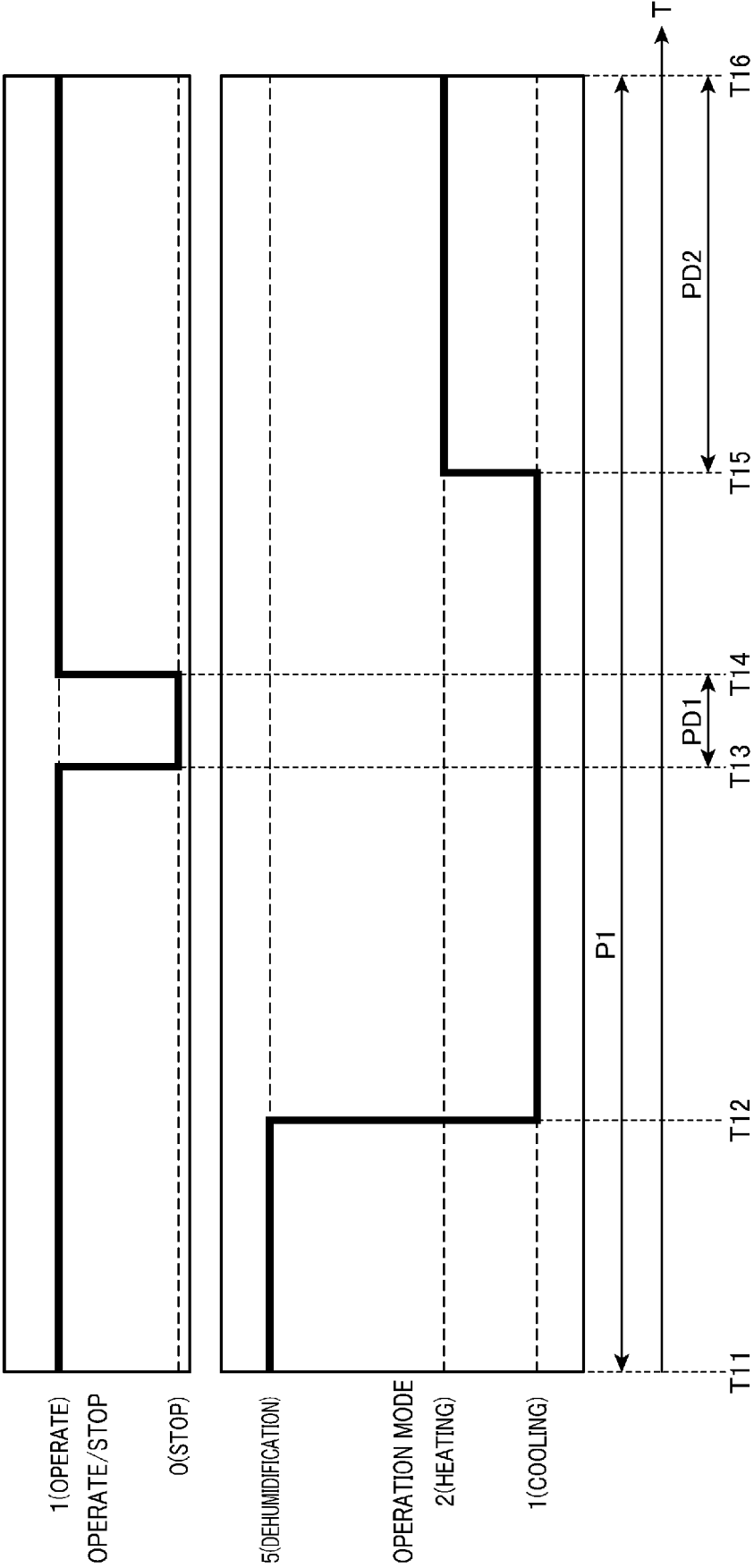


FIG.6

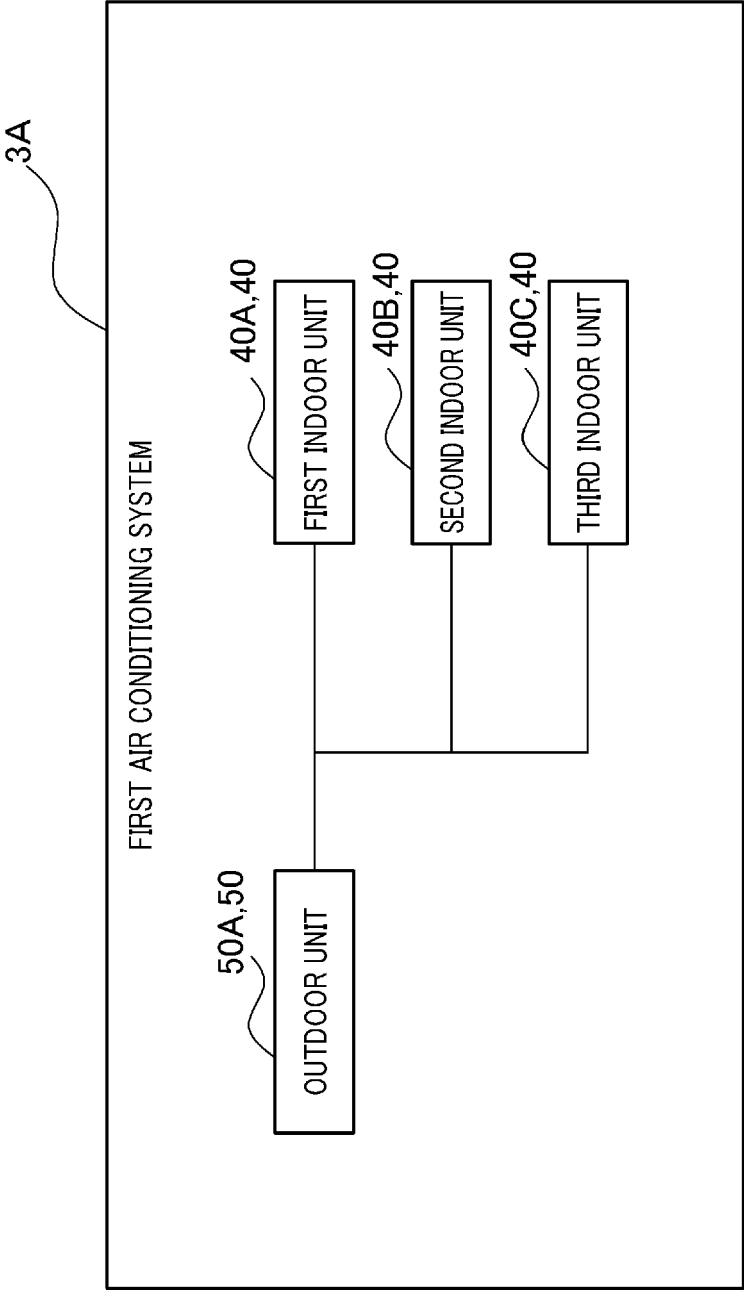


FIG.7

DA

DO

DI1

DI2

DI3

	SCT	HP	...
T1	6	22	...
T2	8	27	...
T3	4	25	...
.	.	.	...
.	.	.	...
.	.	.	...

	OPERATE/STOP	OPERATION STATE	E1 (LP)	E2	...
T1	1	1	20	18	...
T2	1	1	25	17	...
T3	1	1	23	15	...
.	.	.	.	.	...
.	.	.	.	.	...
.	.	.	.	.	...

	OPERATE/STOP	OPERATION STATE	E1 (LP)	E2	...
T1	1	1	20	17	...
T2	1	1	22	17	...
T3	1	1	22	18	...
.	.	.	.	.	...
.	.	.	.	.	...
.	.	.	.	.	...

	OPERATE/STOP	OPERATION STATE	E1 (LP)	E2	...
T1	1	1	23	22	...
T2	1	1	25	14	...
T3	1	1	21	15	...
.	.	.	.	.	...
.	.	.	.	.	...
.	.	.	.	.	...

FIG.8

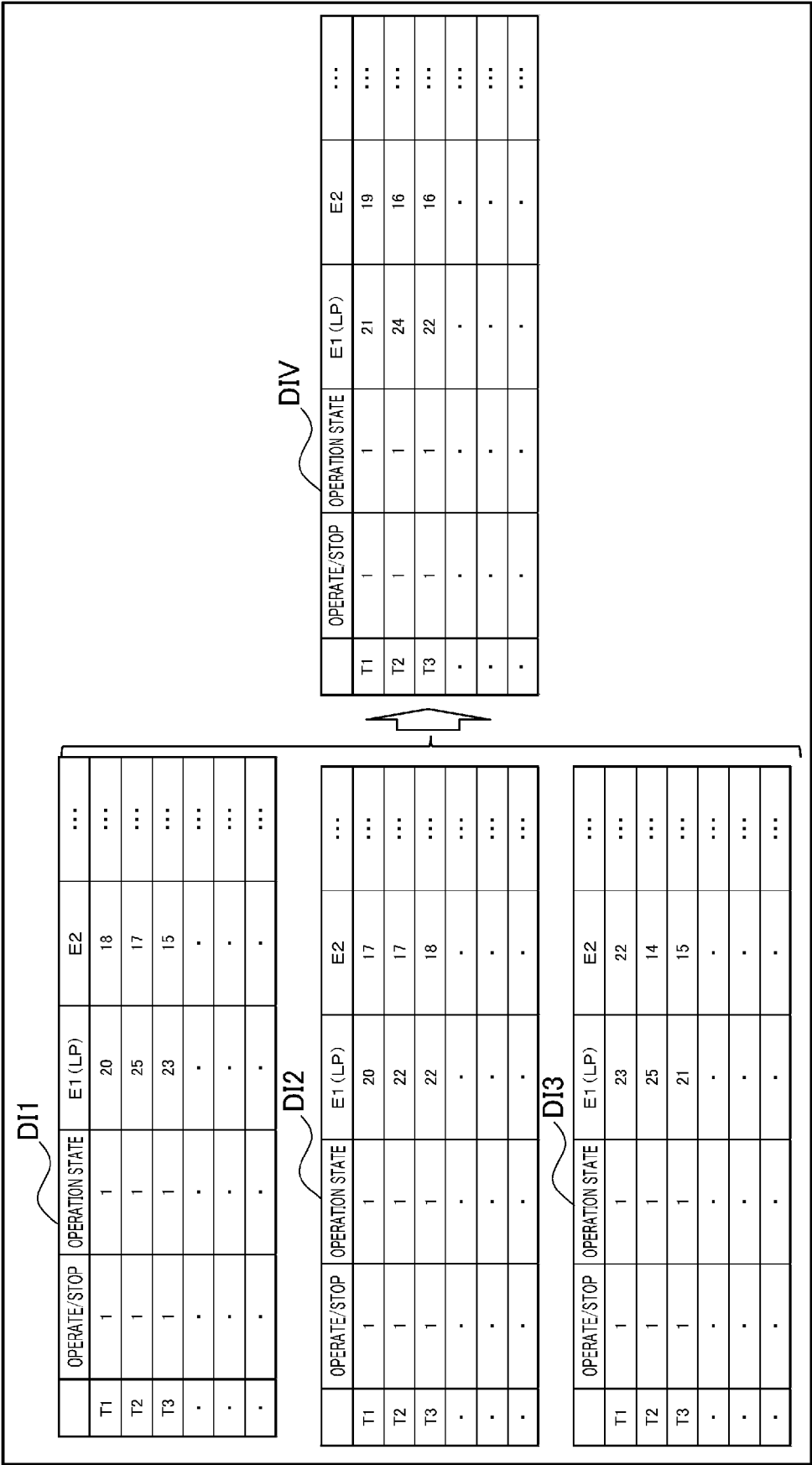


FIG.9

DB									
DO					DIV				
	SCT	HP	...	OPERATE/STOP	OPERATION STATE	E1 (LP)	E2	...	DN
T1	6	22	...	1	1	21	19	...	
T2	8	27	...	1	1	24	16	...	
T3	4	25	...	1	1	22	16	...	
.	.	.	...	.	.	.	.	...	
.	.	.	...	.	.	.	.	...	
.	.	.	...	.	.	.	.	...	

FIG. 10

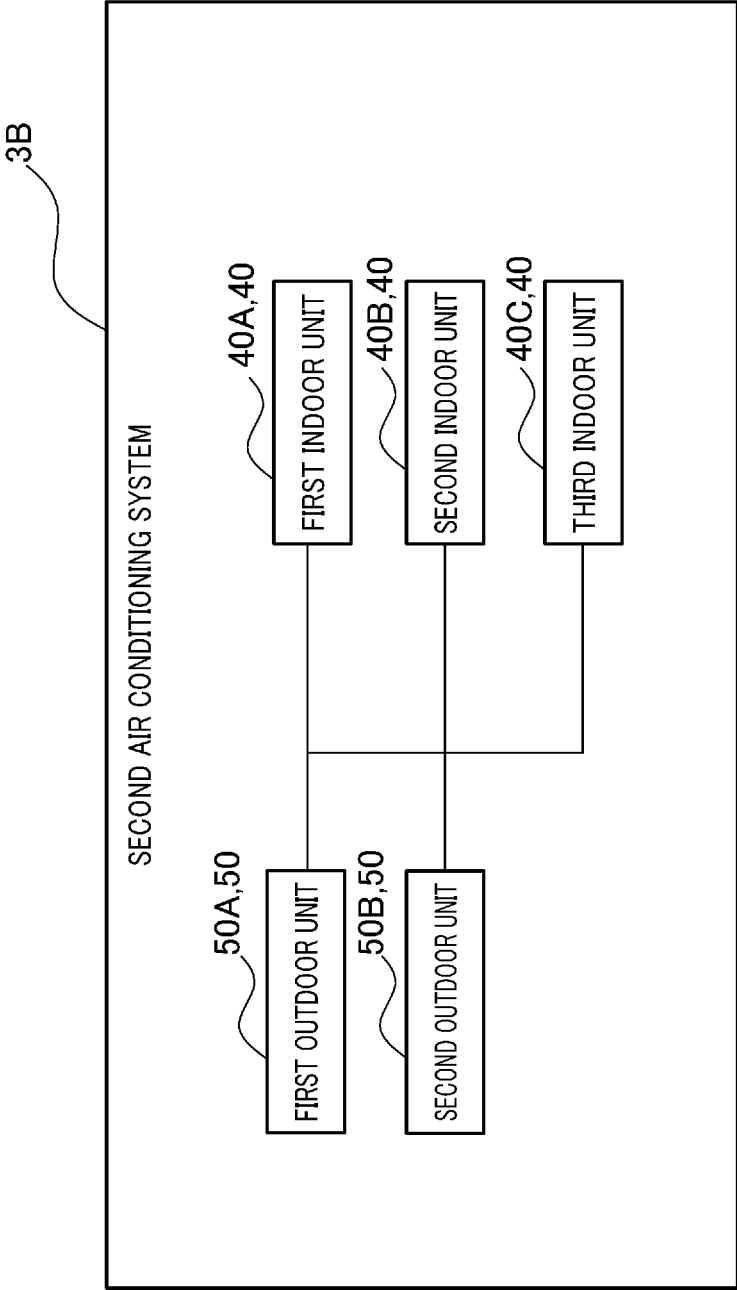


FIG.11

DA

DO1

	SCT	HP	...
T1	6	22	...
T2	8	27	...
T3	4	25	...
.	.	.	...
.	.	.	...
.	.	.	...

DO2

	SCT	HP	...
T1	6	22	...
T2	8	27	...
T3	4	25	...
.	.	.	...
.	.	.	...
.	.	.	...

DI1

	OPERATE/STOP	OPERATION STATE	E1 (LP)	E2	...
T1	1	1	20	18	...
T2	1	1	25	17	...
T3	1	1	23	15	...
.	.	.	.	.	...
.	.	.	.	.	...
.	.	.	.	.	...

DI2

	OPERATE/STOP	OPERATION STATE	E1 (LP)	E2	...
T1	1	1	20	17	...
T2	1	1	22	17	...
T3	1	1	22	18	...
.	.	.	.	.	...
.	.	.	.	.	...
.	.	.	.	.	...

DI3

	OPERATE/STOP	OPERATION STATE	E1 (LP)	E2	...
T1	1	1	23	22	...
T2	1	1	25	14	...
T3	1	1	21	15	...
.	.	.	.	.	...
.	.	.	.	.	...
.	.	.	.	.	...

FIG.12

DB

D01

	SCT	HP	...	OPERATE/STOP	OPERATION STATE	E1 (LP)	E2	...
T1	6	22	...	1	1	21	19	...
T2	8	27	...	1	1	24	16	...
T3	4	25	...	1	1	22	16	...
.	.	.	...	.	.	.	.	...
.	.	.	...	.	.	.	.	...
.	.	.	...	.	.	.	.	...

DN1,DN

D02

	SCT	HP	...	OPERATE/STOP	OPERATION STATE	E1 (LP)	E2	...
T1	6	22	...	1	1	21	19	...
T2	8	27	...	1	1	24	16	...
T3	4	25	...	1	1	22	16	...
.	.	.	...	.	.	.	.	...
.	.	.	...	.	.	.	.	...
.	.	.	...	.	.	.	.	...

DN2,DN



EUROPEAN SEARCH REPORT

Application Number

EP 24 16 1716

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EPO FORM 1503 03.82 (P04C01)

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A	* paragraph [0063] - paragraph [0077]; figures 7-8 *	4	F24F11/36 F24F11/64

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			F24F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 14 August 2024	Examiner Anconetani, Mirco
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