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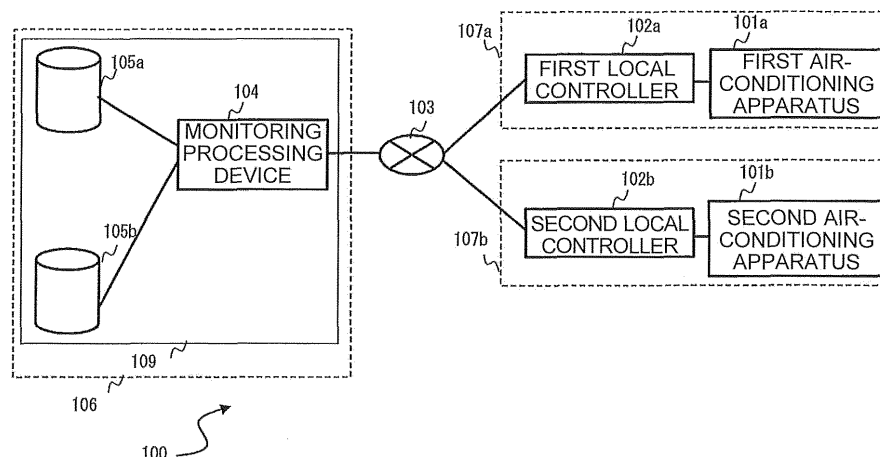
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(54) **MONITORING DEVICE AND METHOD FOR AIR CONDITIONER**

(57) According to the present invention, provided is a monitoring apparatus for monitoring air-conditioning apparatuses (109), the air-conditioning apparatuses each being configured to perform air-conditioning of a target space and each including a refrigerant circuit in which the refrigerant is circulated, the refrigerant circuit including at least a compressor (1), a heat source-side heat exchanger (3), an expansion device, and a use-side heat exchanger. The monitoring apparatus (109) includes: a storage device (105) configured to store operation data indicating an operation state of each of the

air-conditioning apparatuses (101); and a monitoring processing device configured to perform abnormality detection by extracting, from the storage device (105), operation data that is within a range of equality in an extraction condition including a kind of the refrigerant and a specification of a device included in a first air-conditioning apparatus (101 a) that is a target of monitoring by the monitoring apparatus; and comparing the extracted operation data with operation data of the air-conditioning apparatus (101 a) that is the target of monitoring.

FIG. 1



## Description

### Technical Field

**[0001]** The present invention relates to an air-conditioning apparatus monitoring apparatus and a method of monitoring air-conditioning apparatus for monitoring operation states of air-conditioning apparatuses. In particular, the present invention relates to an apparatus for detecting abnormalities of air-conditioning apparatuses.

### Background Art

**[0002]** Hitherto, there have been proposed numerous systems configured to detect an abnormality of an air-conditioning apparatus, and research and development are ongoing to enable detection of an abnormality before the air-conditioning apparatus cannot be operated. One such abnormality detection system is configured to detect an abnormality through use of data (operation data) on past operation states of air-conditioning apparatuses (e.g., refer to Patent Literature 1).

### Citation List

#### Patent Literature

**[0003]** Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2006-275411 (Fig. 1)

### Summary of Invention

#### Technical Problem

**[0004]** For example, the abnormality detection system disclosed in Patent Literature 1 uses past operation state data to detect an abnormality of an air-conditioning apparatus. The abnormality detection system compares operation data of an air-conditioning apparatus with past operation data of another air-conditioning apparatus, here referred to as a second air-conditioning apparatus, which is similar to the operation data of the air-conditioning apparatus in terms of operation condition, to thereby detect an abnormality of the air-conditioning apparatus.

**[0005]** However, in the abnormality detection system disclosed in Patent Literature 1, the two air-conditioning apparatuses are compared with each other on the assumption that the air-conditioning apparatus and the second air-conditioning apparatus have the same configuration, are installed close to each other and environmental conditions are similar to each other. Thus, operation data of an air-conditioning apparatus that deviates from the assumption cannot be referred to, which means that there is limited operation data for reference. Accordingly, there are few opportunities to acquire similar past operation data, resulting in a limited improvement in accuracy of detecting an abnormality.

**[0006]** The present invention has been made to over-

come the above-mentioned problem, and an object thereof is to provide an air-conditioning apparatus monitoring apparatus and the like, which are capable of detecting an abnormality based on a larger amount of operation data.

### Solution to Problem

**[0007]** According to one embodiment of the present invention, there is provided a monitoring apparatus for monitoring air-conditioning apparatuses, the air-conditioning apparatuses each being configured to perform air-conditioning of a target space and each including a refrigerant circuit in which refrigerant is circulated, the refrigerant circuit including at least a compressor, a heat source-side heat exchanger, an expansion device, and a use-side heat exchanger, the monitoring apparatus comprising: a storage device configured to store operation data indicating an operation state of the air-conditioning apparatuses; and a monitoring processing device configured to perform abnormality detection by extracting, from the storage device, operation data that is within a range of equality in an extraction condition including a kind of the refrigerant and a specification of a device included in the air-conditioning apparatus that is a target of monitoring by the monitoring apparatus, and comparing the extracted operation data with operation data of the air-conditioning apparatus that is the target of monitoring

### Advantageous Effects of Invention

**[0008]** According to the one embodiment of the present invention, the operation data of the plurality of air-conditioning apparatuses is collected and stored for a fixed period of time, and a larger amount of operation data to be compared with operation data of the air-conditioning apparatus that is the target of monitoring (target of abnormality detection) can be acquired. Therefore, it is possible to provide the monitoring apparatus for monitoring air-conditioning apparatuses, which is capable of performing the abnormality detection more quickly and accurately than the related art.

### Brief Description of Drawings

#### [0009]

[Fig. 1] Fig. 1 is a diagram for illustrating a system configuration of an air-conditioning apparatus monitoring system 100 according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a block diagram for illustrating a configuration of a monitoring processing device 104 according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is a block diagram for illustrating a configuration of a storage device 105 according to Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is a diagram for illustrating a device configuration and other configurations of an air-conditioning apparatus 101 according to Embodiment 1 of the present invention.

[Fig. 5] Fig. 5 is a diagram for illustrating a flow of processing of abnormality detection and other processing according to Embodiment 1 of the present invention.

[Fig. 6] Fig. 6 is a diagram for illustrating a flow of processing of extracting operation data according to Embodiment 1 of the present invention.

[Fig. 7] Fig. 7 is a table for showing a relationship between an abnormality detection mode and an abnormality detection method according to Embodiment 1 of the present invention.

[Fig. 8] Fig. 8 is a graph for showing an example of a relationship between steady indicator data and monitoring data, which are on a feature value and a variable item, according to Embodiment 1 of the present invention.

[Fig. 9] Fig. 9 is a table for showing an example of a relationship between classification items and storage locations of operation data according to Embodiment 2 of the present invention.

[Fig. 10] Fig. 10 is a table for showing an example of a relationship between related items and air-conditioning apparatuses according to Embodiment 3 of the present invention.

#### Description of Embodiments

**[0010]** Now, an air-conditioning apparatus monitoring system according to embodiments of the present invention is described with reference to the drawings. In the drawings, components denoted by the same reference symbols correspond to the same or equivalent components. This is common throughout the embodiments described below. Further, the forms of the components described herein are merely examples, and the components are not limited to the forms described herein. In particular, the combinations of the components are not limited to only the combinations in each embodiment, and the components described in another embodiment may be applied to still another embodiment. Further, unless otherwise necessary to be distinguished or specified, a plurality of devices of the same type or other components, which are distinguished from one another by suffixes or in another way, may be described without the suffixes. Further, in the drawings, the size relationship between the components may be different from the actual size relationship. In addition, a high-and-low relationship or other relationships of temperature, pressure, or other factors are not determined in relation to particular absolute values, but are determined in a relative manner based on a state, an operation, or other factors of systems, devices, or other conditions.

#### Embodiment 1

##### <Device Configuration>

**[0011]** Fig. 1 is a diagram for illustrating a system configuration of an air-conditioning apparatus monitoring system 100 according to Embodiment 1 of the present invention, which is constructed mainly by an air-conditioning apparatus monitoring apparatus 109. Now, a description is given of the configuration of the air-conditioning apparatus monitoring system 100 of Embodiment 1 with reference to Fig. 1. The air-conditioning apparatus monitoring system 100 of Embodiment 1 includes the air-conditioning apparatus monitoring apparatus 109 configured to monitor an air-conditioning apparatus 101 and perform abnormality detection and other processing. The air-conditioning apparatus monitoring system 100 of Embodiment 1 includes a first air-conditioning apparatus 101 a and a second air-conditioning apparatus 101 b as the air-conditioning apparatus 101. In addition, the air-conditioning apparatus monitoring system 100 includes a local controller 102, which corresponds to each air-conditioning apparatus 101 and is configured to perform control of the air-conditioning apparatus 101 and other processing.

**[0012]** A first local controller 102a is configured to perform control of the first air-conditioning apparatus 101 a and other processing, and a second local controller 102b is configured to perform control of the second air-conditioning apparatus 101b and other processing. Further, the air-conditioning apparatus 101 and the local controller 102 are installed in a housing 107 such as a building, an apartment building, or a commercial facility. The first air-conditioning apparatus 101 a and the first local controller 102a are installed in a housing 107a, and the second air-conditioning apparatus 101 b and the second local controller 102b are installed in a housing 107b.

**[0013]** In Embodiment 1, the first air-conditioning apparatus 101 a is set as an air-conditioning apparatus to be monitored (to be subjected to abnormality detection). Further, the second air-conditioning apparatus 101 b is set as an air-conditioning apparatus whose operation data is to be collected by a monitoring processing device 104. Thus, although only one second air-conditioning apparatus 101 b is illustrated in Fig. 1, the plurality of second air-conditioning apparatuses 101b are connected to an electrical communication line 103 via the local controllers 102 in actuality. The lower the number of second air-conditioning apparatuses 101 b is, the larger the amount of available operation data is expected. The first air-conditioning apparatus 101 a may be the second air-conditioning apparatus 101 b, namely, an air-conditioning apparatus for collection of operation data. Further, the second air-conditioning apparatus 101 b may be the first air-conditioning apparatus 101 a, namely, an air-conditioning apparatus to be monitored.

**[0014]** Further, the air-conditioning apparatus monitoring system 100 includes the air-conditioning apparatus

monitoring apparatus 109 including the monitoring processing device 104 and a storage device 105 in a remote management center 106. The monitoring processing device 104 is connected to each local controller 102 described above via the electrical communication line 103 for communication, and can transmit/receive signals containing various kinds of data. The monitoring processing device 104 of Embodiment 1 is configured to perform processing such as abnormality detection and storage of data into the storage device 105 for data contained in signals transmitted from each local controller 102. The storage device 105 is connected to the monitoring processing device 104 for communication. The storage device 105 is configured to store data contained in signals transmitted from the monitoring processing device 104. Further, the storage device 105 transmits, to the monitoring processing device 104, signals containing operation data necessary for the monitoring processing device 104 to perform processing. In Embodiment 1, it is assumed that the air-conditioning apparatus monitoring apparatus 109 includes two storage devices 105, namely, a storage device 105a and a storage device 105b.

**[0015]** The local controller 102 is connected to the corresponding air-conditioning apparatus 101 for communication directly or via a dedicated adaptor, and can communicate to/from the air-conditioning apparatus 101. Further, the local controller 102 is also connected to the monitoring processing device 104 via the electrical communication line 103, and can communicate to/from the monitoring processing device 104. The local controller 102 controls the air-conditioning apparatus 101 by giving an instruction to the air-conditioning apparatus 101 based on operation data, which is data on an operation of the air-conditioning apparatus 101 transmitted regularly from the air-conditioning apparatus 101. Further, the local controller 102 stores operation data, which is obtained from the air-conditioning apparatus 101, for a predetermined period of time (e.g., one day), and transmits the operation data to the monitoring processing device 104 regularly.

**[0016]** Fig. 2 is a block diagram for illustrating a configuration of the monitoring processing device 104 according to Embodiment 1 of the present invention. The monitoring processing device 104 of Embodiment 1 includes an arithmetic unit 120, a control unit 121, a communication unit 122, a display unit 123, and a storage unit 124. The arithmetic unit 120 is configured to perform arithmetic operations necessary for the control unit 121 to perform processing, for example, calculation of an average value of pieces of indicator data. The control unit 121 is configured to coordinate operations to be executed by the monitoring processing device 104, such as an instruction of operation-related data to the local controller 102, selection of an abnormality detection mode, and abnormality detection.

**[0017]** The communication unit 122 is configured to acquire signals containing operation data transmitted from the local controller 102 via the electrical communi-

cation line 103. Further, the communication unit 122 receives past operation data stored in the storage device 105, and transmits operation data acquired from the local controller 102 to the storage device 105. In Embodiment 1, as described later, it is assumed that the communication unit 122 transmits, to the storage device 105, operation data that is determined by the control unit 121 as data to be stored into the storage device 105. The display unit 123 is configured to display, for example, a result of processing performed by the control unit 121. In Embodiment 1, the display unit 123 displays a determination result in the abnormality detection processing. The storage unit 124 is configured to store data necessary for the monitoring processing device 104 to perform processing, for example, operation data transmitted from the local controller 102.

**[0018]** Units of the monitoring processing device 104 of Embodiment 1, such as the arithmetic unit 120 and the control unit 121, can be implemented as apparatuses by respectively different pieces of hardware. In this description, while respective units of the monitoring processing device 104 are implemented by arithmetic control means (computer), for example, a central processing unit (CPU), those processing procedures may be programed in advance and implemented by, for example, software and firmware. The arithmetic control means executes those programs to perform processing based on those programs, to thereby implement processing performed by the respective units described above. Data of those programs may be stored in, for example, the storage unit 124.

**[0019]** Fig. 3 is a block diagram for illustrating a configuration of the storage device 105 according to Embodiment 1 of the present invention. The storage device 105 of Embodiment 1 includes two storage devices 150 (150a and 150b). Further, respective storage devices 150 include communication units 140 (140a and 140b) and storage units 141 (141a and 141b). The communication unit 140 is configured to communicate signals containing operation data to/from the monitoring processing devices 104. Further, the storage unit 141 is configured to store operation data transmitted from the monitoring processing device 104. For example, data (e.g., data on used refrigerant and component devices) on the second air-conditioning apparatus 101b and operation data of the second air-conditioning apparatus 101b are stored in association with each other. Further, the storage device 105 transmits, to the monitoring processing device 104, operation data necessary for the monitoring processing device 104 to perform processing. The storage device 105 desirably has a storage capacity of operation data for approximately one year of the first air-conditioning apparatus 101a and the second air-conditioning apparatus 101b though the storage capacity is not particularly limited thereto. For example, when operation data can be stored for one year after installation of the air-conditioning apparatus, it is possible to store a series of pieces of operation data on outside air temperature and indoor

loads for respective seasons. Further, for example, operation data for three or more years may be stored in vain because operation data that contains a variation due to degradation over time may be used for abnormality detection, resulting in a failure to detect an abnormality due to degradation over time.

**[0020]** Fig. 4 is a diagram for illustrating a device configuration and other configurations of the air-conditioning apparatus 101 according to Embodiment 1 of the present invention. As described above, the air-conditioning apparatus 101 is installed in the housing 107. The air-conditioning apparatus 101 of Embodiment 1 is an apparatus capable of employing vapor-compression refrigeration to perform refrigerant cycle operations for circulating refrigerant for air conditioning, to thereby cause each use unit 303 to process the selected cooling instruction (cooling on/off) or heating instruction (heating on/off) and cool or heat an air-conditioning target space. The air-conditioning apparatus 101 of Embodiment 1 is configured such that a heat source unit 301 and the use units 303 (303a and 303b) are connected to each other via an indoor liquid pipe 27 and an indoor gas pipe 28, which serve as refrigerant pipes.

<Heat Source Unit 301>

**[0021]** The heat source unit 301 of Embodiment 1 includes a compressor 1, a four-way valve 2, a heat source-side heat exchanger 3, a heat source-side air-sending device 4, a subcooling heat exchanger 11, an accumulator 19, a bypass pressure reducing mechanism 20, and a bypass pipe 21. The compressor 1 is configured to suck and compress refrigerant such that the compressed refrigerant has high temperature and high pressure, and discharge the refrigerant. The compressor 1 of Embodiment 1 includes, for example, an inverter apparatus, and can finely change the capacity (amount of refrigerant to be sent out per unit time) of the compressor 1 by enabling the number of revolutions (driving frequency) to be controlled. In this case, the compressor 1 is one of devices for controlling refrigerant pressure. The four-way valve 2 is a valve configured to switch the direction in which the refrigerant flows. The four-way valve 2 has four ports, namely, first to fourth ports. The first port, the second port, the third port, and the fourth port are connected to a discharge side of the compressor 1, the heat source-side heat exchanger 3, a suction side of the compressor 1, and the indoor gas pipe 28, respectively. The four-way valve 2 changes the flow passage by switching between a state (state indicated by solid line of Fig. 1) in which the first port and the second port communicate to each other and the third port and the fourth port communicate to each other and a state (state indicated by broken line of Fig. 1) in which the first port and the fourth port communicate to each other and the second port and the third port communicate to each other.

**[0022]** The heat source-side heat exchanger 3 is, for example, a cross-fin type fin- and-tube heat exchanger

including a heat transfer tube and many fins. The heat source-side heat exchanger 3 is configured to, for example, exchange heat between outside air and refrigerant. The heat source-side heat exchanger 3 serves as an evaporator configured to evaporate and vaporize refrigerant at the time of, for example, a heating operation. Further, the heat source-side heat exchanger 3 serves as a condenser configured to condense and liquify refrigerant in a cooling operation. Further, the heat source-side air-sending device 4 is a propeller fan or other devices to be driven by a motor (not shown) including, for example, a DC fan motor. The heat source-side air-sending device 4 is configured to supply, for example, outside air to the heat source-side heat exchanger 3. The heat source-side air-sending device 4 of Embodiment 1 comprises a fan capable of changing the flowrate of air to be supplied to the heat source-side heat exchanger 3. In this case, the heat source-side air-sending device is one of devices for controlling refrigerant pressure. The accumulator 19 is configured to store excessive refrigerant in the refrigerant circuit during the operation. Further, the accumulator 19 accumulates liquid refrigerant that temporarily occurs at the time of change in operation state, to thereby prevent a large amount of liquid refrigerant from flowing into the compressor 1.

**[0023]** The subcooling heat exchanger 11 comprises, for example, a double pipe heat exchanger. The subcooling heat exchanger 11 includes a first flow passage and a second flow passage, and is an intermediate heat exchanger configured to exchange heat between flows of refrigerant passing through respective flow passages. Refrigerant flowing into or out of the heat source-side heat exchanger 3 passes through the first flow passage, while a refrigerant that has passed through the bypass pressure reducing mechanism 20 flows into the second flow passage and then out to the bypass pipe 21. The subcooling heat exchanger 11 is not limited to the double pipe heat exchanger, and may have any structure as long as the subcooling heat exchanger 11 allows exchange of heat between the refrigerant passing through the first flow passage and the refrigerant passing through the second flow passage. The bypass pressure reducing mechanism 20 is configured to adjust the pressure and flowrate of refrigerant passing through the subcooling heat exchanger 11 and the bypass pipe 21.

**[0024]** In the heat source unit 301, a pressure sensor 201 is provided to a discharge side pipe of the compressor 1 and a pressure sensor 211 is provided to a suction-side pipe of the compressor 1. The pressure sensor 201 and the pressure sensor 211 are configured to measure (detect) pressures of refrigerant at respective installation positions. Further, a temperature sensor 202 is provided to the discharge side of the compressor 1, and a temperature sensor 203 is provided to a liquid side (liquid refrigerant side or two-phase gas-liquid refrigerant passage side) of the heat source-side heat exchanger 3. Further, a temperature sensor 207 is installed between a high-pressure side of the subcooling heat exchanger 11 and

an indoor liquid pipe, a temperature sensor 212 is installed between the bypass pressure reducing mechanism 20 and a low-pressure side of the subcooling heat exchanger 11, and a temperature sensor 213 is installed at a low-pressure side outlet of the subcooling heat exchanger 11. Each temperature sensor is configured to measure refrigerant temperature at the installation position. Further, an outside air temperature sensor 204 is installed at, for example, an air inlet of the heat source unit 301, and is configured to measure outside air temperature.

**[0025]** Further, the air-conditioning apparatus 101 includes a controller 108 configured to control the operation state of the air-conditioning apparatus 101. In Embodiment 1, the controller 108 transmits operation data, which is obtained by, for example, measurement by various types of sensors installed in the air-conditioning apparatus 101, to the local controller 102.

<Use Unit 303>

**[0026]** The use unit 303 includes a use-side pressure reducing mechanism 14 and a use-side heat exchanger 15. The use-side pressure reducing mechanism 14 is configured to adjust the amount and pressure of refrigerant passing through the use-side heat exchanger 15. The use-side heat exchanger 15 is configured to exchange heat between air and refrigerant in, for example, the air-conditioning target space. For example, the use-side heat exchanger 15 serves as a condenser in a heating operation, and condenses and liquifies refrigerant. Further, the use-side heat exchanger 15 serves as an evaporator in a cooling operation, and evaporates and vaporizes refrigerant.

**[0027]** Further, in the use unit 303, a temperature sensor 208 is provided to a liquid side (liquid refrigerant side or two-phase gas-liquid refrigerant passage side) of the use-side heat exchanger 15. Further, the temperature sensor 208 is provided to a gas side (gas refrigerant side or two-phase gas-liquid refrigerant passage side) of the use-side heat exchanger 15. Further, a temperature sensor 210 is configured to measure temperature of indoor air (air of air-conditioning target space).

<Normal Operation Mode>

**[0028]** In the air-conditioning apparatus 101, the controller 108 controls devices included in the heat source unit 301 and the use unit 303 in accordance with an instruction for air-conditioning required by the use unit 303 and operates in a cooling operation mode or a heating operation mode, to thereby achieve air conditioning for the air-conditioning target space.

**[0029]** First, the cooling operation mode is described. In the cooling operation mode, the controller 108 switches the four-way valve 2 such that the first port and the second port communicate to each other and the third port and the fourth port communicate to each other at the

same time.

**[0030]** The high-temperature, high-pressure gas refrigerant discharged from the compressor 1 flows into the heat source-side heat exchanger 3 via the four-way valve 2. The refrigerant, which has flowed into the heat source-side heat exchanger 3, rejects heat into the outside air through air sent by the heat source-side air-sending device 4. After that, the subcooling heat exchanger 11 cools the refrigerant by a low-pressure refrigerant, and then, the refrigerant is divided into refrigerant flowing through the indoor liquid pipe 27 and refrigerant flowing through the bypass pressure reducing mechanism 20. The pressure of the refrigerant flowing through the indoor liquid pipe 27 is reduced by the use-side pressure reducing mechanism 14, and the refrigerant turns into low-pressure two-phase refrigerant. Then, the low-pressure two-phase refrigerant cools indoor air while passing through the use-side heat exchanger 15, and turns into low-pressure gas refrigerant. After that, the low-pressure gas refrigerant flows through the indoor gas pipe 28 and the four-way valve 2 into the accumulator 19, and then is sucked into the compressor 1 again.

**[0031]** The controller 108 controls the compressor 1 such that evaporating temperature in the use-side heat exchanger 15 is a predetermined value. The evaporating temperature is saturation temperature under the pressure detected by the pressure sensor 211. Further, the controller 108 controls the heat source-side air-sending device 4 such that condensing temperature in the heat source-side heat exchanger 3 is a predetermined value. The condensing temperature is saturation temperature under the pressure detected by the pressure sensor 201. Further, the controller 108 controls the bypass pressure reducing mechanism 20 such that a degree of bypass superheat is a predetermined value. The degree of bypass superheat is a temperature difference obtained by subtracting the temperature detected by the temperature sensor 212 from the temperature detected by the temperature sensor 213. Further, the controller 108 controls the use-side pressure reducing mechanism 14a such that a degree of indoor superheat is a predetermined value. The degree of indoor superheat is a temperature difference obtained by subtracting the temperature detected by the temperature sensor 208 from the temperature detected by the temperature sensor 209.

**[0032]** On the other hand, in the heating operation mode, the controller 108 switches the four-way valve 2 such that the first port and the second port communicate to each other and the third port and the fourth port communicate to each other at the same time. Further, the bypass pressure reducing mechanism 20 has a fully closed opening degree.

**[0033]** The high-temperature and high-pressure gas refrigerant discharged from the compressor 1 flows through the four-way valve 2 into the indoor gas pipe 28, heats indoor air in the use-side heat exchanger 15, and turns into a high-pressure liquid refrigerant. After that, the pressure of the high-pressure liquid refrigerant is re-

duced by the use-side pressure reducing mechanism 14, and the refrigerant turns into low-pressure two-phase refrigerant. Then, the low-pressure two-phase refrigerant passes through the subcooling heat exchanger 11 via the indoor liquid pipe 27, and flows into the heat source-side heat exchanger 3. The refrigerant, which has flowed into the heat source-side heat exchanger 3, receives heat from outside air, and turns into low-pressure gas refrigerant. Then, the low-pressure gas refrigerant passes through the accumulator 19 via the four-way valve 2, and is sucked into the compressor 1 again.

**[0034]** The controller 108 controls the compressor 1 such that condensing temperature in the use-side heat exchanger 15 is a predetermined value. Further, the controller 108 controls the heat source-side air-sending device 4 such that evaporating temperature in the heat source-side heat exchanger 3 is a predetermined value. Further, the controller 108 controls the use-side pressure reducing mechanism 14a such that a degree of indoor subcooling is a predetermined value. The degree of indoor subcooling is a temperature difference obtained by subtracting the temperature detected by the temperature sensor 208 from the saturation temperature under the pressure detected by the pressure sensor 201.

#### <Abnormality Detection Processing>

**[0035]** Fig. 5 is a diagram for illustrating a flow of processing of abnormality detection and other processing according to Embodiment 1 of the present invention. Now, a description is given of processing to be performed by the air-conditioning apparatus monitoring apparatus 109 (monitoring processing device 104) of Embodiment 1 with reference to Fig. 5. The description is based on the assumption that the monitoring processing device 104 uses operation data of the first air-conditioning apparatus 101 a in the cooling operation mode to perform abnormality determination processing.

**[0036]** In Step S1, when one day has passed (for example, when twelve o'clock at night is reached), each local controller 102 transmits a signal. The communication unit 122 of the monitoring processing device 104 obtains operation data of each air-conditioning apparatus 101 from the transmitted signal. The operation data is stored into the storage unit 124. In this description, it is assumed that the operation data is collected on a day-to-day basis, but the frequency is not limited thereto.

**[0037]** Then, in Step S2, the monitoring processing device 104 extracts data on operations in a steady state from among transmitted operation data as monitoring data. Determination of monitoring data is performed as follows. First, steady state parameters for determining whether or not the air-conditioning apparatus 101 is in the steady state are defined in advance. In Embodiment 1, for example, the steady state parameters are the driving frequency of the compressor 1, the pressure (high pressure) detected by the pressure sensor 201, the pressure (low pressure) detected by the pressure sensor 211,

the degree of heat source-side outlet subcooling (saturation temperature converted from pressure detected by pressure sensor 201 - temperature detected by temperature sensor 203) and the degree of bypass superheat (temperature detected by temperature sensor 213 - temperature detected by temperature sensor 212). The arithmetic unit 120 calculates a moving average value of detection values (instantaneous values) for 15 minutes in relation to each steady state parameter. After that, when a difference between the moving average value and each instantaneous value at each measurement time is equal to or smaller than a predetermined value, for example, the arithmetic unit 120 determines that the steady state parameter at that measurement time is stable. Then, the arithmetic unit 120 sets, as the steady state, a state in which all the steady determination parameters are determined as being stable. In this description, a predetermined value is used, but an aberration or other values may be used to perform determination. The calculation and determination as described above are executed at each measurement time, and operation data in a measurement time determined as being the steady state is extracted as monitoring data for that day.

**[0038]** In Step S3, the monitoring processing device 104 selects an abnormality detection mode for determining an abnormality. The abnormality detection mode in Embodiment 1 is refrigerant amount insufficiency detection, heat exchanger contamination detection for a heat source-side heat exchanger, lock detection for the bypass pressure reducing mechanism 20, or compressor degradation detection.

**[0039]** Fig. 6 is a diagram for illustrating a flow of processing of extracting operation data according to Embodiment 1 of the present invention. In Step S4, the monitoring processing device 104 selects the second air-conditioning apparatus 101 b having the same heat amount and the same processing effect associated with the heat amount as the first air-conditioning apparatus 101 a, for example, the second air-conditioning apparatus 101 b having the same model as the first air-conditioning apparatus 101 a, and performs processing of extracting indicator data from operation data of the selected second air-conditioning apparatus 101 b. In the selection of the second air-conditioning apparatus 101 b, the air-conditioning apparatus monitoring apparatus 109 determines whether or not such condition of equality, or equality condition, is satisfied for, for example, devices constituting the air-conditioning apparatus (refrigerant circuit) and other processing. However, depending on specifics of a condition, the equality condition does not always require rigid equality and the equality condition may have a predefined range (range of equality) in which the equality condition can be determined as being satisfied.

**[0040]** First, in Step S30, the monitoring processing device 104 determines whether or not the type of refrigerant included in the refrigerant circuit is the same. When the type of refrigerant differs, the way of controlling devices constituting the refrigerant circuit also differs, lead-

ing to different pieces of operation data. When it is determined that the type of refrigerant is the same, in Step S31, the monitoring processing device 104 determines whether or not a specification of the compressor 1 is the same. The specification of the compressor 1 includes, for example, a compressor cylinder capacity and a compressor type (e.g., scroll compressor and rotary compressor). When the specification of the compressor 1 is the same, the condition on the refrigerant flowrate (cooling capacity) can be considered as being equal.

**[0041]** Further, in Step S32, the monitoring processing device 104 determines whether or not the specification of the heat source-side heat exchanger 3 is the same. The specification of the heat source-side heat exchanger 3 includes, for example, the shape of fin, the pipe outer heat transfer area, and the pipe inner heat transfer area. When the monitoring processing device 104 determines that the specification of the heat source-side heat exchanger 3 is the same, in Step S33, the monitoring processing device 104 further determines whether or not the specification of the heat source-side air-sending device 4 is the same. The specification of the heat source-side air-sending device 4 includes, for example, the shape of fin (e.g., propeller fan) and the range of number of revolutions. When the specification of the heat source-side heat exchanger 3 is the same, the condition on the heat transfer area can be considered as being equal. Further, when the specification of the heat source-side air-sending device 4 is the same, the condition on the flowrate can be considered as being equal. Thus, it is possible to consider that the condition on the heat transfer performance in the heat source-side heat exchanger 3 is equality.

**[0042]** For example, regarding the second air-conditioning apparatus 101 b, when the used refrigerant is the same, and the specifications of the compressor 1, the heat source-side heat exchanger 3, and the heat source-side air-sending device 4 can be considered as being equal, the processable heat amount and the processing efficiency are almost the same even under different specifications of other devices (e.g., pressure reducing mechanism type and accumulator) and other different conditions. As a result, past operation data of the first air-conditioning apparatus 101 a stored in the storage device 105 serves as indicator data. Further, for example, in the development of an air-conditioning apparatus, an air-conditioning apparatus having another model name is often released although only a part of the specification is changed from existing one. Under such circumstances, operation data of the second air-conditioning apparatus 101 b having a different model name but satisfying conditions can be used to detect an abnormality of the first air-conditioning apparatus 101 a. Thus, it is possible to drastically increase the amount of operation data that can be referred to in the abnormality detection processing. As a result, more opportunities for detection can be obtained and the detection accuracy improves.

**[0043]** Further, in Embodiment 1, in Step S34, the mon-

itoring processing device 104 determines whether or not precipitation or wind speed is excessive (whether or not operation data does not satisfy weather conditions). Data on weather (weather information) is used to avoid extraction of operation data, which is obtained when the air-conditioning apparatus is operated under extreme weather conditions, for example, a typhoon, as indicator data, to thereby prevent erroneous detection in the abnormality detection. In this case, excessive precipitation is set as, for example, a day on which a heavy rain warning or a heavy rain advisory is issued in the installation area of the second air-conditioning apparatus 101 b (housing 107b). Further, excessive wind speed is set as, for example, a day on which a storm warning or a storm advisory is issued in the installation area of the second air-conditioning apparatus 101 b. To implement the determination in Step S34, for example, weather information provided from external institutions and operation data are associated with each other and stored in the storage device 105. Further, for example, it may be determined whether or not precipitation or wind speed is excessive based on specific values (e.g., precipitation of 5 mm/h and wind speed of 15 m/s).

**[0044]** Then, in Step S35, operation data of the second air-conditioning apparatus 101 b that satisfies the above-mentioned condition is extracted as indicator data. In this case, for example, operation data of the second air-conditioning apparatus 101 b that is not determined as indicator data may be used as indicator data at the time of abnormality detection processing in another first air-conditioning apparatus 101 a.

**[0045]** Then, in Step S5, the monitoring processing device 104 extracts operation data (hereinafter referred to as "steady indicator data") in the steady state from the indicator data in order to extract indicator data that is similar to the monitoring data extracted in Step S2.

**[0046]** Fig. 7 is a table for showing a relationship between an abnormality detection mode and an abnormality detection method according to Embodiment 1 of the present invention. In Step S6, the monitoring processing device 104 further extracts data on a variable item and a feature value from the extracted steady indicator data in accordance with the abnormality detection mode selected in Step S3. For example, the extracted steady indicator data contains all the pieces of operation data such as all the temperatures and pressures detected in the selected second air-conditioning apparatus 101 b. In view of this, data on the variable item and the feature value necessary for abnormality detection is extracted from the steady indicator data. In this case, the feature value is a parameter that changes due to occurrence of an abnormality. Further, the variable item is a parameter that changes without occurrence of an abnormality. The feature value and the variable item differ depending on the abnormality detection mode.

**[0047]** Now, a specific description is given of a procedure of each abnormality detection. First, there is described a case where an abnormality detection mode for



detecting refrigerant amount insufficiency in the refrigerant circuit is selected. For example, the degree of condenser outlet subcooling (difference between saturation temperature of pressure detected by pressure sensor 201 and temperature detected by temperature sensor 203) is smaller in a case where the refrigerant amount is insufficient compared with a case where the refrigerant amount is not insufficient. Meanwhile, the degree of condenser outlet subcooling changes depending on the outside air temperature even when the refrigerant amount does not decrease. In view of this, the feature value and the variable item in the case where the abnormality detection mode for detecting refrigerant amount insufficiency is selected are set as the degree of condenser outlet subcooling and the outside air temperature, respectively. For example, under a condition in which the outside air temperature is similar, the degree of condenser outlet subcooling in the monitoring data and the degree of condenser outlet subcooling in the steady indicator data are compared with each other, to thereby determine insufficiency of the refrigerant amount. The steady indicator data contains operation data of the second air-conditioning apparatus 101 b. Thus, even when there occurs no leakage of refrigerant in the first air-conditioning apparatus 101 a, insufficiency of the refrigerant amount in the second air-conditioning apparatus 101 b results in abnormality detection of the refrigerant amount insufficiency.

**[0048]** Next, a description is given of a case where an abnormality detection mode for detecting contamination of the heat source-side heat exchanger 3 is selected. When a fin or other components of the heat source-side heat exchanger 3 is contaminated, the heat transfer performance deteriorates. Thus, when the heat source-side heat exchanger 3 serves as a condenser through operation in the cooling operation mode, the temperature difference between the condensing temperature and the outside air temperature increases. Meanwhile, the temperature difference between the condensing temperature and the outside air temperature also changes depending on the outside air temperature. In view of this, the feature value and the variable item in the case where the abnormality detection mode for detecting contamination of the heat source-side heat exchanger 3 is selected are set as the temperature difference between the condensing temperature and the outside air temperature and the outside air temperature, respectively. For example, under a condition in which the outside air temperature is similar, the temperature difference between the condensing temperature and the outside air temperature in the monitoring data and the temperature difference between the condensing temperature and the outside air temperature in the steady indicator data are compared with each other, to thereby determine contamination of the heat source-side heat exchanger 3. The abnormality detection for contamination of the heat source-side heat exchanger 3 can be carried out also in the heating operation mode. In this case, the feature value is set as the

temperature difference between the evaporating temperature and the outside air temperature.

**[0049]** Next, a description is given of a case where an abnormality detection mode for detecting locking of the bypass pressure reducing mechanism 20 is selected. When a valve of the bypass pressure reducing mechanism 20 does not operate, the degree of superheat of the refrigerant in the second flow passage of the subcooling heat exchanger 11 changes and cannot be controlled to a fixed value. For example, when a valve opening degree is fixed in an opening state, the degree of superheat increases by 10 degrees Celsius or more. Further, when the valve opening degree is fixed in a closed state, the refrigerant does not pass through the second flow passage, and thus the degree of superheat is 0. In view of this, the feature value in the case where the abnormality detection mode for detecting locking of the bypass pressure reducing mechanism 20 is selected is set as the degree of superheat of the refrigerant in the subcooling heat exchanger 11. Further, the variable item is set as the opening degree of the bypass pressure reducing mechanism 20. The degree of superheat in the monitoring data and the degree of superheat in the steady indicator data are compared with each other, to thereby determine locking of the bypass pressure reducing mechanism 20.

**[0050]** Next, a description is given of a case where an abnormality detection mode for detecting degradation of the compressor is selected. The feature value in the case where the abnormality detection mode for detecting degradation of the compressor is selected is the discharge temperature of the compressor 1. Further, the variable item is the condensing temperature and the evaporating temperature. The discharge temperature in the monitoring data and the discharge temperature in the steady indicator data are compared with each other, to thereby determine compressor degradation.

**[0051]** In Step S7, the arithmetic unit 120 calculates an average value of pieces of feature value data for each variable item. For example, the variable item is divided at a fixed interval or by other methods to divide the feature value data, and the average value of a group of pieces of feature value data is calculated. For example, when the variable item is the outside air temperature, the outside air temperature is divided in units of 4.5 degrees Celsius (... , 20.5 degrees Celsius to 25.0 degrees Celsius, 25.5 degrees Celsius to 30.0 degrees Celsius, ...) to calculate the average value.

**[0052]** Fig. 8 is a graph for showing an example of a relationship between the steady indicator data and the monitoring data, which are on the feature value and the variable item, according to Embodiment 1 of the present invention. In Step S8, the arithmetic unit 120 calculates a difference value between the average value of feature values and the monitoring data. Then, in Step S9, the control unit 121 determines whether or not the difference value calculated by the arithmetic unit 120 is equal to or larger than a predetermined value. When the control unit

121 determines that the difference value is equal to or larger than the predetermined value, the control unit 121 determines that the value is abnormal and issues an abnormality notification (Step S10). Further, when the control unit 121 determines that the difference is not equal to or larger than the predetermined value, the control unit 121 determines that the value is normal and issues a normality notification (Step S11). The determination of an abnormality in a case where there are a plurality of pieces of monitoring data is not particularly limited. For example, when the control unit 121 determines that the difference is equal to or larger than a predetermined value for at least one of the plurality of pieces of monitoring data, the control unit 121 may determine that there is an abnormality. Instead, when the control unit 121 determines that the difference is equal to or larger than a predetermined value for every one of the plurality of pieces of monitoring data, the control unit 121 may determine that there is an abnormality.

**[0053]** In Step S12, the monitoring processing device 104 determines whether or not the processing is complete for all the abnormality detection modes. When the monitoring processing device 104 determines that the processing is not complete, the monitoring processing device 104 returns to Step S2, selects an abnormality detection mode that has not been selected yet, and performs determination of abnormality detection.

**[0054]** On the contrary, when determination of abnormality detection is complete for all the abnormality detection modes, in Step S13, the control unit 121 determines whether or not the difference value between the average value of feature values and the monitoring data is equal to or smaller than an appropriate difference value for all of the abnormality detection modes. When the control unit 121 determines that the difference is equal to or smaller than the appropriate difference value, the control unit 121 causes the storage device 105 to store operation data of the first air-conditioning apparatus 101 a. In this manner, through storage of operation data containing monitoring data that is determined as being equal to or smaller than an appropriate difference value, it is possible to store operation data for which an abnormality has not occurred. Therefore, it is possible to ensure that the indicator data is an aggregate of pieces of normal operation data and to ensure reliability of data. In this case, reliability of operation data to be stored into the storage device 105 can be improved by causing the difference value threshold value of Step S13 to be smaller than the difference value determination value of Step S9.

**[0055]** Operation data is stored in the storage device 105 after processing of Step S13 for one year after installation of the air-conditioning apparatus, for example. When operation data for one year can be stored, a series of pieces of operation data on outside air temperature and indoor loads can be stored. For example, continuous storage of data for three or four years may result in a failure to determine degradation when degradation over time has progressed. In view of this, the system of Em-

bodiment 1 stores operation data for only a predetermined period of time after installation of the air-conditioning apparatus.

**[0056]** As described above, the monitoring processing device 104 of Embodiment 1 collects operation data of the second air-conditioning apparatus 101 b and stores the operation data into the storage device 105, to thereby be able to detect an abnormality based on a larger amount of operation data.

## Embodiment 2

**[0057]** Fig. 9 is a table for showing an example of a relationship between classification items and storage locations of operation data according to Embodiment 2 of the present invention. Although not particularly mentioned in Embodiment 1 described above, the storage location of operation data may be classified and divided based on conditions on abnormality detection for the air-conditioning apparatus 101, such as a refrigerant name and the specification of the compressor, and then the operation data may be stored in the storage device 105 based thereon. For example, the air-conditioning apparatus monitoring system 100 includes two storage devices 105. Further, each storage device 105 includes two storage devices 150. Thus, the storage area of operation data in the entire system can be divided into four areas.

**[0058]** In the example shown in Fig. 9, the monitoring processing device 104 classifies the storage location of operation data depending on whether the refrigerant type is R32 or R410A and on whether the compressor 1 is a rotary compressor or a scroll compressor. For example, operation data of the air-conditioning apparatus 101 in which the refrigerant type is R32 and the compressor 1 is a rotary compressor is classified such that the operation data is stored in the storage device 150a of the storage device 105a. Further, operation data of the air-conditioning apparatus 101 in which the refrigerant type is R32 and the compressor 1 is a scroll compressor is classified such that the operation data is stored in the storage device 150b of the storage device 105a. Further, operation data of the air-conditioning apparatus 101 in which the refrigerant type is R410A and the compressor 1 is a rotary compressor is classified such that the operation data is stored in the storage device 150a of the storage device 105b. Finally, operation data of the air-conditioning apparatus 101 in which the refrigerant type is R410A and the compressor 1 is a scroll compressor is classified such that the operation data is stored in the storage device 150b of the storage device 105b.

**[0059]** As described above, the air-conditioning apparatus monitoring system 100 of Embodiment 2 classifies the storage location of operation data based on conditions on abnormality detection for the air-conditioning apparatus 101 and stores the operation data based on the classification. Thus, operation data can be accessed by specifying in advance the storage device 105 or other similar apparatuses at the time of, for example, extraction

of operation data by the monitoring processing device 104. Therefore, it is possible to speed up information processing by avoiding unnecessary data access. For example, unnecessary data access can be avoided more effectively by, for example, classifying the storage location of operation data based on conditions on abnormality detection in a frequently selected abnormality detection mode.

### Embodiment 3

**[0060]** Fig. 10 is a table for showing an example of a relationship between related items and air-conditioning apparatuses according to Embodiment 3 of the present invention. For example, an installation crew member (construction crew member) or other such person inputs an extended pipe length (longest part) and an extended pipe height difference in the air-conditioning apparatus 101 into the local controller 102 as data at the time of installation of the air-conditioning apparatus 101. Then, the local controller 102 transmits the data to the monitoring processing device 104. The monitoring processing device 104 stores the data into the storage device 105. At this time, classification is made based on the extended pipe length and the extended pipe height difference, and the storage location of operation data of each air-conditioning apparatus 101 is defined. With this, it is possible to access operation data by specifying in advance the storage device 105 or other similar apparatuses at the time of, for example, extraction of operation data by the monitoring processing device 104. Therefore, it is possible to speed up information processing by avoiding unnecessary data access.

**[0061]** For example, when the pipe length is large or the pipe height difference is large, its pipe resistance increases the refrigerant pressure (condensing temperature). Thus, when abnormality detection for contamination of the heat source-side heat exchanger 3 is performed, consideration of the pipe length or the pipe height difference increases the determination accuracy of abnormality detection. In view of this, operation data stored in the storage device 105 is classified based on the extended pipe length (longest part) or the extended pipe height difference. Then, the control unit 121 extracts operation data of the second air-conditioning apparatus 101 b, which is classified into the same category as the first air-conditioning apparatus 101 a, at the time of performing abnormality detection for contamination of the heat source-side heat exchanger 3, and determines abnormality detection.

**[0062]** Further, as data on device connection, the number of connected use units 303 and the capacity of the use-side heat exchanger 15 of each use unit 303 in the air-conditioning apparatus 101 may be used to classify operation data for storage into the storage device 105. For example, in the case where an abnormality of locking of the bypass pressure reducing mechanism 20 described above is detected, regarding, for example,

locking of the bypass pressure reducing mechanism 20, when the number of use units 303 increases, the number of use-side pressure reducing mechanisms 14 also increases. Thus, the total amount of valve opening degrees in the use units 303 increases. As a result, even when the valve opening degree of the bypass pressure reducing mechanism 20 is increased, the refrigerant may be less likely to flow into the bypass pressure reducing mechanism 20, and detection of an abnormality may be affected. In view of this, operation data stored in the storage device 105 is classified based on the number of connected use units 303 and the capacity of the use-side heat exchanger 15 of each use unit 303. Then, the control unit 121 extracts operation data of the second air-conditioning apparatus 101 b, which is classified into the same category as the first air-conditioning apparatus 101 a, at the time of performing abnormality detection for locking of the bypass pressure reducing mechanism 20, and determines abnormality detection.

### Reference Signs List

#### [0063]

1 compressor 2 four-way valve 3 heat source-side heat exchanger 4 heat source-side air-sending device 5 outdoor heat exchanger 5a outdoor air-sending device 11 subcooling heat exchanger 14, 14a, 14b use-side pressure reducing mechanism 15, 15a, 15b use-side heat exchanger 19 accumulator 20 bypass pressure reducing mechanism 21 bypass pipe 27 indoor liquid pipe 28 indoor gas pipe 100 air-conditioning apparatus monitoring system 101 air-conditioning apparatus 101 a first air-conditioning apparatus 101b second air-conditioning apparatus 102 local controller 102a first local controller 102b second local controller 103 electrical communication line 104 monitoring processing device 105, 105a, 105b storage device 106 remote management center 107, 107a, 107b housing 108 controller 109 air-conditioning apparatus monitoring apparatus 120 arithmetic unit 121 control unit 122 communication unit 123 display unit 124 storage unit 140 communication unit 141 storage unit 150 storage device 201, 211 pressure sensor 202, 203, 208, 208a, 208b, 209, 209a, 209b, 212, 213 temperature sensor 204 outside air temperature sensor 301 heat source unit 303, 303a, 303b use unit

### Claims

1. A monitoring apparatus for monitoring air-conditioning apparatuses, the air-conditioning apparatuses each being configured to perform air-conditioning of a target space and each including a refrigerant circuit in which refrigerant is circulated, the refrigerant cir-

cuit including at least a compressor, a heat source-side heat exchanger, an expansion device, and a use-side heat exchanger, the monitoring apparatus comprising:

a storage device configured to store operation data indicating an operation state of the air-conditioning apparatuses; and  
a monitoring processing device configured to perform abnormality detection by

extracting, from the storage device, operation data that is within a range of equality in an extraction condition including a kind of the refrigerant and a specification of a device included in the air-conditioning apparatus that is a target of monitoring by the monitoring apparatus, and  
comparing the extracted operation data with operation data of the air-conditioning apparatus that is the target of monitoring.

2. The monitoring apparatus for monitoring air-conditioning apparatuses of claim 1, wherein the device comprises at least one of the compressor and a heat source-side air-sending device configured to supply air to the heat source-side heat exchanger.
3. The monitoring apparatus for monitoring air-conditioning apparatuses of claim 1 or 2, wherein the extraction condition on the specification of the device is determined as being equal when a number of compressors included in each air-conditioning apparatus is determined as being within a range of equality and a cylinder capacity of each compressor is determined as being within a range of equality and a compressor type is the same.
4. The monitoring apparatus for monitoring air-conditioning apparatuses of any one of claims 1 to 3, wherein the extraction condition on the specification of the device is determined as being equal when a heat transfer area of the heat source-side heat exchanger is determined as being within a range of equality and a configuration of a heat source-side air-sending device configured to supply air to the heat source-side heat exchanger is determined as being within a range of equality.
5. The monitoring apparatus for monitoring air-conditioning apparatuses of any one of claims 1 to 4, wherein  
the operation data of each of the air-conditioning apparatuses is classified based on a specification of the compressor and the refrigerant of the each of the air-conditioning apparatuses, to thereby divide a storage area of the storage device into storage areas for respective classifications, and

the operation data is stored into one of the storage areas of the storage device.

6. The monitoring apparatus for monitoring air-conditioning apparatuses of any one of claims 1 to 5, wherein  
the operation data of each of the air-conditioning apparatuses is classified based on at least one of a pipe length, a pipe height difference, or a number of indoor units of the each of the air-conditioning apparatuses, to thereby divide a storage area of the storage device into storage areas for respective classifications, and  
the operation data is stored into one of the storage areas of the storage device.
7. The monitoring apparatus for monitoring air-conditioning apparatuses of any one of claims 1 to 6, wherein  
the operation data of each of the air-conditioning apparatuses comprises a plurality of items of data, and the monitoring processing device is configured to extract an item of data to be used for performing the abnormality detection and compare the item of data with the item of data of the air-conditioning apparatus that is the target of monitoring.
8. The monitoring apparatus for monitoring air-conditioning apparatuses of any one of claims 1 to 7, wherein  
the operation data is associated with data on weather at a time when each of the air-conditioning apparatuses is operated,  
the monitoring processing device is configured to set at least one of rain or wind as a weather condition, and  
the monitoring processing device is configured to avoid using operation data to perform the abnormality detection, the operation data being associated with the data on weather not satisfying the set weather condition.
9. The monitoring apparatus for monitoring air-conditioning apparatuses of any one of claims 1 to 8, wherein the monitoring processing device is configured to detect at least one of abnormalities relating to refrigerant amount insufficiency, fixation of a valve opening degree in the air-conditioning apparatus that is the target of monitoring, contamination of the heat source-side heat exchanger, and degradation of the compressor.
10. The monitoring apparatus for monitoring air-conditioning apparatuses of any one of claims 1 to 9, wherein the monitoring processing device is configured to use the operation data determined as being obtained under stable operation to perform the abnormality detection among the operation data ex-

tracted from the storage device and the operation data of the air-conditioning apparatus that is the target of monitoring.

11. A method of monitoring air-conditioning apparatuses, for performing abnormality detection of the air-conditioning apparatuses, the air-conditioning apparatuses each including a refrigerant circuit in which refrigerant is circulated to perform air-conditioning of a target space, the method comprising:

extracting, from a storage device configured to store the operation data for each of the air-conditioning apparatuses, operation data that is within a range of equality in an extraction condition including a kind of the refrigerant and a specification of a device included in the air-conditioning apparatus that is a target of monitoring, the operation data indicating an operation state of each of the air-conditioning apparatuses; and comparing the extracted operation data with operation data of the air-conditioning apparatus that is the target of monitoring, to thereby detect an abnormality of the air-conditioning apparatus that is the target of monitoring.

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FIG. 1

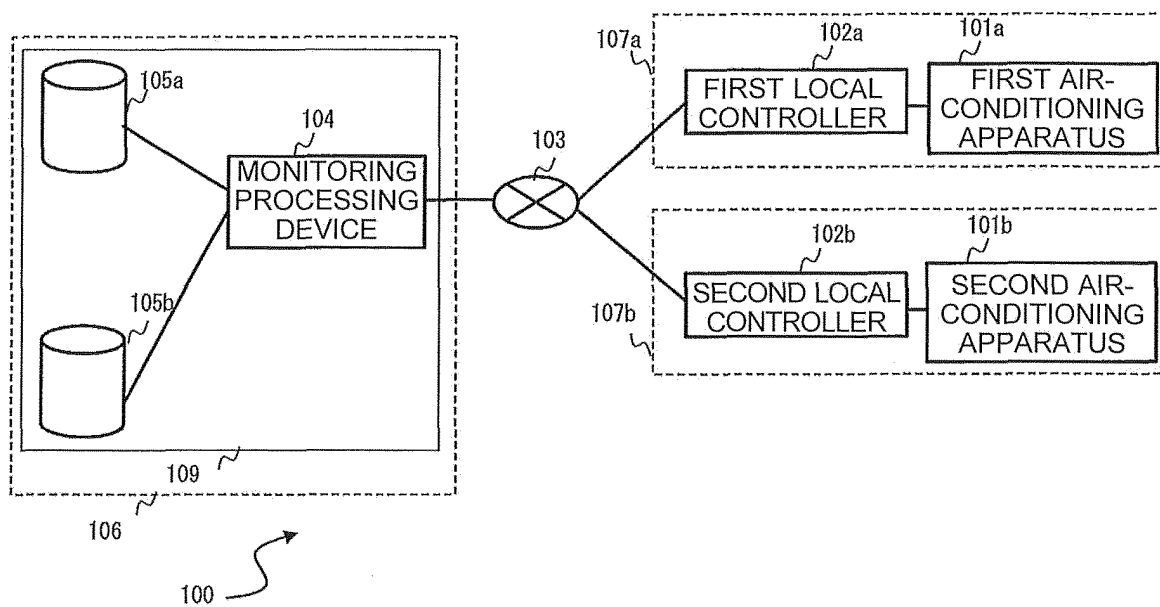


FIG. 2

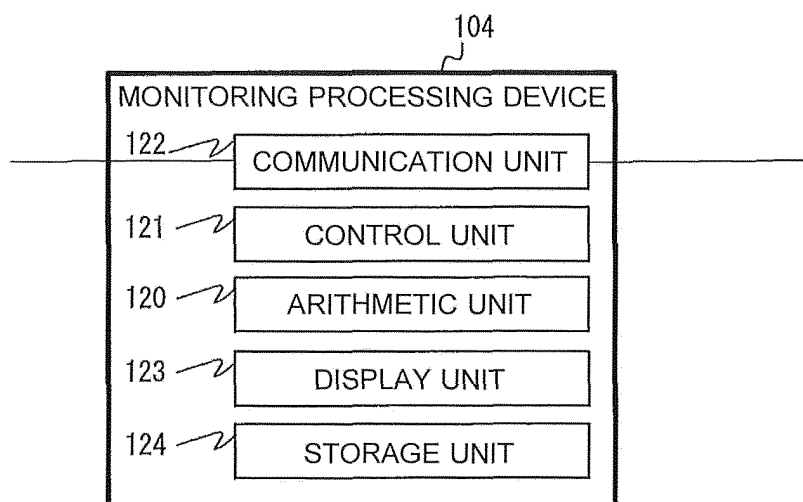


FIG. 3

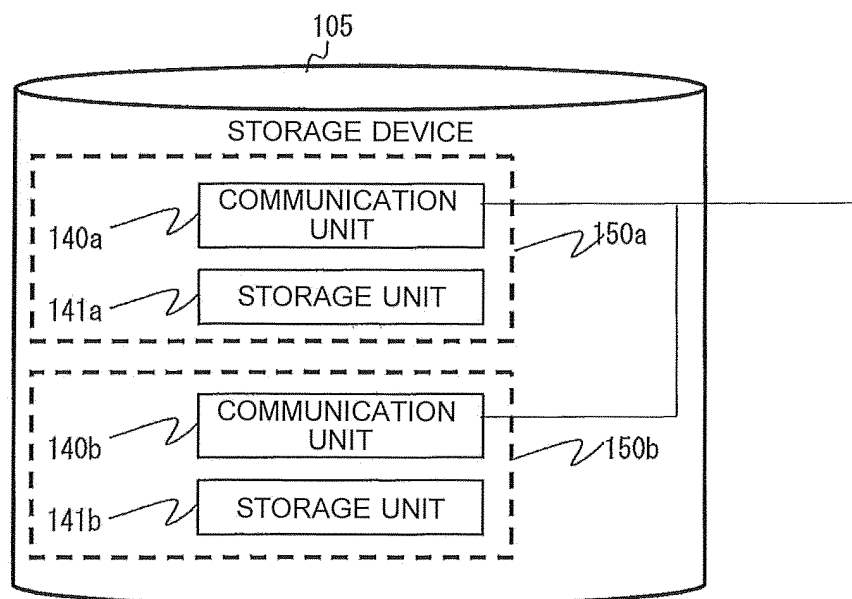


FIG. 4

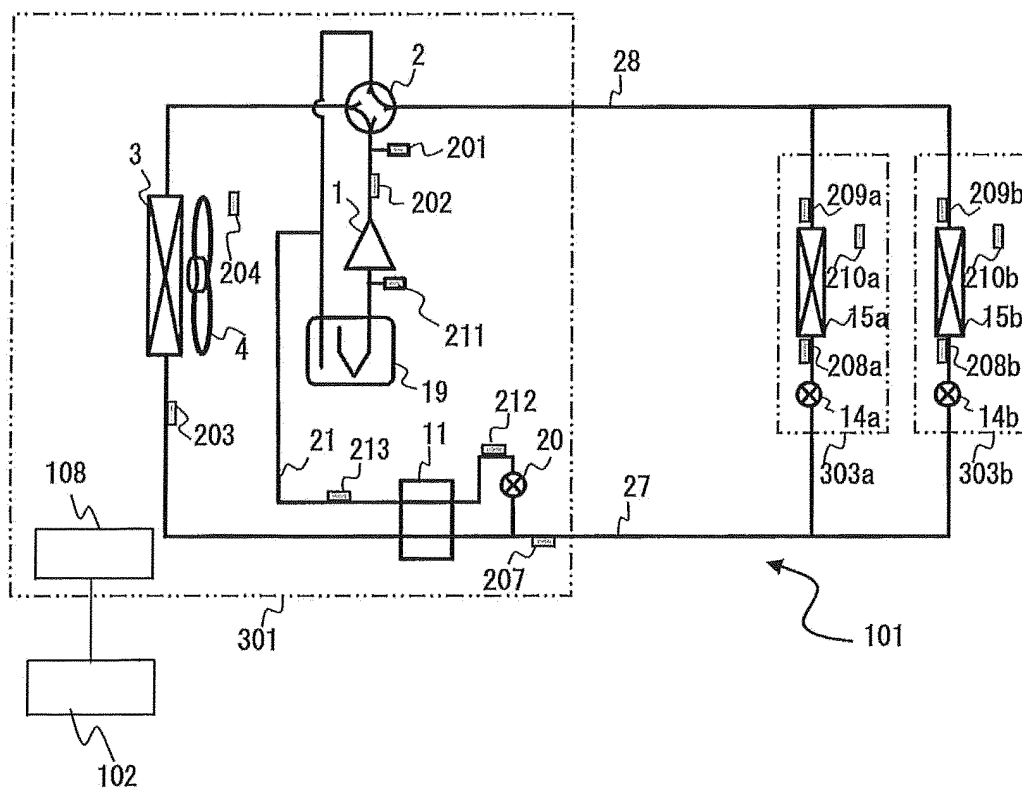


FIG. 5

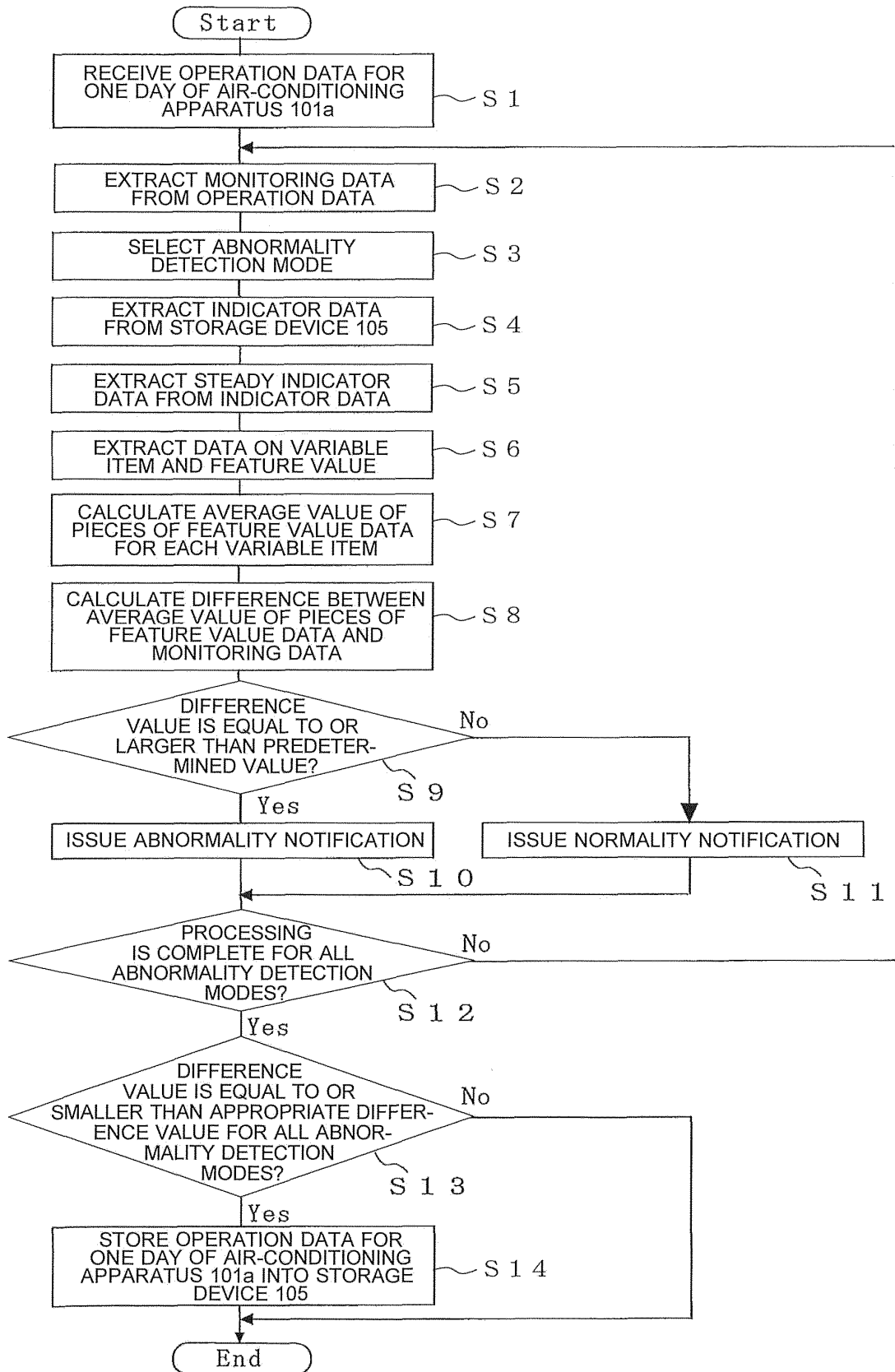




FIG. 6

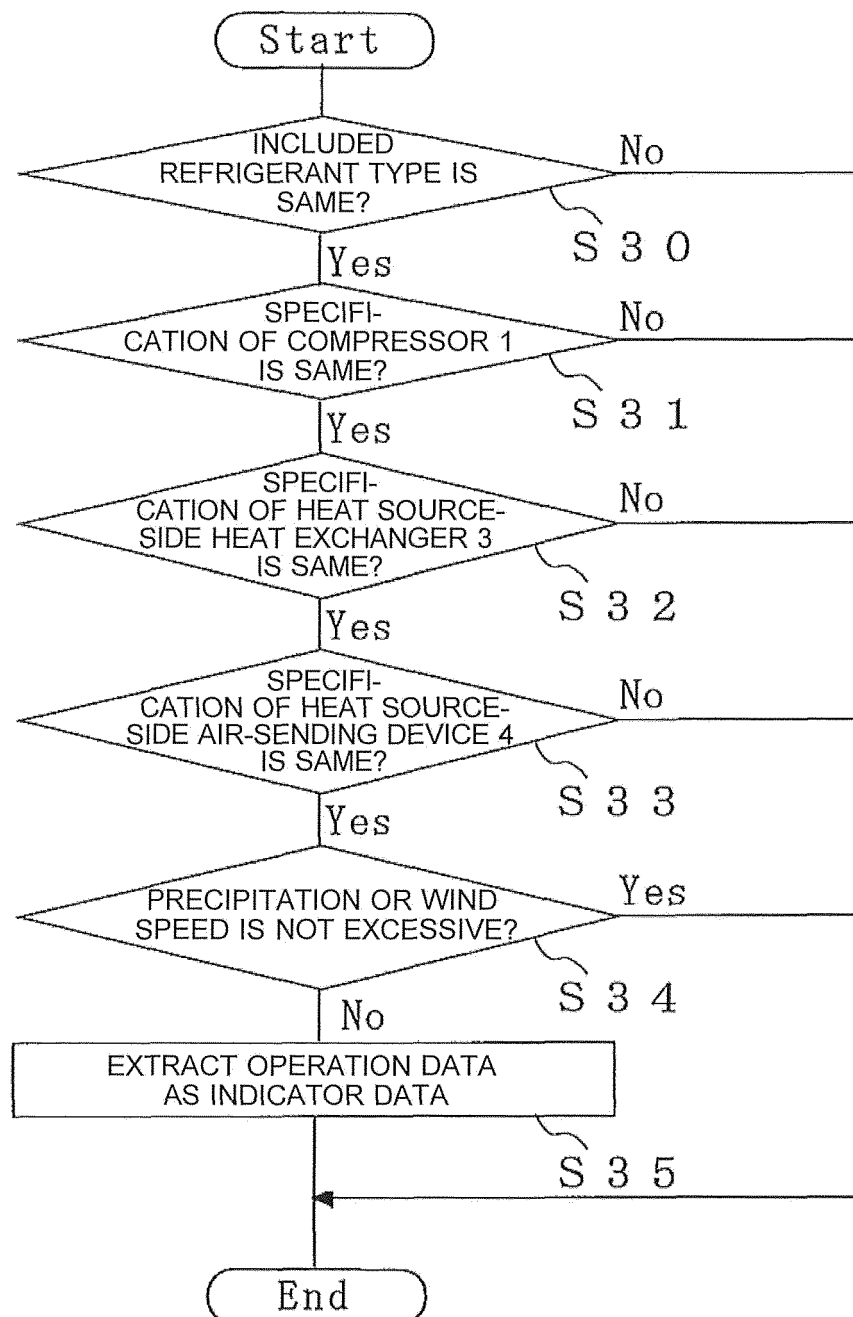


FIG. 7

ABNORMALITY DETECTION MODE	VARIABLE ITEM	FEATURE VALUE	ABNORMALITY DETERMINATION METHOD
REFRIGERANT AMOUNT INSUFFICIENCY	OUTDOOR AIR TEMPERATURE [°C]	DEGREE [°C] OF SUBCOOLING AT CONDENSER OUTLET	DEGREE [°C] OF SUBCOOLING AT CONDENSER DECREASES BY 5 DEGREES CELSIUS OR MORE
CONTAMINATION OF HEAT SOURCE-SIDE HEAT EXCHANGER 3	OUTDOOR AIR TEMPERATURE [°C]	TEMPERATURE DIFFERENCE [°C] BETWEEN CONDENSING TEMPERATURE AND OUTDOOR AIR TEMPERATURE	TEMPERATURE DIFFERENCE INCREASES BY 5 DEGREES CELSIUS OR MORE
LOCKING OF BYPASS PRESSURE REDUCING MECHANISM 20	VALVE OPENING DEGREE [PULSE] OF BYPASS PRESSURE REDUCING MECHANISM 20	DEGREE [°C] OF SUPERHEAT AT LOW-PRESSURE SIDE OUTLET OF PRESSURE REDUCING MECHANISM 20	<OPENED LOCK> NO DEGREE OF SUPERHEAT  <CLOSED LOCK> DEGREE OF SUPERHEAT INCREASES BY 10 DEGREES CELSIUS OR MORE
FAULT OF COMPRESSOR 1	TEMPERATURE DIFFERENCE [°C] BETWEEN CONDENSING TEMPERATURE AND EVAPORATING TEMPERATURE	DISCHARGE TEMPERATURE [°C]	DISCHARGE TEMPERATURE INCREASES BY 10 DEGREES CELSIUS OR MORE

FIG. 8

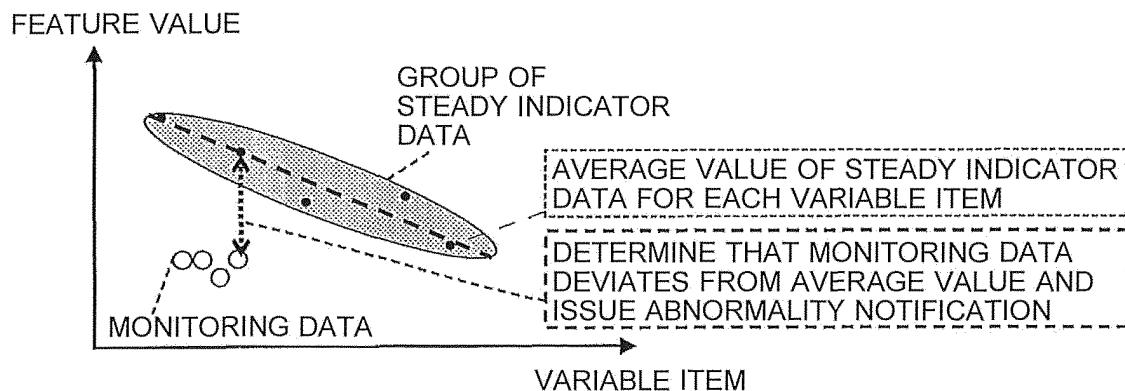


FIG. 9

REFRIGERANT NAME	TYPE OF COMPRESSOR 1	STORAGE LOCATION OF OPERATION DATA
R32	ROTARY	STORE OPERATION DATA INTO STORAGE DEVICE 150a OF STORAGE DEVICE 105a
R32	SCROLL	STORE OPERATION DATA INTO STORAGE DEVICE 150b OF STORAGE DEVICE 105a
R410A	ROTARY	STORE OPERATION DATA INTO STORAGE DEVICE 150a OF STORAGE DEVICE 105b
R410A	SCROLL	STORE OPERATION DATA INTO STORAGE DEVICE 150b OF STORAGE DEVICE 105b

FIG. 10

GROUP	LONGEST EXTENDED PIPE LENGTH	PIPE HEIGHT DIFFERENCE	STORAGE LOCATION OF OPERATION DATA
1	0m TO 50m	0m TO 50m	STORE OPERATION DATA INTO STORAGE DEVICE 150a OF STORAGE DEVICE 105a
2	51m TO 100m	0m TO 20m	STORE OPERATION DATA INTO STORAGE DEVICE 150b OF STORAGE DEVICE 105a
3	51m TO 100m	21m TO 40m	STORE OPERATION DATA INTO STORAGE DEVICE 150a OF STORAGE DEVICE 105b
	.	.	.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/062807

## A. CLASSIFICATION OF SUBJECT MATTER

F24F11/02(2006.01)i

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24F11/02

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015  
 Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014/0297208 A1 (EMERSON ELECTRIC CO.), 02 October 2014 (02.10.2014), paragraphs [0003] to [0012], [0053] to [0220]; fig. 1 to 16B & WO 2012/118830 A2 & EP 2681497 A & AU 2012223466 A & CA 2828740 A	1-11
Y	US 2014/0163744 A1 (LIEBERT CORP.), 12 June 2014 (12.06.2014), paragraphs [0031] to [0044] & WO 2014/089154 A1	1-11
Y	JP 2010-107189 A (Daikin Industries, Ltd.), 13 May 2010 (13.05.2010), paragraphs [0001] to [0003], [0036] (Family: none)	1-11



Further documents are listed in the continuation of Box C.



See patent family annex.

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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

22 July 2015 (22.07.15)

Date of mailing of the international search report

04 August 2015 (04.08.15)

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Japan Patent Office  
 3-4-3, Kasumigaseki, Chiyoda-ku,  
 Tokyo 100-8915, Japan

Authorized officer

Telephone No.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/062807

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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