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(54) REFRIGERANT RECOVERY DEVICE

(57) A refrigerant-collecting apparatus (100) includes a first port (101), a second port (102), a refrigerant channel (30), and an identifying unit (210). The first port (101) is connected to target equipment (10) from which a refrigerant is collected. The second port (102) is connected to a container (110) in which the refrigerant collected from the target equipment (10) is put. The refrigerant channel (30) connects the first port (101) and the second port (102). The refrigerant channel (30) includes at least an expansion mechanism (40), a compressor (80), and a heat exchanger (90). The identifying unit (210) identifies the type of the refrigerant that is being collected from the target equipment (10). On the basis of a first value and a second value, the identifying unit (210) identifies the type of the refrigerant that is being collected from the target equipment (10). The first value relates to a first refrigerant temperature, which is a refrigerant temperature on the first-port-(101) side of the compressor (80). The second value relates to a second refrigerant temperature, which is a refrigerant temperature on the second-port-(102) side of the compressor (80).

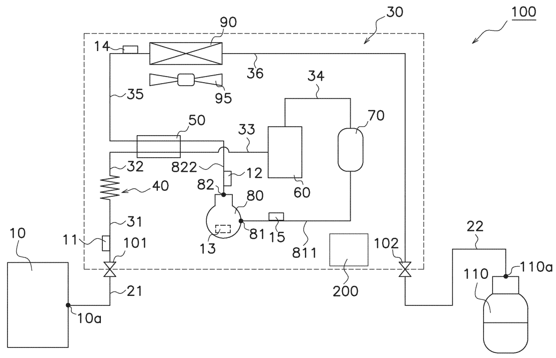

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a refrigerant-collecting apparatus.

BACKGROUND ART

[0002] In some cases, refrigerant-collecting apparatuses have been used to collect a used refrigerant from refrigeration apparatuses and the like. Further, as disclosed in PTL 1 (WO 2020/003509), management systems that manage information relating to the collected refrigerant have been known. In the management system described in PTL 1 describe above, a collection worker who has performed refrigerant collection work transmits, to a management apparatus, information relating to the collected refrigerant. As disclosed in PTL 1 described above, the information transmitted to the management apparatus by the collection worker includes information relating to the type of the collected refrigerant.

SUMMARY OF INVENTION

<Technical Problem>

[0003] It is conceivable that in a case where a collection worker transmits, to a management apparatus, information relating to the type of a collected refrigerant, the collection worker identifies the type of the collected refrigerant. However, when the collection worker identifies the type of the collected refrigerant, there is a possibility that the collection worker makes a recognition mistake or a recording mistake. In a case where due to the recognition mistake or the recording mistake of the collection worker, information that a refrigerant of a type different from the original type has been collected is transmitted to the management apparatus, it becomes difficult to manage the collected refrigerant.

<Solution to Problem>

[0004] A refrigerant-collecting apparatus according to a first aspect includes a first port, a second port, a refrigerant channel, and an identifying unit. The first port is connected to target equipment from which a refrigerant is collected. The second port is connected to a container in which the refrigerant collected from the target equipment is put. The refrigerant channel connects the first port and the second port. The refrigerant channel includes at least an expansion mechanism, a compressor, and a heat exchanger. The identifying unit identifies the type of the refrigerant that is being collected from the target equipment. On the basis of a first value and a second value, the identifying unit identifies the type of the refrigerant that is being collected from the target equipment. Alternatively, on the basis of the first value and a third value, the identifying unit identifies the type of the refrigerant that is being collected from the target equipment. Alternatively, on the basis of the first value, the second value, and the third value, the identifying unit identifies the type of the refrigerant that is being collected from the target equipment. The first value relates to a first refrigerant temperature, which is a refrigerant temperature on the first-port side of the compressor. The second value relates to a second refrigerant temperature, which is a refrigerant temperature on the second-port side of the compressor. The third value is a value relating to electric power consumed by the compressor.

[0005] Here, the identifying unit identifies the type of the refrigerant that is being collected from the target equipment. This configuration eliminates a possibility that the collection worker makes a recognition mistake or a recording mistake. Therefore, the refrigerant-collecting apparatus according to the first aspect can identify the type of the collected refrigerant without a mistake. Since the type of the collected refrigerant is identified without a mistake, it is easy to manage the collected refrigerant.

[0006] A refrigerant-collecting apparatus according to a second aspect is the apparatus according to the first aspect in which the first value may be an outside-air temperature, a refrigerant temperature near the first port, or a refrigerant temperature near a suction opening of the compressor.

[0007] Here, the outside-air temperature, the refrigerant temperature near the first port, or the refrigerant temperature near the suction opening of the compressor is employed as the first value. The outside-air temperature, the refrigerant temperature near the first port, and the refrigerant temperature near the suction opening of the compressor can be measured by relatively inexpensive sensors. Therefore, the refrigerant-collecting apparatus according to the second aspect can reduce the manufacturing cost of the refrigerant-collecting apparatus.

[0008] A refrigerant-collecting apparatus according to a third aspect is the apparatus according to the first aspect or the second aspect in which the heat exchanger may be a condenser that condenses the refrigerant. The second value may be a refrigerant temperature near a discharge opening of the compressor, or a refrigerant temperature near the condenser.

[0009] Here, the refrigerant temperature near the discharge opening of the compressor, or the refrigerant temperature near the condenser is employed as the second value. The refrigerant temperature near the discharge opening of the compressor, and the refrigerant temperature near the condenser can be measured by relatively inexpensive sensors. Therefore, the refrigerant-collecting apparatus according to the third aspect can reduce the manufacturing cost of the refrigerant-collecting apparatus.

[0010] A refrigerant-collecting apparatus according to a fourth aspect is the apparatus according to any one of the first aspect to the third aspect in which the third value may be a electric-current value of the compressor, or an electric-power value of the compressor.

[0011] Here, the electric-current value of the compressor, or the electric-power value of the compressor is employed as the third value. The electric-current value of the compressor and the electric-power value of the compressor can be measured by relatively inexpensive sensors. Therefore, the refrigerant-collecting apparatus according to the fourth aspect can reduce the manufacturing cost of the refrigerant-collecting apparatus.

[0012] A refrigerant-collecting apparatus according to a fifth aspect is the apparatus according to any one of the first aspect to the fourth aspect that may further include a collected-amount-estimating unit. On the basis of at least a time period during which the refrigerant is being collected from the target equipment, the collected-amount-estimating unit may estimate a collected amount of the refrigerant collected from the target equipment.

[0013] Here, the collected-amount-estimating unit estimates the collected amount of the refrigerant. This configuration estimates the collected amount of the collected refrigerant, in addition to the type of the collected refrigerant. Therefore, the refrigerant-collecting apparatus according to the fifth aspect makes it easier to manage the collected refrigerant.

[0014] A refrigerant-collecting apparatus according to a sixth aspect is the apparatus according to the fifth aspect that may further include a storage unit. The storage unit may store the type of the refrigerant identified by the identifying unit, and a collected amount of the refrigerant estimated by the collected-amount-estimating unit that are associated with each other.

[0015] In a case where a plurality of pieces of target equipment exists at a site where refrigerants are collected, there is a possibility that due to a recognition mistake or a recording mistake of the collection worker, the type and collected amount of the refrigerant collected from one piece of the target equipment are confused with the type and collected amount of the refrigerant collected from another piece of the target equipment. For example, in a case where two pieces of target equipment exist at a site where refrigerants are collected, there is a possibility that due to a recognition mistake or a recording mistake, the collection worker confuses the type of the refrigerant collected from a first one of the target equipment with the refrigerant collected from a second one of the target equipment. Alternatively, there is a possibility that due to a recognition mistake or a recording mistake, the collection worker confuses the collected amount of the refrigerant collected from a first one of the target equipment with the collected amount of the refrigerant collected from a second one of the target equipment.

[0016] Here, the storage unit stores the type of the refrigerant, and a collected amount of the refrigerant that are associated with each other. Therefore, the refrigerant-collecting apparatus according to the sixth aspect makes it easier to manage the collected refrigerant.

[0017] A refrigerant-collecting apparatus according to a seventh aspect is the apparatus according to the fifth aspect or the sixth aspect in which on the basis of a liquid collection state and a gas collection state of the refrigerant, the collected-amount-estimating unit may estimate a collected-liquid amount and a collected-gas amount of the refrigerant, respectively, to estimate a collected amount of the refrigerant.

[0018] A refrigerant-collecting apparatus according to an eighth aspect is the apparatus according to the seventh aspect in which the collected-amount-estimating unit may determine the liquid collection state on the basis of a refrigerant temperature near the first port or a refrigerant temperature on the downstream side of the expansion mechanism.

[0019] Here, the collected-amount-estimating unit determines the liquid collection state on the basis of the refrigerant temperature near the first port or the refrigerant temperature on the downstream side of the expansion mechanism. The refrigerant temperature near the first port and the refrigerant temperature on the downstream side of the expansion mechanism can be measured by relatively inexpensive sensors. Therefore, the refrigerant-collecting apparatus according to the eighth aspect can reduce the manufacturing cost of the refrigerant-collecting apparatus.

[0020] A refrigerant-collecting apparatus according to a ninth aspect is the apparatus according to the eighth aspect in which the collected-amount-estimating unit may compute a suction saturation pressure using a first corrected measured value obtained by correcting a refrigerant temperature near the first port. Alternatively, the collected-amount-estimating unit may compute a suction saturation pressure using a second corrected measured value obtained by correcting a refrigerant temperature on the downstream side of the expansion mechanism. The collected-amount-estimating unit may compute a discharge saturation pressure using a third corrected measured value obtained by correcting a refrigerant temperature near the heat exchanger.

[0021] Here, the collected-amount-estimating unit computes the suction saturation pressure using the first corrected measured value obtained by correcting the refrigerant temperature near the first port, or using the second corrected measured value obtained by correcting the refrigerant temperature on the downstream side of the expansion mechanism. Therefore, the suction saturation pressure can be calculated without the provision of a relatively expensive sensor, such as a pressure sensor.

[0022] Further, the collected-amount-estimating unit computes the discharge saturation pressure using the third corrected measured value obtained by correcting the refrigerant temperature near the heat exchanger. Therefore, the discharge saturation pressure can be calculated without the provision of a relatively expensive sensor, such as a pressure sensor. Therefore, the refrigerant-collecting apparatus according to the ninth aspect can reduce the manufacturing cost of the refrigerant-collecting apparatus.

[0023] A refrigerant-collecting apparatus according to a tenth aspect is the apparatus according to the ninth aspect in which the collected-amount-estimating unit may estimate the collected-liquid amount on the basis of a compressor efficiency of the compressor, the third value, the suction saturation pressure, and the discharge saturation pressure in a liquid collection operation for collecting the refrigerant in a liquid state.

[0024] Here, the collected-amount-estimating unit estimates the collected-liquid amount on the basis of the compressor efficiency of the compressor, the third value, the suction saturation pressure, and the discharge saturation pressure. The compressor efficiency can be calculated from the type of the refrigerant and the first value. The third value can be measured by a relatively inexpensive sensor. The suction saturation pressure can be computed using the first corrected measured value obtained by correcting the refrigerant temperature near the first port, or using the second corrected measured value obtained by correcting the refrigerant temperature on the downstream side of the expansion mechanism. The discharge saturation pressure can be computed using the third corrected measured value obtained by correcting the refrigerant temperature near the heat exchanger. Therefore, the refrigerant-collecting apparatus according to the tenth aspect can reduce the manufacturing cost of the refrigerant-collecting apparatus.

[0025] A refrigerant-collecting apparatus according to an eleventh aspect is the apparatus according to any one of the fifth aspect to the tenth aspect in which the collected-amount-estimating unit may estimate the collected-gas amount on the basis of an operation time period in a gas collection operation for collecting the refrigerant in a gas state. Alternatively, the collected-amount-estimating unit may estimate the collected-gas amount on the basis of the collected-liquid amount.

[0026] A refrigerant-collecting apparatus according to a twelfth aspect is the apparatus according to the ninth aspect that may further include an updating unit. On the basis of a recorded value of a collected amount of the refrigerant manually recorded by a collection worker who performs collection work of the refrigerant using the refrigerant-collecting apparatus, the updating unit may update at least one of a first correction value for calculating the first corrected measured value, a second correction value for calculating the second corrected measured value, a third correction value for calculating the third corrected measured value, a compressor efficiency of the compressor, and an estimation parameter for estimating a collected amount of the refrigerant in a gas state.

[0027] Here, on the basis of the recorded value of the collected amount of the refrigerant manually recorded by the collection worker, the updating unit updates at least one of the first correction value, the second correction value, the third correction value, the compressor efficiency, and the estimation parameter. Therefore, the refrigerant-collecting apparatus according to the twelfth aspect improves the precision of the first correction value, the second correction value, the third correction value, the compressor efficiency, and the estimation parameter.

[0028] A refrigerant-collecting apparatus according to a thirteenth aspect is the apparatus according to any one of the first aspect to the twelfth aspect in which the refrigerant channel may further include an impurity separator. The separation scheme of the impurity separator may be a gas-liquid separation scheme or an electrostatic separation scheme.

[0029] A refrigerant-collecting apparatus according to a fourteenth aspect is the apparatus according to any one of the first aspect to the thirteenth aspect in which the refrigerant collected from the target equipment may be R32, R410A, R134a, or R404A.

[0030] A refrigerant-collecting apparatus according to a fifteenth aspect includes a first port, a second port, a refrigerant channel, a collected-amount-estimating unit, and an output unit. The first port is connected to target equipment from which a refrigerant is collected. The second port is connected to a container in which the refrigerant collected from the target equipment is put. The refrigerant channel connects the first port and the second port. The refrigerant channel includes at least an expansion mechanism, a compressor, and a heat exchanger. On the basis of a time period during which the refrigerant is being collected from the target equipment, the collected-amount-estimating unit estimates a collected amount of the refrigerant collected from the target equipment. The output unit outputs a result estimated by the collected-amount-estimating unit.

[0031] Here, on the basis of a time period during which the refrigerant is being collected from the target equipment, the collected-amount-estimating unit estimates a collected amount of the refrigerant collected from the target equipment. This configuration eliminates a possibility that the collection worker makes a recognition mistake or a recording mistake. Therefore, the refrigerant-collecting apparatus according to the fifteenth aspect can identify the collected amount of the collected refrigerant without a mistake. Since the collected amount of the collected refrigerant is identified without a mistake, it is easy to manage the collected refrigerant.

BRIEF DESCRIPTION OF DRAWINGS

[0032]

Fig. 1 is a schematic diagram showing the overall configuration of a refrigerant-collecting apparatus.

Fig. 2 is a schematic diagram showing functional blocks of a controller.

Fig. 3 is a graph showing the relationships between the types of refrigerants, refrigerant temperatures near a first port, and discharge temperatures.

Fig. 4 is a graph created on the basis of data obtained from a test machine of the refrigerant-collecting apparatus.

Fig. 5 is a graph created on the basis of data obtained from the test machine of the refrigerant-collecting apparatus.

Fig. 6 is a graph showing the relationships between the types of refrigerants, outside-air temperatures, and discharge temperatures.

Fig. 7 is a graph showing the relationships between the types of refrigerants, refrigerant temperatures near the first port, and compressor electric-power.

Fig. 8 is a graph showing the relationships between the types of refrigerants, outside-air temperatures, and compressor electric-power.

Fig. 9 is a schematic diagram showing the overall configuration of a refrigerant-collecting apparatus according to a modification 1D.

Fig. 10 is a schematic diagram showing functional blocks of a controller according to a second embodiment.

DESCRIPTION OF EMBODIMENTS

[0033] Hereinafter, embodiments of a refrigerant-collecting apparatus according to the present disclosure will be described with reference to the drawings as appropriate. However, an unnecessarily detailed description may be omitted. For example, a detailed description of an already well-known fact, and a redundant description of substantially the same configurations may be omitted. This is to avoid the following description from being unnecessarily redundant to facilitate understanding by those skilled in the art.

<First Embodiment>

(1) Overall Configuration

[0034] An outline of a refrigerant-collecting apparatus 100 according to the present embodiment will be described with reference to Fig. 1. Fig. 1 is a diagram schematically showing the configuration of the refrigerant-collecting apparatus 100. The refrigerant-collecting apparatus 100 is an apparatus that collects a refrigerant from target equipment 10 installed in a building or the like, and puts the collected refrigerant in a container 110. The target equipment 10 is, for example, an air-conditioning apparatus. The refrigerant collected by the refrigerant-collecting apparatus 100 is a fluorocarbon-based refrigerant, such as R32, R410A, R134a, or R404A.

[0035] As shown in Fig. 1, the refrigerant-collecting apparatus 100 mainly includes a first port 101, a second port 102, a refrigerant channel 30, and a controller 200. As shown in Fig. 1, the refrigerant-collecting apparatus 100 also includes a first sensor 11, a second sensor 12, a third sensor 13, a fourth sensor 14, and a fifth sensor 15.

[0036] As shown in Fig. 1, the first port 101 is connected to a first service port 10a of the target equipment 10 (air-conditioning apparatus) via a first hose 21. Further, as shown in Fig. 1, the second port 102 is connected to a second service port 110a of the container 110 via a second hose 22.

[0037] As shown in Fig. 1, the refrigerant channel 30 includes at least an expansion mechanism 40, a compressor 80, and a first heat exchanger 90 (corresponding to a heat exchanger described in the claims). Further, as shown in Fig. 1, the refrigerant channel 30 connects the first port 101 and the second port 102. In the present embodiment, when the refrigerant-collecting apparatus 100 starts operation, the refrigerant contained in the target equipment 10 flows through the first service port 10a, the first hose 21, the first port 101, the refrigerant channel 30, the second port 102, the second hose 22, the second service port 110a, and the container 110 in this order.

[0038] As shown in Fig. 1, the refrigerant-collecting apparatus 100 incorporates the controller 200. The controller 200 functions as an identifying unit 210 and a collected-amount-estimating unit 220, and the details will be described later. On the basis of the contents measured by the first sensor 11, the second sensor 12, the third sensor 13, the fourth sensor 14, and the fifth sensor 15, the controller 200 can calculate the type of the refrigerant that is being collected, and a collected amount of the refrigerant that is being collected.

(2) Detailed Configuration of Refrigerant Channel

[0039] Hereinafter, the configuration of the refrigerant channel 30 will be described in detail.

[0040] The refrigerant collected from the target equipment 10 and sent to the container 110 flows through the refrigerant channel 30. The refrigerant channel 30 includes at least the expansion mechanism 40, the compressor 80, and the first heat exchanger 90. In addition, here, the refrigerant channel 30 includes, as an additional configuration, a second heat exchanger 50, an impurity separator 60, and a dryer 70 (see Fig. 1). Further, the refrigerant channel 30 includes, as connection pipes, a first pipe 31, a second pipe 32, a third pipe 33, a fourth pipe 34, a fifth pipe 35, a sixth pipe 36, a suction pipe 811, and a discharge pipe 822 (see Fig. 1).

(2-1) Expansion Mechanism

[0041] The expansion mechanism 40 adjusts the pressure and flow rate of the refrigerant. The expansion mechanism 40 is, for example, a capillary tube. However, the expansion mechanism 40 is not limited to the capillary tube, and, for example, a mechanism generally used as an expansion mechanism in the refrigerant-collecting apparatus 100 may be appropriately selected.

[0042] In the refrigerant channel 30, the refrigerant that has flowed from the first pipe 31 to the expansion mechanism 40 and has a pressure reduced by the expansion mechanism 40 flows to the second pipe 32. The refrigerant that has flowed to the second pipe 32 flows to the second heat exchanger 50.

(2-2) Second Heat Exchanger

[0043] The second heat exchanger 50 is, for example, a heat exchanger having a double-pipe structure. The second heat exchanger 50 performs heat exchange between the refrigerant flowing from the second pipe 32 to the second heat exchanger 50, and the refrigerant flowing from the discharge pipe 822 to the second heat exchanger 50. The refrigerant flowing from the second pipe 32 to the second heat exchanger 50 performs heat exchange with the refrigerant flowing from the discharge pipe 822 to the second heat exchanger 50, and thus evaporates.

[0044] In the refrigerant channel 30, the refrigerant that has evaporated in the second heat exchanger 50 flows to the third pipe 33. The refrigerant that has flowed to the third pipe 33 flows to the impurity separator 60.

[0045] Note that, for example, the second heat exchanger 50 may be a heat exchanger that performs heat exchange between the refrigerant and air. The details will be described later in a modification 1D.

(2-3) Impurity Separator

[0046] The impurity separator 60 separates, from the refrigerant, impurities (refrigerating-machine oil, dust, and the like) contained in the refrigerant. The impurity separator 60 separates impurities from the refrigerant by, for example, a gas-liquid separation scheme, but is not limited to the gas-liquid separation scheme. However, for example, the impurity separator 60 may separate, from the refrigerant, impurities contained in the refrigerant by an electrostatic separation scheme. In this case, the impurity separator 60 includes an electrostatic precipitator for removing electrically-charged impurities.

[0047] In the refrigerant channel 30, the refrigerant from which impurities have been separated by the impurity separator 60 flows to the fourth pipe 34. The refrigerant that has flowed to the fourth pipe 34 flows to the dryer 70.

(2-4) Dryer

[0048] The dryer 70 removes, from the refrigerant, moisture contained in the refrigerant. The dryer 70 includes, for example, a tubular casing filled with a moisture adsorbent, such as alumina or silica gel.

[0049] In the refrigerant channel 30, the refrigerant from which moisture has been removed by the dryer 70 flows to the suction pipe 811. The refrigerant that has flowed to the suction pipe 811 is sucked into the compressor 80.

(2-5) Compressor

[0050] The compressor 80 sucks the refrigerant flowing through the suction pipe 811, compresses the sucked refrigerant with a compression mechanism (not shown), and discharges the compressed refrigerant to the discharge pipe 822. The compressor 80 has a suction opening 81 connected to the suction pipe 811. The compressor 80 also has a discharge opening 82 connected to the discharge pipe 822. The refrigerant-collecting apparatus 100 collects the refrigerant from the target equipment 10 by the suction force of the compressor 80.

[0051] In the refrigerant channel 30, the refrigerant compressed by the compressor 80 is discharged to the discharge pipe 822 via the discharge opening 82. The refrigerant discharged to the discharge pipe 822 flows to the first heat exchanger 90 via the second heat exchanger 50 and the fifth pipe 35.

(2-6) First Heat Exchanger 90

[0052] The first heat exchanger 90 is a heat exchanger that functions as a refrigerant condenser. The first heat exchanger 90 performs heat exchange between the refrigerant flowing from the discharge pipe 822 to the first heat exchanger 90, and air sent from a fan 95 arranged near the first heat exchanger 90. In the first heat exchanger 90, the refrigerant flowing from the discharge pipe 822 to the first heat exchanger 90 performs heat exchange with the air, and thus condenses.

[0053] In the refrigerant channel 30, the refrigerant that has condensed in the first heat exchanger 90 flows to the sixth pipe 36. The refrigerant that has flowed to the sixth pipe 36 flows to the container 110 via the second port 102, the second hose 22, and the second service port 110a.

(3) Detailed Configurations of Sensors

[0054] Hereinafter, the sensors included in the refrigerant-collecting apparatus 100 will be described in detail.

[0055] As shown in Fig. 1, the refrigerant-collecting apparatus 100 includes the first sensor 11, the second sensor 12, the third sensor 13, the fourth sensor 14, and the fifth sensor 15. Each of the sensors 11, 12, 13, 14, and 15 is electrically connected to the controller 200. Values measured by each of the sensors 11, 12, 13, 14, and 15 are appropriately transmitted to the controller 200.

(3-1) First Sensor

[0056] The first sensor 11 is a sensor that measures a value relating to a first refrigerant temperature, which is a refrigerant temperature on the first-port-101 side. Hereinafter, the "value relating to a first refrigerant temperature, which is a refrigerant temperature on the first-port-101 side" may be referred to as a "first value". The first value is, for example, a temperature near the first port 101. As shown in Fig. 1, the first sensor 11 is attached to, for example, the first pipe 31. Here, the first sensor 11 is a thermistor.

(3-2) Second Sensor

[0057] The second sensor 12 is a sensor that measures a value relating to a second refrigerant temperature, which is a refrigerant temperature on the second-port-102 side of the compressor 80. Hereinafter, the "value relating to a second refrigerant temperature, which is a refrigerant temperature on the second-port side of the compressor 80" may be referred to as a "second value". The second value is, for example, a refrigerant temperature near the discharge opening 82 of the compressor 80. As shown in Fig. 1, the second sensor 12 is attached to, for example, the discharge pipe 822. Here, the second sensor 12 is a thermistor.

(3-3) Third Sensor

[0058] The third sensor 13 is a sensor that measures a value relating to electric power consumed by the compressor 80. Hereinafter, the "value relating to electric power consumed by the compressor 80" may be referred to as a "third value". The "third value" is, for example, an electric-power value of the compressor 80. As shown in Fig. 1, the third sensor 13 is attached to, for example, the compressor 80. Here, the third sensor 13 is a wattmeter.

(3-4) Fourth Sensor

[0059] The fourth sensor 14 is a sensor that measures the refrigerant temperature on the inlet side of the first heat exchanger 90 (condenser). Hereinafter, the "refrigerant temperature on the inlet side of the first heat exchanger 90" may be referred to as a "fourth value". As shown in Fig. 1, the fourth sensor 14 is attached to, for example, the fifth pipe 35. Here, the fourth sensor 14 is a thermistor.

(3-5) Fifth Sensor

[0060] The fifth sensor 15 is a sensor that measures the suction temperature of the compressor 80. Hereinafter, the "suction temperature of the compressor 80" may be referred to as a "fifth value". As shown in Fig. 1, the fifth sensor 15 is attached to, for example, the suction pipe 811. Here, the fifth sensor 15 is a thermistor.

[0061] (3-6)

As described in (3-1) to (3-5) above, in the refrigerant-collecting apparatus 100 according to the present embodiment, expensive sensors, such as a pressure sensor, a flowmeter, a non-contact sensor, and a thermographic camera, are not employed as the sensors. Therefore, in the present embodiment, the manufacturing cost of the refrigerant-collecting apparatus 100 is reduced.

(4) Detailed Configuration of Controller

[0062] Hereinafter, the configuration of the controller 200 will be described in detail.

[0063] The controller 200 is electrically connected to each unit of the refrigerant-collecting apparatus 100 in such a manner that control signals, information, and the like can be transmitted and received. The controller 200 is implemented by a computer. The controller 200 includes a control arithmetic device and a storage device. As the control arithmetic device, a processor, such as a central processing unit (CPU) or a graphics processing unit (GPU), can be used. The control arithmetic device reads programs stored in the storage device, and performs predetermined arithmetic processing according to the programs. In addition, according to the programs, the control arithmetic device can write an arithmetic result into the storage device, and can read information stored in the storage device. Fig. 2 shows various functional blocks implemented by the control arithmetic device. As shown in Fig. 2, the controller 200 has functions as the identifying unit 210, the collected-amount-estimating unit 220, and an updating unit 230. Further, a storage unit 300 of the controller 200 can be used as a database.

(4-1) Storage Unit

[0064] The storage unit 300 includes the storage device, such as a read-only memory (ROM) and a random-access memory (RAM), of the controller 200. The storage unit 300 stores a program for controlling the workings of the refrigerant-collecting apparatus 100, a communication protocol used when the refrigerant-collecting apparatus 100 communicates with other equipment, and the like. The storage unit 300 also stores various data obtained by the inventor of the present application operating a test machine of the refrigerant-collecting apparatus 100 (which may be hereinafter simply referred to as the "test machine").

[0065] (4-1-1)

For example, the storage unit 300 stores some data corresponding to the information shown in the graph of Fig. 3. The graph of Fig. 3 is created on the basis of various data obtained by making the test machine collect various types of refrigerants. More specifically, for each type of refrigerant, the level of the refrigerant temperature near the first port at the time when the test machine collects the refrigerant, and the level of the refrigerant temperature near the discharge opening of the compressor at the time when the test machine collects the refrigerant are measured to obtain some data. On the basis of the data, the graph of Fig. 3 is created. The horizontal axis of the graph of Fig. 3 indicates the level of the refrigerant temperature near the first port (described as "FIRST-PORT TEMPERATURE °C in Fig. 3"). The vertical axis of the graph of Fig. 3 indicates the level of the refrigerant temperature near the discharge opening of the compressor (described as "DISCHARGE TEMPERATURE °C in Fig. 3").

[0066] As shown in the graph of Fig. 3, the level of the refrigerant temperature near the first port, and the level of the refrigerant temperature near the discharge opening of the compressor vary according to the type of the refrigerant. From this fact, the inventor of the present application has found that if the refrigerant temperature near the first port and the refrigerant temperature near the discharge opening are measured, the type of the refrigerant flowing through the refrigerant-collecting apparatus can be identified. More specifically, the inventor of the present application has found that if a value relating to a first refrigerant temperature, which is the refrigerant temperature on the first-port side of the compressor, and a value relating to a second refrigerant temperature, which is the refrigerant temperature on the second-port side of the compressor are measured, the type of the refrigerant flowing through the refrigerant-collecting apparatus can be identified.

[0067] Note that for convenience of explanation, Fig. 3 is a graph showing the data obtained by making the test machine collect R410A, R32, and R134a. However, the data stored in the storage unit 300 is not limited to the data relating to R410A, R32, and R134a. For example, the storage unit 300 may store some data obtained by making the test machine collect R404A. In addition, for example, the storage unit 300 may store some data obtained by making the test machine collect various types of refrigerants.

[0068] (4-1-2)

Further, for example, the storage unit 300 stores some data corresponding to the information shown in the graph of Fig. 4. For the test machine that has started a refrigerant collection operation, the refrigerant temperature near the first port, the refrigerant temperature on the downstream side of the expansion mechanism, the saturation temperature of the refrigerant flowing through the suction side of the compressor (which may be hereinafter referred to as the "suction saturation temperature"), and the pressure of the refrigerant flowing through the suction side of the compressor are measured to obtain some data. On the basis of the data, the graph of Fig. 4 is created. The horizontal axis of the graph of Fig. 4 indicates the time period that has elapsed from the start of the operation of the test machine. The vertical axis on the left side of the graph of Fig. 4 indicates the level of the refrigerant temperature. The vertical axis on the right side of the graph of Fig. 4 indicates the level of the pressure of the refrigerant. Here, the inventor of the present application has confirmed that the refrigerant is in a liquid state during a time slot indicated from a point A to a point B of the graph of Fig. 4. The inventor of the present application also has confirmed that the refrigerant is in a gas state during a time slot indicated from the point B to a point C of the graph of Fig. 4.

[0069] As shown in the graph of Fig. 4, the refrigerant temperature in a liquid state is generally stable, and the refrigerant temperature in a gas state is unstable. From this fact, the inventor of the present application has found that it is possible to easily determine whether a currently collected refrigerant is a refrigerant in a liquid state or a refrigerant in a gas state by measuring the refrigerant temperature of the refrigerant that is being collected by the refrigerant-collecting apparatus (for example, the refrigerant temperature near the first port).

[0070] Further, as shown in the graph of Fig. 4, during the time slot indicated from the point A to the point B (time slot during which the refrigerant is in a liquid state), the behavior of the refrigerant temperature near the first port (see the dashed double-dotted line of Fig. 4), and the behavior of the suction saturation temperature (see the solid line of Fig. 4) are very similar. From this fact, the inventor of the present application has found that a value corresponding to the suction saturation temperature can be calculated by correcting the refrigerant temperature near the first port with a predetermined correction value. Hereinafter, the "value corresponding to the suction saturation temperature" may be referred to as the "first corrected measured value". Further, hereinafter, the "predetermined correction value" for calculating the first corrected measured value may be referred to as the "first correction value".

[0071] (4-1-3)

Further, for example, the storage unit 300 stores some data corresponding to the information shown in the graph of Fig. 5. For the test machine that has started a refrigerant collection operation, the refrigerant temperature on the inlet side of the condenser, the saturation temperature of the refrigerant flowing through the discharge side of the compressor (which may be hereinafter referred to as the "discharge saturation temperature"), and the pressure of the refrigerant flowing through the discharge side of the compressor are measured to obtain some data. On the basis of the data, the graph of Fig. 5 is created. The horizontal axis of the graph of Fig. 5 indicates the time period that has elapsed from the start of the operation of the test machine. The vertical axis on the left side of the graph of Fig. 5 indicates the level of the refrigerant temperature. The vertical axis on the right side of the graph of Fig. 5 indicates the level of the pressure of the refrigerant. Note that the inventor of the present application has confirmed that the refrigerant is in a liquid state during a time slot indicated from a point A to a point B of the graph of Fig. 5. The inventor of the present application also has confirmed that the refrigerant is in a gas state during a time slot indicated from the point B to a point C of the graph of Fig. 5.

[0072] As shown in the graph of Fig. 5, during the time slot indicated from the point A to the point B (time slot during which the refrigerant is in a liquid state), the behavior of the refrigerant temperature on the inlet side of the condenser (see the dashed double-dotted line of Fig. 5), and the behavior of the discharge saturation temperature (see the solid line of Fig. 5) are very similar. From this fact, the inventor of the present application has found that a value corresponding to the discharge saturation temperature can be calculated by correcting the refrigerant temperature on the inlet side of the condenser with a predetermined correction value. Hereinafter, the "value corresponding to the discharge saturation temperature" may be referred to as the "third corrected measured value". Further, hereinafter, the "predetermined correction value" for calculating the third corrected measured value may be referred to as the "third correction value".

(4-2) Identifying Unit

[0073] The identifying unit 210 identifies the type of refrigerant flowing through the refrigerant channel 30. The identifying unit 210 identifies the type of the refrigerant on the basis of a first value measured by the first sensor 11, a second value measured by the second sensor 12, and various data stored in the storage unit 300.

[0074] For example, suppose a situation where as a result of the measurement by the first sensor 11 and the second sensor 12, it has been determined that the first value (here, the temperature near the first port 101) is 6°C, and the second value (here, the refrigerant temperature near the discharge opening 82 of the compressor 80) is 41°C. In this case, the identifying unit 210 refers to the data stored in the storage unit 300 (data corresponding to the information shown in the graph of Fig. 3), and thus identifies the type of the refrigerant as R134a.

[0075] Alternatively, for example, suppose a situation where as a result of the measurement by the first sensor 11 and the second sensor 12, it has been determined that the first value is 21°C and the second value is 95°C. In this case, the identifying unit 210 refers to the data stored in the storage unit 300 (data corresponding to the information shown in the graph of Fig. 3), and thus identifies the type of the refrigerant as R410A.

[0076] As described above, in the refrigerant-collecting apparatus 100 according to the present embodiment, the identifying unit 210 identifies the type of the refrigerant collected by the refrigerant-collecting apparatus 100. This configuration eliminates a possibility that the collection worker makes a recognition mistake or a recording mistake when the type of the collected refrigerant is identified. Therefore, the type of the refrigerant collected by the refrigerant-collecting apparatus 100 can be identified without a mistake. Since the type of the refrigerant collected by the refrigerant-collecting apparatus 100 is identified without a mistake, it is easy to manage the refrigerant collected by the refrigerant-collecting apparatus 100.

[0077] Further, in the refrigerant-collecting apparatus 100 according to the present embodiment, the type of the collected refrigerant is identified on the basis of a value measured by the first sensor 11 and a value measured by the second sensor 12. In the present embodiment, the first sensor 11 and the second sensor 12 are thermistors. As described above, the refrigerant-collecting apparatus 100 according to the present embodiment can identify the type of the refrigerant with a relatively inexpensive configuration.

(4-3) Collected-Amount-Estimating Unit

[0078] The collected-amount-estimating unit 220 estimates a collected amount of the refrigerant collected from the target equipment 10 by the refrigerant-collecting apparatus 100. The collection of the refrigerant by the refrigerant-collecting apparatus 100 includes a liquid collection state, which is a state in which the refrigerant in a liquid state is collected, and a gas collection state, which is a state in which the refrigerant in a gas state is collected. The collected-amount-estimating unit 220 totals a collected amount of the refrigerant in the liquid collection state (which may be hereinafter referred to as the collected-liquid amount), and the collected amount of the refrigerant in the gas collection state (which may be hereinafter referred to as the collected-gas amount) to estimate a collected amount of the refrigerant collected by the refrigerant-collecting apparatus 100. Hereinafter, the estimation of the collected-liquid amount and the estimation of the collected-gas amount by the collected-amount-estimating unit 220 will be each described in order.

(4-3-1) Estimation of Collected-Liquid Amount

[0079] Before the collected-amount-estimating unit 220 starts estimation of a collected-liquid amount, the collected-amount-estimating unit 220 refers to a first value measured by the first sensor 11. As described above, the first value measured by the first sensor 11 is referred to determine whether a currently collected refrigerant is a liquid refrigerant or a gas refrigerant. The collected-amount-estimating unit 220 that has referred to the first value, and thus confirmed that the state of the currently collected refrigerant is a liquid state determines that the current operation is in the liquid collection state. The collected-amount-estimating unit 220 that has determined that the current operation is in the liquid collection state starts estimation of a collected-liquid amount.

[0080] The collected-liquid amount can be estimated by integrating the flow rate of the refrigerant in a liquid state flowing through the refrigerant channel 30 over the operation time period in the liquid collection state. Note that the operation time period in the liquid collection state can be measured by a timer or the like (not shown).

[0081] Here, in a case where the flow rate of the refrigerant in a liquid state flowing through the refrigerant channel 30 is G, the electric-power value of the compressor 80 is W, the compressor efficiency of the compressor 80 is η, and the enthalpy difference obtained by subtracting the enthalpy on the suction side of the compressor 80 from the enthalpy on the discharge side of the compressor 80 is ΔH_comp, the flow rate G of the refrigerant in a liquid state flowing through the refrigerant channel 30 can be derived from the following Expression 1.

$$\text{(Expression 1)}: G = W \times \eta / \Delta H\_comp$$

[0082] The electric-power value W is measured as a third value by the third sensor 13. Therefore, when the collected-amount-estimating unit 220 estimates a collected-liquid amount, the collected-amount-estimating unit 220 communicates with the third sensor 13 to refer to a third value.

[0083] The compressor efficiency η can be calculated from the type of the refrigerant identified by the identifying unit 210, and a first value. Therefore, when the collected-amount-estimating unit 220 estimates a collected-liquid amount, the collected-amount-estimating unit 220 communicates with the identifying unit 210 and the first sensor 11 to refer to the type of the refrigerant and a first value.

[0084] The enthalpy difference ΔH_comp will be described in detail below.

[0085] As described above, the enthalpy difference ΔH_comp can be obtained by subtracting the enthalpy on the suction side of the compressor 80 from the enthalpy on the discharge side of the compressor 80.

[0086] The enthalpy on the discharge side of the compressor 80 can be obtained from the refrigerant temperature near the discharge opening 82 of the compressor 80 and a discharge saturation pressure. The refrigerant temperature near the discharge opening 82 of the compressor 80 is measured as a second value by the second sensor 12. The discharge saturation pressure can be calculated from the type of the refrigerant flowing through the refrigerant channel 30 and the discharge saturation temperature. The type of the refrigerant flowing through the refrigerant channel 30 is identified by the identifying unit 210. A value corresponding to the discharge saturation temperature (third corrected measured value) can be calculated by correcting the refrigerant temperature on the inlet side of the condenser with the third correction value. The refrigerant temperature on the inlet side of the condenser is measured as a fourth value by the fourth sensor 14.

[0087] Therefore, when the collected-amount-estimating unit 220 estimates a collected-liquid amount, the collected-amount-estimating unit 220 communicates with the second sensor 12, the fourth sensor 14, and the identifying unit 210 to refer to the second value, the fourth value, and the type of the refrigerant. The collected-amount-estimating unit 220 that has referred to the fourth value corrects the fourth value with the third correction value to calculate a third corrected measured value. The collected-amount-estimating unit 220 that has calculated the third corrected measured value computes a discharge saturation pressure on the basis of the third corrected measured value and the type of the refrigerant identified by the identifying unit 210. The collected-amount-estimating unit 220 that has calculated the discharge saturation pressure calculates the enthalpy on the discharge side of the compressor 80 on the basis of the discharge saturation pressure and the second value (the refrigerant temperature near the discharge opening 82 of the compressor 80).

[0088] Similarly, the enthalpy on the suction side of the compressor 80 can be obtained from the suction temperature of the compressor 80 and a suction saturation pressure. The suction temperature of the compressor 80 is measured as a fifth value by the fifth sensor 15. The suction saturation pressure can be calculated from the type of the refrigerant flowing through the refrigerant channel 30, and the suction saturation temperature. The type of the refrigerant flowing through the refrigerant channel 30 is identified by the identifying unit 210. A value corresponding to the suction saturation temperature (first corrected measured value) can be calculated by correcting the refrigerant temperature near the first port 101 with the first correction value. The refrigerant temperature near the first port 101 is measured as a first value by the first sensor 11.

[0089] Therefore, when the collected-amount-estimating unit 220 estimates a collected-liquid amount, the collected-amount-estimating unit 220 communicates with the first sensor 11, the fifth sensor 15, and the identifying unit 210 to refer to the first value, the fifth value, and the type of the refrigerant. The collected-amount-estimating unit 220 that has referred to the first value corrects the first value with the first correction value to calculate a first corrected measured value. The collected-amount-estimating unit 220 that has calculated the first corrected measured value computes a suction saturation pressure on the basis of the first corrected measured value and the type of the refrigerant identified by the identifying unit 210. The collected-amount-estimating unit 220 that has calculated the suction saturation pressure calculates the enthalpy on the suction side of the compressor 80 on the basis of the suction saturation pressure and the fifth value (the suction temperature of the compressor 80).

[0090] The collected-amount-estimating unit 220 that has calculated the enthalpy on the discharge side of the compressor 80 and the enthalpy on the suction side of the compressor 80 subtracts the enthalpy on the suction side of the compressor 80 from the enthalpy on the discharge side of the compressor 80 to calculate ΔH_comp.

[0091] In this way, the collected-amount-estimating unit 220 that has referred to or calculated each of the electric-power value W, the compressor efficiency η, and ΔH_comp computes Expression 1 described above to calculate the flow rate G of the refrigerant in a liquid state flowing through the refrigerant channel 30. Then the collected-amount-estimating unit 220 integrates the flow rate G of the refrigerant in a liquid state over the operation time period in the liquid collection state measured by the timer or the like (not shown) to estimate a collected-liquid amount.

(4-3-2) Estimation of Collected-Gas Amount

[0092] Before the collected-amount-estimating unit 220 starts estimation of a collected-gas amount, the collected-amount-estimating unit 220 refers to a first value measured by the first sensor 11. As described above, the first value measured by the first sensor 11 is referred to determine whether a currently collected refrigerant is a liquid refrigerant or a gas refrigerant. The collected-amount-estimating unit 220 that has referred to the first value, and thus confirmed that the state of the currently collected refrigerant is a gas state determines that the current operation is in the gas collection state. The collected-amount-estimating unit 220 that has determined that the current operation is in the gas collection state starts estimation of a collected-gas amount.

[0093] As a result of various studies, the inventor of the present application has found that the collected-gas amount can be calculated by multiplying a collected-liquid amount by a predetermined estimation parameter. Here, the predetermined estimation parameter for estimating a collected amount of the refrigerant in a gas state is 10%. Therefore, the collected-amount-estimating unit 220 multiplies a collected-liquid amount estimated in (4-3-1) described above by 1/10 to estimate a collected-gas amount. Note that the estimation parameter is stored in a predetermined storage area of the storage unit 300.

(4-3-3) Estimation of Collected-Refrigerant Amount

[0094] The collected-amount-estimating unit 220 that has estimated a collected-liquid amount of the refrigerant and a collected-gas amount of the refrigerant totals the collected-liquid amount and the collected-gas amount. The collected-amount-estimating unit 220 estimates, as a collected amount of the refrigerant, a numerical value calculated by totaling the collected-liquid amount and the collected-gas amount.

[0095] As described above, in the refrigerant-collecting apparatus 100 according to the present embodiment, the collected-amount-estimating unit 220 estimates a collected amount of the refrigerant collected by the refrigerant-collecting apparatus 100. This configuration estimates a collected amount of the refrigerant collected by the refrigerant-collecting apparatus 100, in addition to the type of the refrigerant collected by the refrigerant-collecting apparatus 100. Therefore, the refrigerant-collecting apparatus 100 according to the present embodiment makes it easier to manage the refrigerant collected by the refrigerant-collecting apparatus 100.

[0096] Further, in the refrigerant-collecting apparatus 100 according to the present embodiment, a collected amount of the collected refrigerant is identified on the basis of values measured by the first sensor 11, the second sensor 12, the third sensor 13, the fourth sensor 14, and the fifth sensor 15. In the present embodiment, the first sensor 11, the second sensor 12, the fourth sensor 14, and the fifth sensor 15 are thermistors. Further, the third sensor 13 is a wattmeter. As described above, the refrigerant-collecting apparatus 100 according to the present embodiment can identify a collected amount of the refrigerant with a relatively inexpensive configuration. Therefore, in the present embodiment, the manufacturing cost of the refrigerant-collecting apparatus 100 is reduced.

[0097] Note that the type of the refrigerant identified by the identifying unit 210 and the collected amount of the refrigerant estimated by the collected-amount-estimating unit 220 are stored in the storage unit 300. At this time, the storage unit 300 stores the type of the refrigerant, and the collected amount of the refrigerant that are associated with each other. This configuration makes it easier to manage the refrigerant collected by the refrigerant-collecting apparatus 100.

[0098] Further, for example, the type of the refrigerant and the collected amount of the refrigerant stored in the storage unit 300 may be transmitted to a management apparatus, a server, or the like (not shown) through a communication network (not shown).

[0099] Further, for example, the controller 200 may have a function for calculating, from the type of the refrigerant and the collected amount of the refrigerant that are associated with each other and stored in the storage unit 300, the CO2 amount of the collected-refrigerant amount.

[0100] The CO2 amount of the collected-refrigerant amount can be calculated by multiplying the collected amount of the refrigerant by the global warming potential (GWP) of the type of the refrigerant. Therefore, for example, after the refrigerant collection work ends, the controller 200 may multiply the collected amount of the refrigerant by the global warming potential (GWP) of the type of the refrigerant to calculate the CO2 amount of the collected-refrigerant amount. Note that in a case where the controller 200 has a function for calculating the CO2 amount of the collected-refrigerant amount, the storage unit 300 stores the global warming potential (GWP) for each type of refrigerant.

(5) Features

[0101] (5-1)

The refrigerant-collecting apparatus 100 according to the present embodiment includes the first port 101, the second port 102, the refrigerant channel 30, and the identifying unit 210. The first port 101 is connected to the target equipment 10 from which a refrigerant is collected. The second port 102 is connected to the container 110 in which the refrigerant collected from the target equipment 10 is put. The refrigerant channel 30 connects the first port 101 and the second port 102. The refrigerant channel 30 includes at least the expansion mechanism 40, the compressor 80, and the heat exchanger 90. The identifying unit 210 identifies the type of the refrigerant that is being collected from the target equipment 10. On the basis of the first value and the second value, the identifying unit 210 identifies the type of the refrigerant that is being collected from the target equipment 10. The first value relates to a first refrigerant temperature, which is the refrigerant temperature on the first-port-101 side of the compressor 80. The second value relates to a second refrigerant temperature, which is the refrigerant temperature on the second-port-102 side of the compressor 80.

[0102] In the present embodiment, the identifying unit 210 identifies the type of the refrigerant that is being collected from the target equipment 10. This configuration eliminates a possibility that the collection worker makes a recognition mistake or a recording mistake. Therefore, the refrigerant-collecting apparatus 100 according to the present embodiment can identify the type of the collected refrigerant without a mistake. Since the type of the collected refrigerant is identified without a mistake, it is easy to manage the collected refrigerant.

[0103] (5-2)

In the refrigerant-collecting apparatus 100 according to the present embodiment, the first value is the refrigerant temperature near the first port 101.

[0104] Here, the refrigerant temperature near the first port 101 is employed as the first value. The refrigerant temperature near the first port 101 can be measured by a relatively inexpensive sensor. Therefore, the refrigerant-collecting apparatus 100 according to the present embodiment can reduce the manufacturing cost of the refrigerant-collecting apparatus 100.

[0105] (5-3)

In the refrigerant-collecting apparatus 100 according to the present embodiment, the heat exchanger 90 is a condenser that condenses the refrigerant. The second value is the refrigerant temperature near the discharge opening 82 of the compressor 80.

[0106] Here, the refrigerant temperature near the discharge opening 82 of the compressor 80 is employed as the second value. The refrigerant temperature near the discharge opening 82 of the compressor 80 can be measured by a relatively inexpensive sensor. Therefore, the refrigerant-collecting apparatus 100 according to the present embodiment can reduce the manufacturing cost of the refrigerant-collecting apparatus 100.

[0107] (5-4)

In the refrigerant-collecting apparatus 100 according to the present embodiment, the third value is an electric-power value of the compressor 80.

[0108] Here, the electric-power value of the compressor 80 is employed as the third value. The electric-power value of the compressor 80 can be measured by a relatively inexpensive sensor. Therefore, the refrigerant-collecting apparatus 100 according to the present embodiment can reduce the manufacturing cost of the refrigerant-collecting apparatus 100.

[0109] (5-5)

The refrigerant-collecting apparatus 100 according to the present embodiment further includes the collected-amount-estimating unit 220. On the basis of at least a time period during which the refrigerant is being collected from the target equipment 10, the collected-amount-estimating unit 220 estimates a collected amount of the refrigerant collected from the target equipment 10.

[0110] In the present embodiment, the collected-amount-estimating unit 220 estimates a collected amount of the refrigerant. This configuration estimates a collected amount of the collected refrigerant, in addition to the type of the collected refrigerant. Therefore, the refrigerant-collecting apparatus 100 according to the present embodiment makes it easier to manage the collected refrigerant.

[0111] (5-6)

The refrigerant-collecting apparatus 100 according to the present embodiment further includes the storage unit. The storage unit stores the type of the refrigerant identified by the identifying unit 210, and a collected amount of the refrigerant estimated by the collected-amount-estimating unit 220 that are associated with each other.

[0112] In a case where a plurality of pieces of target equipment exists at a site where refrigerants are collected, there is a possibility that due to a recognition mistake or a recording mistake of the collection worker, the type and collected amount of the refrigerant collected from one piece of the target equipment are confused with the type and collected amount of the refrigerant collected from another piece of the target equipment. For example, in a case where two pieces of target equipment exist at a site where refrigerants are collected, there is a possibility that due to a recognition mistake or a recording mistake, the collection worker confuses the type of the refrigerant collected from a first one of the target equipment with the refrigerant collected from a second one of the target equipment. Alternatively, there is a possibility that due to a recognition mistake or a recording mistake, the collection worker confuses the collected amount of the refrigerant collected from a first one of the target equipment with the collected amount of the refrigerant collected from a second one of the target equipment.

[0113] In the present embodiment, the storage unit 300 stores the type of the refrigerant, and the collected amount of the refrigerant that are associated with each other. Therefore, the refrigerant-collecting apparatus 100 according to the present embodiment makes it easier to manage the collected refrigerant.

[0114] (5-7)

In the refrigerant-collecting apparatus 100 according to the present embodiment, on the basis of the liquid collection state and the gas collection state of the refrigerant, the collected-amount-estimating unit 220 estimates a collected-liquid amount and a collected-gas amount of the refrigerant, respectively, to estimate a collected amount of the refrigerant.

[0115] (5-8)

In the refrigerant-collecting apparatus 100 according to the present embodiment, the collected-amount-estimating unit 220 determines the liquid collection state on the basis of the refrigerant temperature near the first port 101.

[0116] The refrigerant temperature near the first port 101 can be measured by a relatively inexpensive sensor. Therefore, the refrigerant-collecting apparatus 100 according to the present embodiment can reduce the manufacturing cost of the refrigerant-collecting apparatus 100.

[0117] (5-9)

In the refrigerant-collecting apparatus 100 according to the present embodiment, the collected-amount-estimating unit 220 computes the suction saturation pressure using the first corrected measured value obtained by correcting the refrigerant temperature near the first port 101. The collected-amount-estimating unit 220 computes the discharge saturation pressure using the third corrected measured value obtained by correcting the refrigerant temperature near the heat exchanger 90.

[0118] In the present embodiment, the collected-amount-estimating unit 220 computes the suction saturation pressure using the first corrected measured value obtained by correcting the refrigerant temperature near the first port 101. Therefore, the suction saturation pressure can be calculated without the provision of a relatively expensive sensor, such as a pressure sensor.

[0119] Further, the collected-amount-estimating unit 220 computes the discharge saturation pressure using the third corrected measured value obtained by correcting the refrigerant temperature near the heat exchanger 90. Therefore, the discharge saturation pressure can be calculated without the provision of a relatively expensive sensor, such as a pressure sensor. Therefore, the refrigerant-collecting apparatus 100 according to the present embodiment can reduce the manufacturing cost of the refrigerant-collecting apparatus 100.

[0120] (5-10)

In the refrigerant-collecting apparatus 100 according to the present embodiment, the collected-amount-estimating unit 220 estimates a collected-liquid amount on the basis of the compressor efficiency of the compressor 80, the third value, the suction saturation pressure, and the discharge saturation pressure in a liquid collection operation for collecting the refrigerant in a liquid state.

[0121] In the present embodiment, the collected-amount-estimating unit 220 estimates a collected-liquid amount on the basis of the compressor efficiency of the compressor 80, the third value, the suction saturation pressure, and the discharge saturation pressure. The compressor efficiency can be calculated from the type of the refrigerant and the first value. The third value can be measured by a relatively inexpensive sensor. The suction saturation pressure can be computed using the first corrected measured value obtained by correcting the refrigerant temperature near the first port 101. The discharge saturation pressure can be computed using the third corrected measured value obtained by correcting the refrigerant temperature near the heat exchanger 90. Therefore, the refrigerant-collecting apparatus 100 according to the present embodiment can reduce the manufacturing cost of the refrigerant-collecting apparatus 100.

[0122] (5-11)

In the refrigerant-collecting apparatus 100 according to the present embodiment, the collected-amount-estimating unit 220 estimates a collected-gas amount on the basis of the operation time period in a gas collection operation for collecting the refrigerant in a gas state. Alternatively, the collected-amount-estimating unit 220 estimates a collected-gas amount on the basis of a collected-liquid amount.

[0123] (5-12)

In the refrigerant-collecting apparatus 100 according to the present embodiment, the refrigerant channel 30 further includes the impurity separator 60. The separation scheme of the impurity separator is a gas-liquid separation scheme or an electrostatic separation scheme.

[0124] (5-13)

For the refrigerant-collecting apparatus 100 according to the present embodiment, a refrigerant collected from the target equipment 10 is R32, R410A, R134a, or R404A.

(6) Modifications

[0125] Modifications of the embodiment described above will be described below. The following modifications may be appropriately combined as long as they do not contradict each other. Note that a configuration substantially similar to the configuration of the embodiment described above is denoted by similar reference signs, and the detailed description thereof is omitted.

(6-1) Modification 1A

[0126] In the embodiment described above, an example in which the refrigerant is collected from an air-conditioning apparatus as an example of the target equipment 10 has been described. However, the target equipment 10 is not limited to the air-conditioning apparatus. The target equipment 10 may be, for example, a refrigerator, a freezer, a water heater, or the like.

(6-2) Modification 1B

[0127] In the embodiment described above, an example in which the refrigerant temperature near the first port 101 is measured as the first value has been described. However, examples of the first value are not limited to this example. As described in the embodiment described above, the inventor of the present application has found that if a value relating to a first refrigerant temperature, which is the refrigerant temperature on the first-port side of the compressor, and a value relating to a second refrigerant temperature, which is the refrigerant temperature on the second-port side of the compressor are measured, the type of the refrigerant flowing through the refrigerant-collecting apparatus can be identified. Therefore, for example, the first value may be an outside-air temperature or a refrigerant temperature near the suction opening 81 of the compressor 80. Hereinafter, a case where an outside-air temperature is employed as the first value will be described as an example.

[0128] In a case where an outside-air temperature is employed as the first value, the refrigerant-collecting apparatus 100 includes a sensor that can detect an outside-air temperature, in addition to the first sensor 11 or instead of the first sensor 11. Further, in a case where an outside-air temperature is employed as the first value, the storage unit 300 of the refrigerant-collecting apparatus 100 stores some data corresponding to the information shown in the graph of Fig. 6. The graph of Fig. 6 is created on the basis of some data obtained by making the test machine collect various types of refrigerants. More specifically, for each type of refrigerant, the level of an outside-air temperature at the time when the test machine collects the refrigerant, and the level of the refrigerant temperature near the discharge opening of the compressor at the time when the test machine collects the refrigerant are measured to obtain some data. On the basis of the data, the graph of Fig. 6 is created. The horizontal axis of the graph of Fig. 6 indicates the level of the outside-air temperature (described as "OUTSIDE-AIR TEMPERATURE °C in Fig. 6"). The vertical axis of the graph of Fig. 6 indicates the level of the refrigerant temperature near the discharge opening of the compressor (described as "DISCHARGE TEMPERATURE °C in Fig. 6").

[0129] In a case where the refrigerant-collecting apparatus 100 includes the sensor that can detect an outside-air temperature, the identifying unit 210 can identify the type of the refrigerant on the basis of the data stored in the storage unit 300 (data corresponding to the information shown in the graph of Fig. 6). For example, suppose a situation where as a result of the measurement by the sensor that detects an outside-air temperature and the second sensor 12, it has been determined that the first value is 21°C and the second value is 91°C. In this case, the identifying unit 210 refers to the data stored in the storage unit 300 (data corresponding to the information shown in the graph of Fig. 6), and thus identifies the type of the refrigerant as R32.

(6-3) Modification 1C

[0130] In the embodiment described above, an example in which the identifying unit 210 identifies the type of the refrigerant on the basis of the first value and the second value has been described. However, methods for the identification by the identifying unit 210 are not limited to this example, and, for example, the identifying unit 210 may identify the type of the refrigerant on the basis of the first value and the third value.

[0131] In a case where the identifying unit 210 identifies the type of the refrigerant on the basis of the first value and the third value, the storage unit 300 stores some data corresponding to the information shown in the graph of Fig. 7. The graph of Fig. 7 is created on the basis of some data obtained by making the test machine collect various types of refrigerants. More specifically, for each type of refrigerant, the level of the refrigerant temperature near the first port at the time when the test machine collects the refrigerant, and the level of the electric-power value of the compressor at the time when the test machine collects the refrigerant are measured to obtain some data. On the basis of the data, the graph of Fig. 7 is created. The horizontal axis of the graph of Fig. 7 indicates the level of the refrigerant temperature near the first port (described as "SUCTION PORT TEMPERATURE °C" in Fig. 7). The vertical axis of the graph of Fig. 7 indicates the level of the electric-power value of the compressor (described as "COMPRESSOR ELECTRIC-POWER W" in Fig. 7).

[0132] As shown in the graph of Fig. 7, the level of the refrigerant temperature near the first port, and the level of the electric-power value of the compressor vary according to the type of the refrigerant. From this fact, the inventor of the present application has found that if the refrigerant temperature near the first port and the electric-power value of the compressor are measured, the type of the refrigerant flowing through the refrigerant-collecting apparatus can be identified. More specifically, the inventor of the present application has found that if a value relating to a first refrigerant temperature, which is the refrigerant temperature on the first-port side of the compressor, and a value relating to the electric power consumed by the compressor are measured, the type of the refrigerant flowing through the refrigerant-collecting apparatus can be identified.

[0133] Therefore, the identifying unit 210 can identify the type of the refrigerant on the basis of the first value, the third value, and the data stored in the storage unit 300 and corresponding to the information shown in the graph of Fig. 7.

[0134] Note that as described in the modification 1B, in a case where the refrigerant-collecting apparatus 100 measures an outside-air temperature as the first value, the storage unit 300 stores some data corresponding to the information shown in the graph of Fig. 8. The graph of Fig. 8 is created on the basis of some data obtained by making the test machine collect various types of refrigerants. More specifically, for each type of refrigerant, the level of an outside-air temperature at the time when the test machine collects the refrigerant, and the level of the electric-power value of the compressor at the time when the test machine collects the refrigerant are measured to obtain some data. On the basis of the data, the graph of Fig. 8 is created. The horizontal axis of the graph of Fig. 8 indicates the level of the outside-air temperature (described as "OUTSIDE-AIR TEMPERATURE °C" in Fig. 8). The vertical axis of the graph of Fig. 8 indicates the level of the electric-power value of the compressor 80 (described as "COMPRESSOR ELECTRIC-POWER W" in Fig. 8). Therefore, the identifying unit 210 can identify the type of the refrigerant on the basis of the first value, the third value, and the data stored in the storage unit 300 and corresponding to the information shown in the graph of Fig. 8.

[0135] Note that, for example, the identifying unit 210 may identify the type of the refrigerant on the basis of the first value, the second value, and the third value. In this case, for example, the identifying unit 210 may identify the type of the refrigerant on the basis of the first value, the second value, and some data corresponding to the information shown in the graph of Fig. 6, and then may identify the type of the refrigerant on the basis of the first value, the third value, and some data corresponding to the information shown in the data of Fig. 7. Since this configuration confirms the type of the refrigerant twice, this configuration can precisely identify the type of the refrigerant.

(6-4) Modification 1D

[0136] In the embodiment described above, an example has been described in which the refrigerant-collecting apparatus 100 includes the second heat exchanger 50 that performs heat exchange between the refrigerant flowing from the second pipe 32 to the second heat exchanger 50, and the refrigerant flowing from the discharge pipe 822 to the second heat exchanger 50. However, the configuration of the second heat exchanger 50 is not limited to this example. For example, the second heat exchanger 50 may be an evaporator that performs heat exchange between the refrigerant flowing from the second pipe 32 to the second heat exchanger 50, and air sent to the second heat exchanger 50 by a fan (not shown) (see Fig. 9).

[0137] As shown in Fig. 9, in the refrigerant-collecting apparatus 100 according to the modification 1D, the refrigerant flowing through the discharge pipe 822 does not flow to the second heat exchanger 50. Therefore, in the refrigerant-collecting apparatus 100 according to the modification 1D, the temperature variation of the refrigerant flowing through the discharge pipe 822 is suppressed.

[0138] Due to this configuration, the refrigerant temperature of the refrigerant flowing through the discharge pipe 822 is substantially the same as the refrigerant temperature of the refrigerant flowing through the inlet side of the first heat exchanger 90 (condenser). Therefore, for example, for the refrigerant-collecting apparatus 100 according to the modification 1D, the refrigerant temperature near the first heat exchanger 90 (condenser) measured by the fourth sensor 14 may be used as the second value. In other words, for example, the fourth sensor 14 may also function as the second sensor 12. In this case, as shown in Fig. 9, it is not necessary to attach the second sensor 12 to the refrigerant-collecting apparatus 100. Therefore, the refrigerant-collecting apparatus 100 according to the modification 1D can reduce the number of assembly steps of the refrigerant-collecting apparatus 100.

[0139] Note that, for example, the temperature measured by the second sensor 12 may be used as the refrigerant temperature near the first heat exchanger 90 (condenser). In other words, for example, the second sensor 12 may also function as the fourth sensor 14. In this case, although not shown, it is not necessary to attach the fourth sensor 14 to the refrigerant-collecting apparatus 100.

[0140] Further, for example, in the refrigerant-collecting apparatus 100 according to the modification 1D, the first heat exchanger 90 and the second heat exchanger 50 may share a fan. For example, the arrangement position of each equipment may be adjusted such that the air sent from the fan 95 passes through the first heat exchanger 90, and then flows to the second heat exchanger 50.

(6-5) Modification 1E

[0141] In the embodiment described above, an example in which the electric-power value of the compressor 80 is measured as the third value has been described. However, examples of the third value are not limited to this example, and the third value may be, for example, the electric-current value of the compressor 80. In this case, the refrigerant-collecting apparatus 100 includes, as the third sensor, an ammeter instead of the wattmeter. Further, to calculate the electric-power value of the compressor 80, the controller 200 performs a predetermined computation on the electric-current value measured by the third sensor 13.

(6-6) Modification 1F

[0142] In the embodiment described above, an example has been described in which the collected-amount-estimating unit 220 refers to the refrigerant temperature near the first port 101 to determine the liquid collection state. However, methods in which the collected-amount-estimating unit 220 determines the liquid collection state are not limited to this example. For example, the refrigerant-collecting apparatus 100 may include a sensor that measures the refrigerant temperature on the downstream side of the expansion mechanism 40, and the collected-amount-estimating unit 220 may determine the liquid collection state on the basis of the refrigerant temperature on the downstream side of the expansion mechanism 40.

[0143] Note that although not shown here, the sensor that measures the refrigerant temperature on the downstream side of the expansion mechanism 40 is arranged at, for example, the second pipe 32.

(6-7) Modification 1G

[0144] In the embodiment described above, an example has been described in which the collected-amount-estimating unit 220 computes the suction saturation pressure on the basis of the first corrected measured value and the type of the refrigerant. However, methods in which the collected-amount-estimating unit 220 estimates the suction saturation pressure are not limited to this example. For example, the refrigerant-collecting apparatus 100 may include a sensor that measures the refrigerant temperature on the downstream side of the expansion mechanism 40, and the collected-amount-estimating unit 220 may compute the suction saturation pressure using a second corrected measured value obtained by correcting the refrigerant temperature on the downstream side of the expansion mechanism with a predetermined correction value (second correction value).

[0145] As indicated by the broken line of the graph of Fig. 4, during a time slot indicated from a point A to a point B (time slot during which the refrigerant is in a liquid state), the behavior of the refrigerant temperature on the downstream side of the expansion mechanism 40 (see the broken line of the graph of Fig. 4), and the behavior of the suction saturation temperature (see the solid line of the graph of Fig. 4) are very similar. From this fact, the inventor of the present application has found that a value corresponding to the suction saturation temperature can be calculated by correcting the refrigerant temperature on the downstream side of the expansion mechanism 40 with a predetermined correction value (second correction value).

[0146] Note that although not shown here, the sensor that measures the refrigerant temperature on the downstream side of the expansion mechanism 40 is arranged at, for example, the second pipe 32.

(6-8) Modification 1H

[0147] In the embodiment described above, an example has been described in which the collected-amount-estimating unit 220 estimates a collected-gas amount by multiplying a collected-liquid amount by a predetermined estimation parameter. However, methods in which the collected-amount-estimating unit 220 estimates a collected-gas amount are not limited to this example.

[0148] For example, the storage unit 300 may store a data set in which an operation time period in the gas collection state and a collected-gas amount are associated with each other. Further, for example, the collected-amount-estimating unit 220 may measure an operation time period in the gas collection state with a timer (not shown). In addition, for example, the collected-amount-estimating unit 220 may refer to an operation time period in the gas collection state measured by the timer (not shown), and a data set in question to estimate a collected-gas amount.

(6-9) Modification 1I

[0149] For example, the controller 200 may have a function as an updating unit 230 although the description is omitted in the embodiment described above. The updating unit 230 updates at least one of the first correction value, the second correction value, the third correction value, the compressor efficiency, and the estimation parameter in, for example, the following manner.

[0150] In the modification 1I, suppose a situation where after refrigerant collection work ends, the collection worker who has performed the refrigerant collection work manually records, in the storage unit 300, an actually-measured value of the collected-refrigerant amount.

[0151] In the refrigerant-collecting apparatus 100 according to the modification 1I, the collected-refrigerant amount actually measured by the collection worker is recorded in the storage unit 300. Further, the storage unit 300 of the refrigerant-collecting apparatus 100 according to the modification 1I stores the electric-power value of the compressor 80, the first value, the fourth value, and the operation time period in the liquid collection state that are associated with the actually-measured collected-refrigerant amount. In addition, the storage unit 300 of the refrigerant-collecting apparatus 100 according to the modification 1I stores a predetermined estimation formula for estimating an estimated value of a collected-refrigerant amount from the electric-power value of the compressors 80, the first value, the fourth value, and the operation time period in the liquid collection state. The parameters of the predetermined estimation formula are the first correction value, the third correction value, the estimation parameter, and the compressor efficiency.

[0152] Here, when a predetermined amount of data is accumulated, the updating unit 230 calculates, as an optimization problem, the parameters (the first correction value, the third correction value, the estimation parameter, and the compressor efficiency) such that the mean square error between actually-measured values of collected-refrigerant amounts and estimated values of the collected-refrigerant amounts is minimized, and updates the parameters. Used for the optimization is, for example, the method of steepest descent or Newton's method. In this way, every time a predetermined amount of data is accumulated, the values of the first correction value, the third correction value, the compressor efficiency, and the estimation parameter are updated to improve the estimation precision of the collected-refrigerant amount.

[0153] Note that as described in the modification 1G, in a case where the second correction value, instead of the first correction value, is used to compute the suction saturation pressure, the updating unit 230 updates the second correction value, the third correction value, the estimation parameter, and the compressor efficiency.

(6-10) Modification 1J

[0154] In the embodiment described above, an example in which the identifying unit 210 identifies the types of refrigerants that are fluorocarbon-based refrigerants has been described. However, the types of refrigerants that can be identified by the identifying unit 210 are not limited to fluorocarbon-based refrigerants, and the identifying unit 210 can identify various types of refrigerants. Similarly, the collected-amount-estimating unit 220 can estimate the collected amounts of various types of refrigerants.

(6-11) Modification 1K

[0155] In the embodiment described above, an example in which the identifying unit 210 of the refrigerant-collecting apparatus 100 identifies the type of the refrigerant has been described. However, the configuration of the identifying unit 210 is not limited to this example, and, for example, part of the function as the identifying unit 210 may be implemented by a server or the like (not shown). For example, the refrigerant-collecting apparatus 100 may transmit the first value and the second value to a server having part of the function as the identifying unit 210, with communication equipment (not shown). In addition, for example, the result of a computation performed in the server may be transmitted to the refrigerant-collecting apparatus 100. At this time, for example, the result of the computation performed in the server may be transmitted to a mobile terminal or the like of the collection worker. In other words, for example, the identified type of the refrigerant may be transmitted to a smartphone, a tablet, or the like of the collection worker.

[0156] Similarly, for example, part of the function as the collected-amount-estimating unit 220 may be implemented by a server or the like (not shown). In this case, for example, the refrigerant-collecting apparatus 100 may transmit the first value, the second value, the third value, the fourth value, and the fifth value to a server having part of the function as the identifying unit 210, with communication equipment (not shown). In addition, for example, the result of a computation performed in the server may be transmitted to the refrigerant-collecting apparatus 100. At this time, for example, the result of the computation performed in the server may be transmitted to a mobile terminal or the like of the collection worker. In other words, for example, the estimated collected-refrigerant amount may be transmitted to a smartphone, a tablet, or the like of the collection worker.

(6-12) Modification 1L

[0157] In the embodiment described above, an example in which thermistors are employed as the first sensor 11, the second sensor 12, the fourth sensor 14, and the fifth sensor 15 has been described. However, examples of the first sensor 11, the second sensor 12, the fourth sensor 14, and the fifth sensor 15 are not limited to this example, and may be, for example, thermocouples. Alternatively, as the first sensor 11, the second sensor 12, the fourth sensor 14, and the fifth sensor 15, sensors that can measure the temperature of the refrigerant and can be obtained at relatively low cost may be appropriately selected.

<Second Embodiment>

(7) Configuration

[0158] Next, a refrigerant-collecting apparatus 100S according to a second embodiment of the present disclosure will be described. In the second embodiment, only the configuration different from the configuration of the first embodiment will be described, and the other description will be omitted.

(7-1) Controller 200S

[0159] A controller 200S is electrically connected to each unit of the refrigerant-collecting apparatus 100S in such a manner that control signals, information, and the like can be transmitted and received. The controller 200S is implemented by a computer. The controller 200S includes a control arithmetic device and a storage device. As the control arithmetic device, a processor, such as a CPU or a GPU, can be used. The control arithmetic device reads programs stored in the storage device, and performs predetermined arithmetic processing according to the programs. In addition, according to the programs, the control arithmetic device can write an arithmetic result into the storage device, and can read information stored in the storage device. Fig. 10 shows various functional blocks implemented by the control arithmetic device. As shown in Fig. 10, the controller 200S has functions as a collected-amount-estimating unit 220S, an updating unit 230, and a storage unit 300S . Further, the storage unit 300S of the controller 200S can be used as a database.

(7-1-2) Storage Unit

[0160] The storage unit 300S includes the storage device, such as a ROM and a RAM, of the controller 200S. The storage unit 300S stores a program for controlling the workings of the refrigerant-collecting apparatus 100S, a communication protocol used when the refrigerant-collecting apparatus 100S communicates with other equipment, and the like. The storage unit 300S also stores various data obtained by the inventor of the present application operating a test machine of the refrigerant-collecting apparatus 100S (which may be hereinafter simply referred to as the "test machine").

[0161] For example, the storage unit 300S stores a data set in which an operation time period in a liquid collection state and a collected-liquid amount are associated with each other. The storage unit 300S also stores a data set in which an operation time period in a gas collection state and a collected-gas amount are associated with each other.

(7-1-3) Collected-Amount-Estimating Unit

[0162] The collected-amount-estimating unit 220S refers to an operation time period in the liquid collection state measured by a timer (not shown), an operation time period in the gas collection state measured by the timer (not shown), and various data sets stored in the storage unit 300S to estimate the collected-liquid amount and the collected-gas amount.

(7-2) Output Unit

[0163] The refrigerant-collecting apparatus 100S includes the output unit 240. The output unit 240 is, for example, a liquid crystal display, and can appropriately display a collected-refrigerant amount estimated by the collected-amount-estimating unit 220S. Note that, for example, the output unit 240 may display various information, such as values measured by various sensors.

(8) Features

[0164] (8-1)
The refrigerant-collecting apparatus 100S according to the present embodiment includes a first port 101, a second port 102, a refrigerant channel 30, the collected-amount-estimating unit 220S, and the output unit 240. The first port 101 is connected to target equipment 10 from which a refrigerant is collected. The second port 102 is connected to a container 110 in which the refrigerant collected from the target equipment 10 is put. The refrigerant channel 30 connects the first port 101 and the second port 102. The refrigerant channel 30 includes at least an expansion mechanism 40, a compressor 80, and a heat exchanger 90. On the basis of a time period during which the refrigerant is being collected from the target equipment 10, the collected-amount-estimating unit 220S estimates a collected amount of the refrigerant collected from the target equipment 10. The output unit 240 outputs the result estimated by the collected-amount-estimating unit 220S.

[0165] Here, on the basis of a time period during which the refrigerant is being collected from the target equipment 10, the collected-amount-estimating unit 220S estimates a collected amount of the refrigerant collected from the target equipment 10. This configuration eliminates a possibility that the collection worker makes a recognition mistake or a recording mistake. Therefore, the refrigerant-collecting apparatus 100S according to the present embodiment can identify the collected amount of the collected refrigerant without a mistake. Since the type of the collected refrigerant is identified without a mistake, it is easy to manage the collected refrigerant.

<Other Embodiments>

[0166] While the embodiments according to the present disclosure have been described above, it will be understood that various changes to the form and details are possible without departing from the spirit and scope of the claims.

[0167] The present disclosure is not limited to each of the embodiments described above. The present disclosure can be embodied by modifying the components without departing from the gist of the present disclosure in an implementation stage. Further, the present disclosure can form various disclosures by appropriate combination of a plurality of components disclosed in each of the embodiments described above. For example, some components may be eliminated from all the components shown in the embodiment. In addition, components may be appropriately combined with the different embodiment. Therefore, it should be considered that the present embodiments are only examples in all respects and are not limiting. Thus, it is intended that the present embodiments include all revisions obvious to those skilled in the art.

REFERENCE SIGNS LIST

[0168]

10 target equipment
30 refrigerant channel
40 expansion mechanism
60 impurity separator
80 compressor
81 suction opening
82 discharge opening
90 heat exchanger (first heat exchanger)
100, 100S refrigerant-collecting apparatus
101 first port
102 second port
110 container
210 identifying unit
220, 220S collected-amount-estimating unit
230 updating unit
240 output unit

CITATION LIST

PATENT LITERATURE

[0169] PTL 1: WO 2020/003509

Claims

1. A refrigerant-collecting apparatus (100) comprising:

a first port (101) connected to target equipment (10) from which a refrigerant is collected;
a second port (102) connected to a container (110) in which the refrigerant collected from the target equipment is put;
a refrigerant channel (30) that connects the first port and the second port, and includes at least an expansion mechanism (40), a compressor (80), and a heat exchanger (90); and
an identifying unit (210) that identifies a type of the refrigerant that is being collected from the target equipment, wherein
the identifying unit identifies,
on a basis of a first value relating to a first refrigerant temperature, which is a refrigerant temperature on the first-port side of the compressor, and a second value relating to a second refrigerant temperature, which is a refrigerant temperature on the second-port side of the compressor,

or
on a basis of the first value and a third value, which is a value relating to electric power consumed by the compressor,
or
on a basis of the first value, the second value, and the third value,
a type of the refrigerant that is being collected from the target equipment.

2. The refrigerant-collecting apparatus according to claim 1, wherein
the first value is an outside-air temperature, a refrigerant temperature near the first port, or a refrigerant temperature near a suction opening of the compressor.

3. The refrigerant-collecting apparatus according to claim 1 or 2, wherein

the heat exchanger is a condenser that condenses the refrigerant, and
the second value is a refrigerant temperature near a discharge opening (82) of the compressor, or a refrigerant temperature near the condenser.

4. The refrigerant-collecting apparatus according to any one of claims 1 to 3, wherein
the third value is a electric-current value of the compressor, or an electric-power value of the compressor.

5. The refrigerant-collecting apparatus according to any one of claims 1 to 4, further comprising

a collected-amount-estimating unit (220), wherein
on a basis of at least a time period during which the refrigerant is being collected from the target equipment, the collected-amount-estimating unit estimates a collected amount of the refrigerant collected from the target equipment.

6. The refrigerant-collecting apparatus according to claim 5, further comprising

a storage unit (300), wherein
the storage unit stores a type of the refrigerant identified by the identifying unit, and a collected amount of the refrigerant estimated by the collected-amount-estimating unit that are associated with each other.

7. The refrigerant-collecting apparatus according to claim 5 or 6, wherein
on a basis of a liquid collection state and a gas collection state of the refrigerant, the collected-amount-estimating unit estimates a collected-liquid amount and a collected-gas amount of the refrigerant, respectively, to estimate a collected amount of the refrigerant.

8. The refrigerant-collecting apparatus according to claim 7, wherein
the collected-amount-estimating unit determines the liquid collection state on a basis of a refrigerant temperature near the first port or a refrigerant temperature on a downstream side of the expansion mechanism.

9. The refrigerant-collecting apparatus according to claim 8, wherein

the collected-amount-estimating unit
computes a suction saturation pressure using a first corrected measured value obtained by correcting a refrigerant temperature near the first port, or using a second corrected measured value obtained by correcting a refrigerant temperature on the downstream side of the expansion mechanism, and
computes a discharge saturation pressure using a third corrected measured value obtained by correcting a refrigerant temperature near the heat exchanger.

10. The refrigerant-collecting apparatus according to claim 9, wherein

the collected-amount-estimating unit
estimates the collected-liquid amount on a basis of a compressor efficiency of the compressor, the third value, the suction saturation pressure, and the discharge saturation pressure in a liquid collection operation for collecting the refrigerant in a liquid state.

11. The refrigerant-collecting apparatus according to any one of claims 5 to 10, wherein

the collected-amount-estimating unit
estimates the collected-gas amount on a basis of an operation time period in a gas collection operation for collecting the refrigerant in a gas state,
or
estimates the collected-gas amount on a basis of the collected-liquid amount.

12. The refrigerant-collecting apparatus according to claim 9, further comprising

an updating unit (230), wherein
on a basis of a recorded value of a collected amount of the refrigerant manually recorded by

a collection worker who performs collection work of the refrigerant using the refrigerant-collecting apparatus, the updating unit updates at least one of a first correction value for calculating the first corrected measured value, a second correction value for calculating the second corrected measured value, a third correction value for calculating the third corrected measured value, a compressor efficiency of the compressor, and an estimation parameter for estimating a collected amount of the refrigerant in a gas state.

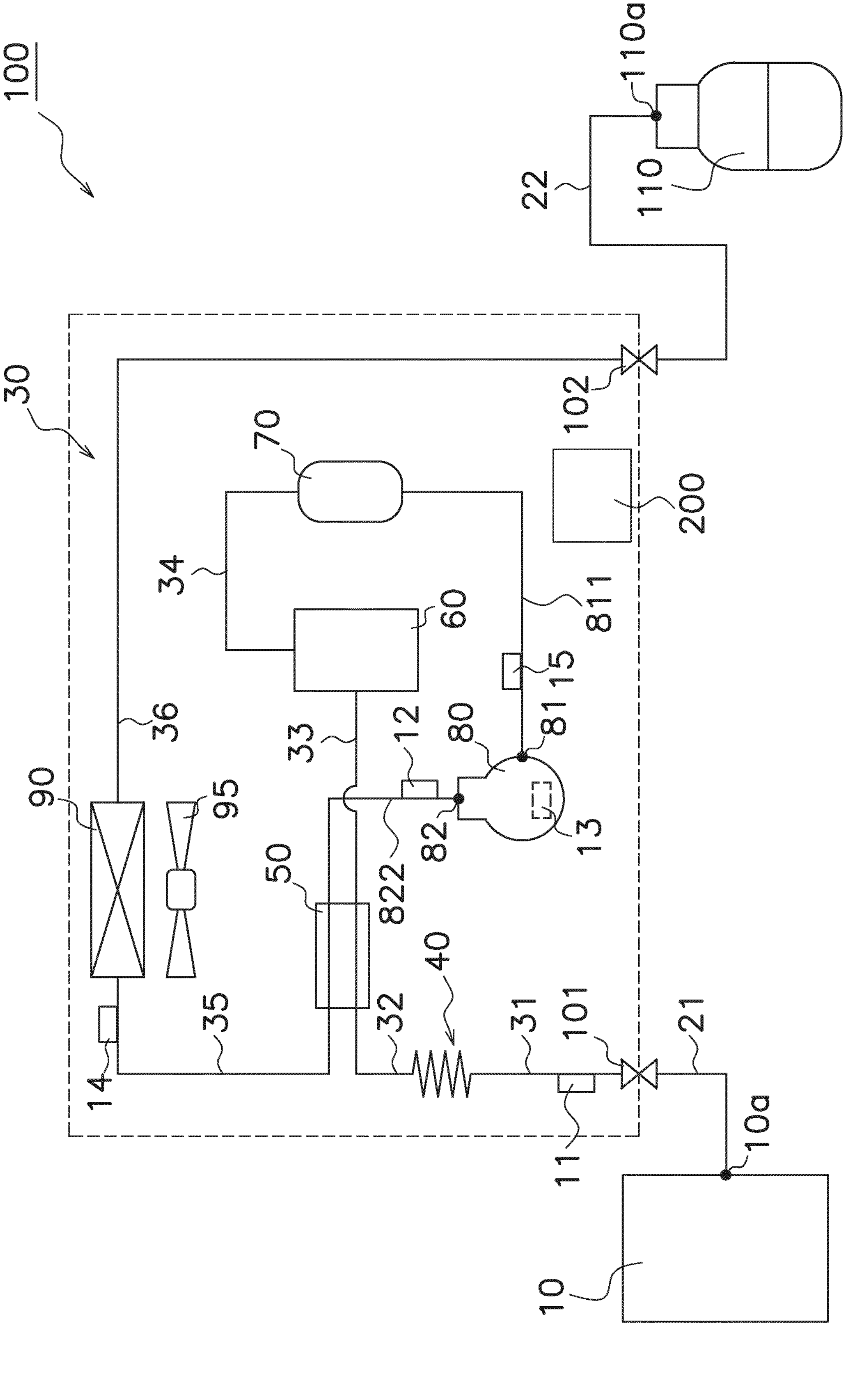
13. The refrigerant-collecting apparatus according to any one of claims 1 to 12, wherein

the refrigerant channel further includes an impurity separator (60), and
a separation scheme of the impurity separator is a gas-liquid separation scheme or an electrostatic separation scheme.

14. The refrigerant-collecting apparatus according to any one of claims 1 to 13, wherein
the refrigerant collected from the target equipment is R32, R410A, R134a, or R404A.

15. A refrigerant-collecting apparatus (100S) comprising:

a first port (101) connected to target equipment (10) from which a refrigerant is collected;
a second port (102) connected to a container (110) in which the refrigerant collected from the target equipment is put;
a refrigerant channel (30) that connects the first port and the second port, and includes at least an expansion mechanism (40), a compressor (80), and a heat exchanger (90); a collected-amount-estimating unit (220S); and an output unit (240), wherein
on a basis of a time period during which the refrigerant is being collected from the target equipment, the collected-amount-estimating unit estimates a collected amount of the refrigerant collected from the target equipment, and
the output unit outputs a result estimated by the collected-amount-estimating unit.


100
30
70
34
60
811
15
200
102
22
110a
110
36
33
12
80
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11
10a
10

FIG. 1

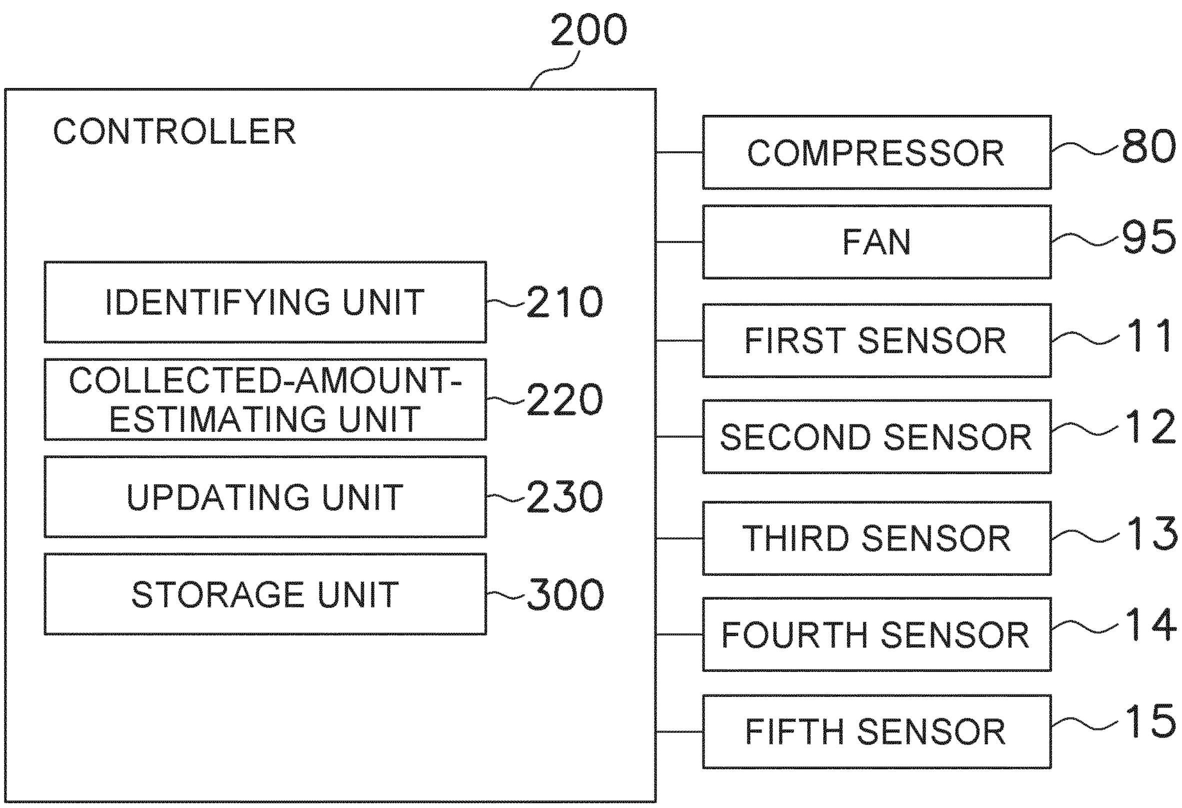

200
CONTROLLER
IDENTIFYING UNIT
210
COLLECTED-AMOUNT-ESTIMATING UNIT
220
UPDATING UNIT
230
STORAGE UNIT
300
COMPRESSOR
80
FAN
95
FIRST SENSOR
11
SECOND SENSOR
12
THIRD SENSOR
13
FOURTH SENSOR
14
FIFTH SENSOR
15

FIG. 2

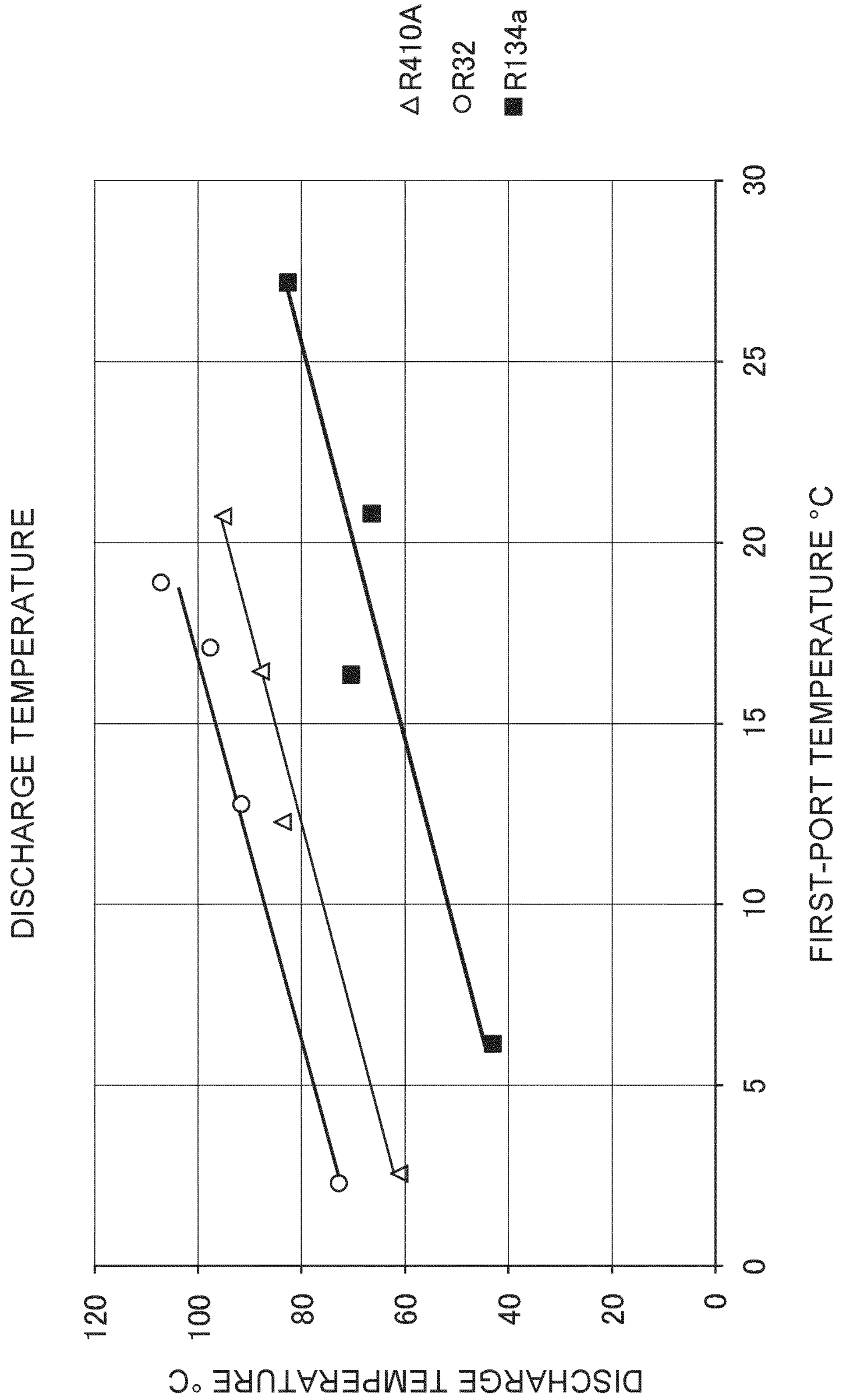

DISCHARGE TEMPERATURE
ΔR410A
○R32
■R134a
DISCHARGE TEMPERATURE °C
120
100
80
60
40
20
0
FIRST-PORT TEMPERATURE °C
0
5
10
15
20
25
30

FIG. 3

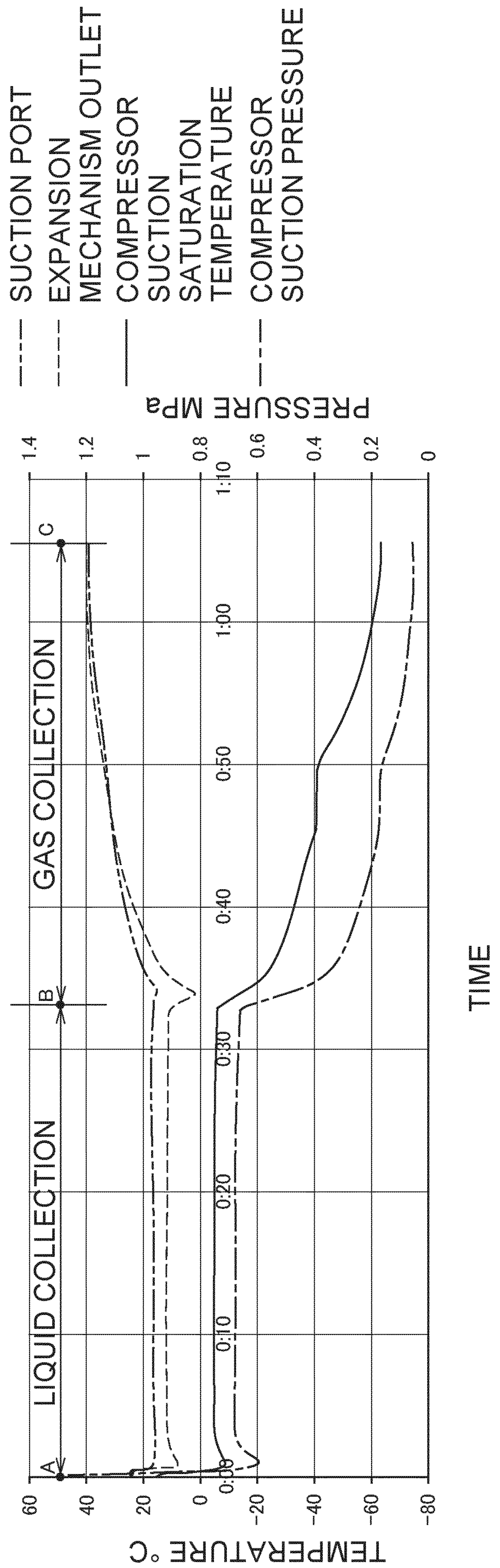

SUCTION PORT
EXPANSION MECHANISM OUTLET
COMPRESSOR SUCTION SATURATION TEMPERATURE
COMPRESSOR SUCTION PRESSURE
LIQUID COLLECTION
GAS COLLECTION
A
B
C
TEMPERATURE °C
60
40
20
0
−20
−40
−60
−80
PRESSURE MPa
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0:00
0:10
0:20
0:30
0:40
0:50
1:00
1:10
TIME

FIG. 4

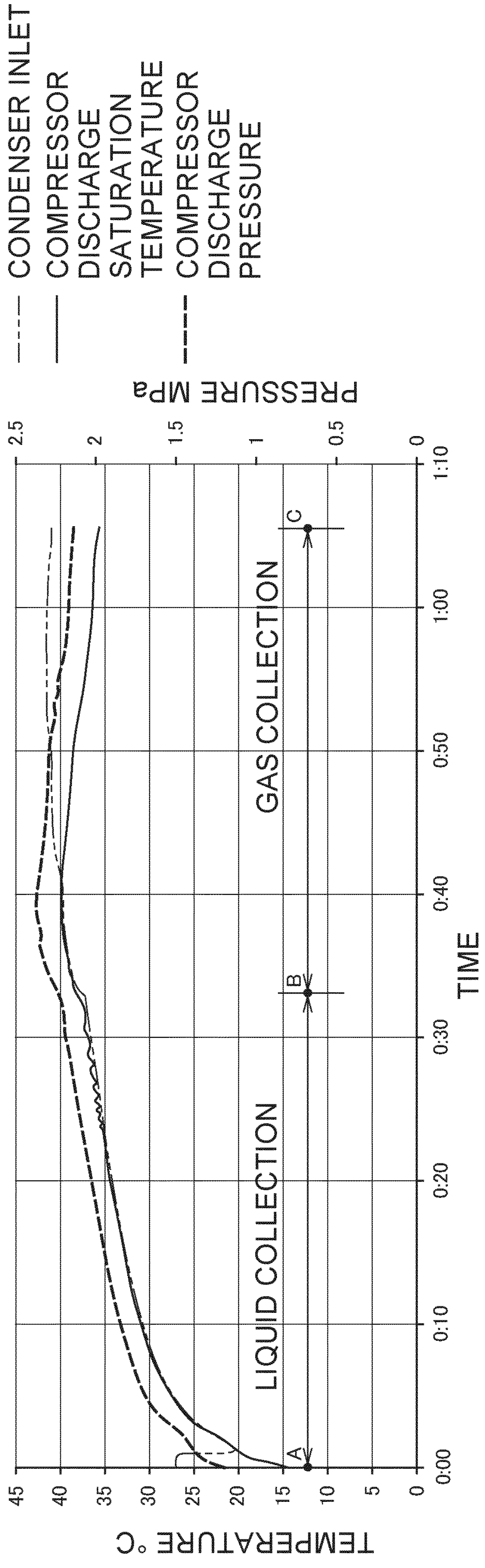
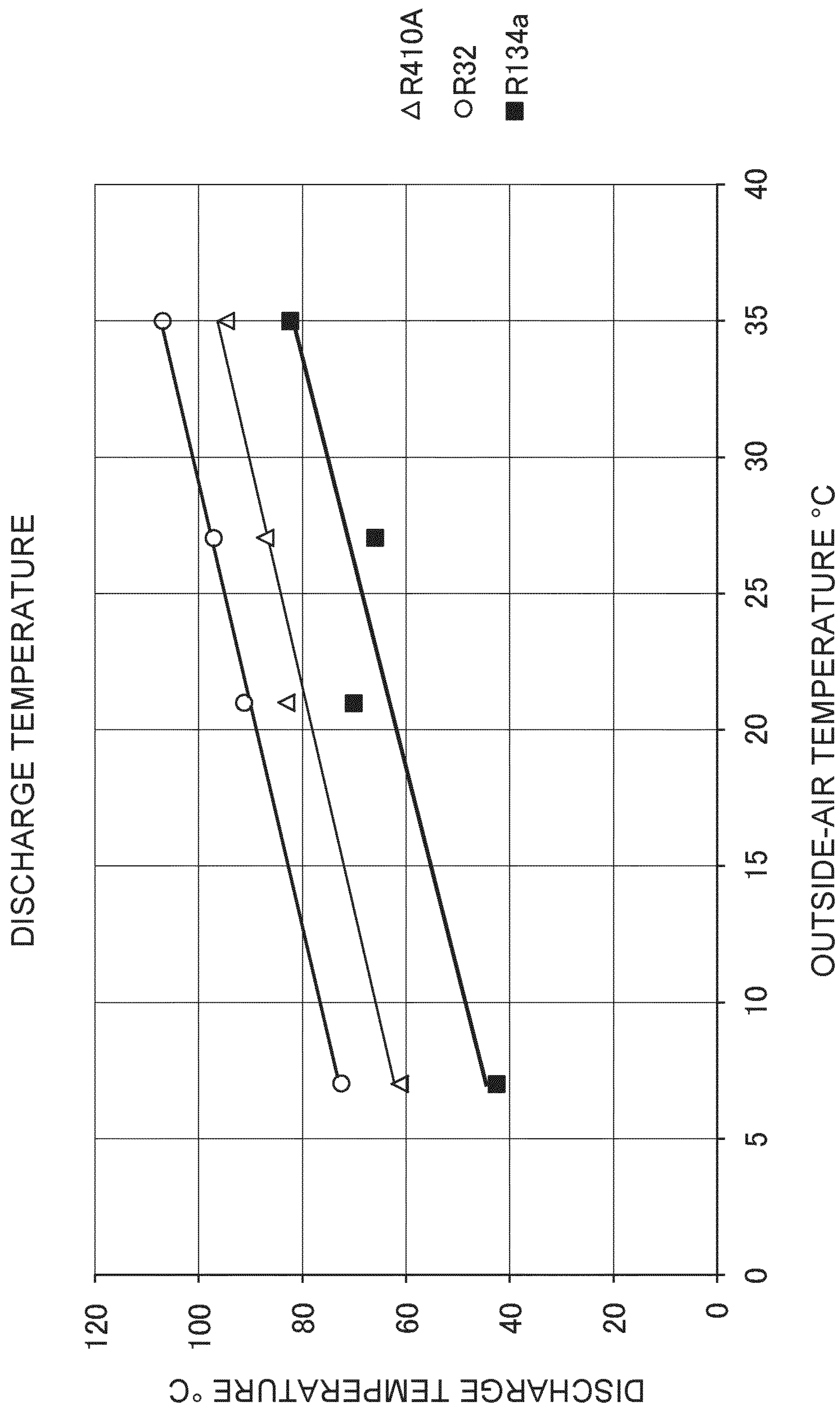

CONDENSER INLET
COMPRESSOR DISCHARGE SATURATION TEMPERATURE
COMPRESSOR DISCHARGE PRESSURE
PRESSURE MPa
2.5
2
1.5
1
0.5
0
TEMPERATURE °C
45
40
35
30
25
20
15
10
5
0
TIME
0:00
0:10
0:20
0:30
0:40
0:50
1:00
1:10
LIQUID COLLECTION
GAS COLLECTION
A
B
C

FIG. 5


DISCHARGE TEMPERATURE
△R410A
○R32
■R134a
DISCHARGE TEMPERATURE °C
OUTSIDE-AIR TEMPERATURE °C
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20
40
60
80
100
120
0
5
10
15
20
25
30
35
40

FIG. 6

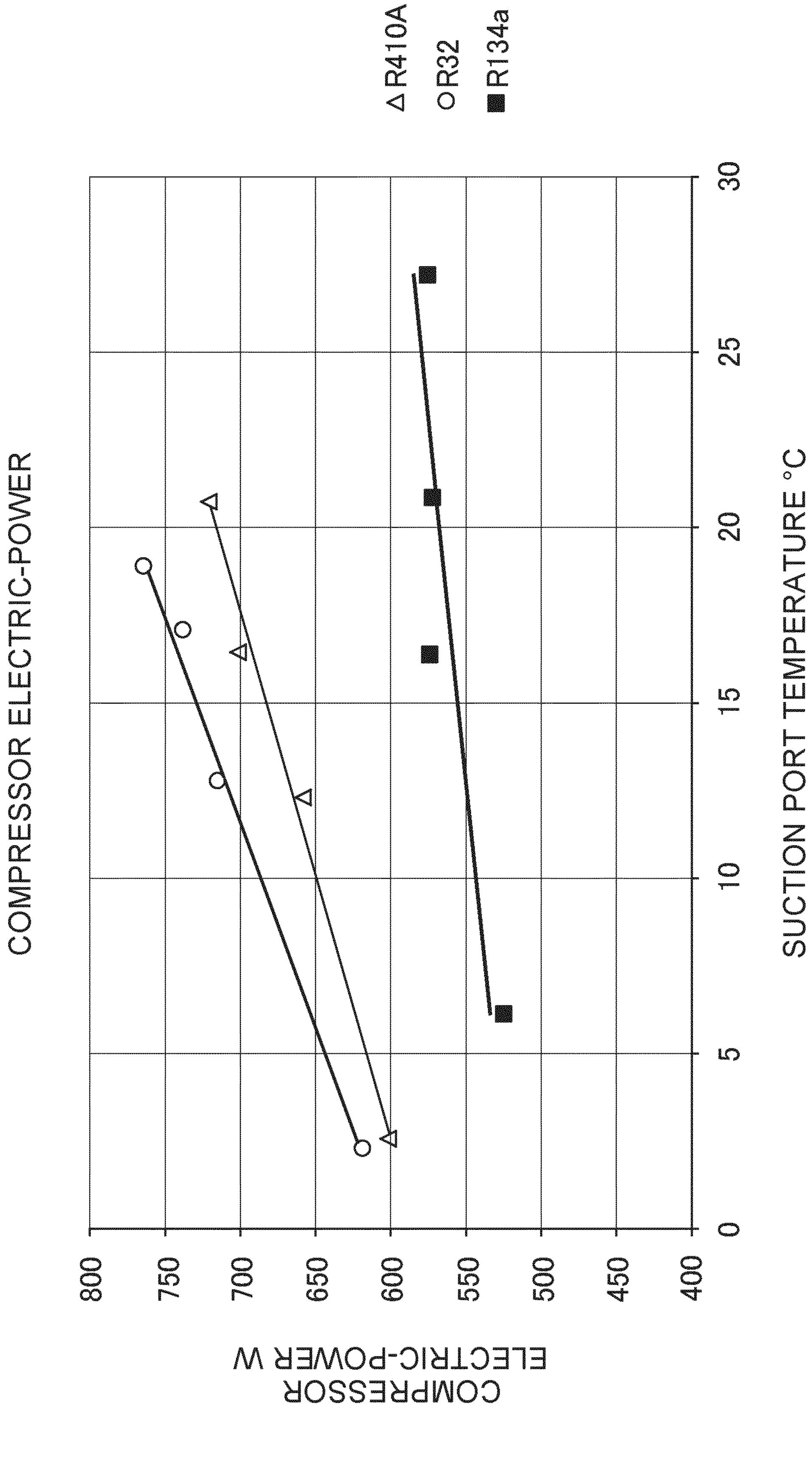
COMPRESSOR ELECTRIC-POWER
COMPRESSOR ELECTRIC-POWER W
SUCTION PORT TEMPERATURE °C
800
750
700
650
600
550
500
450
400
0
5
10
15
20
25
30
Δ R410A
○ R32
■ R134a

FIG. 7

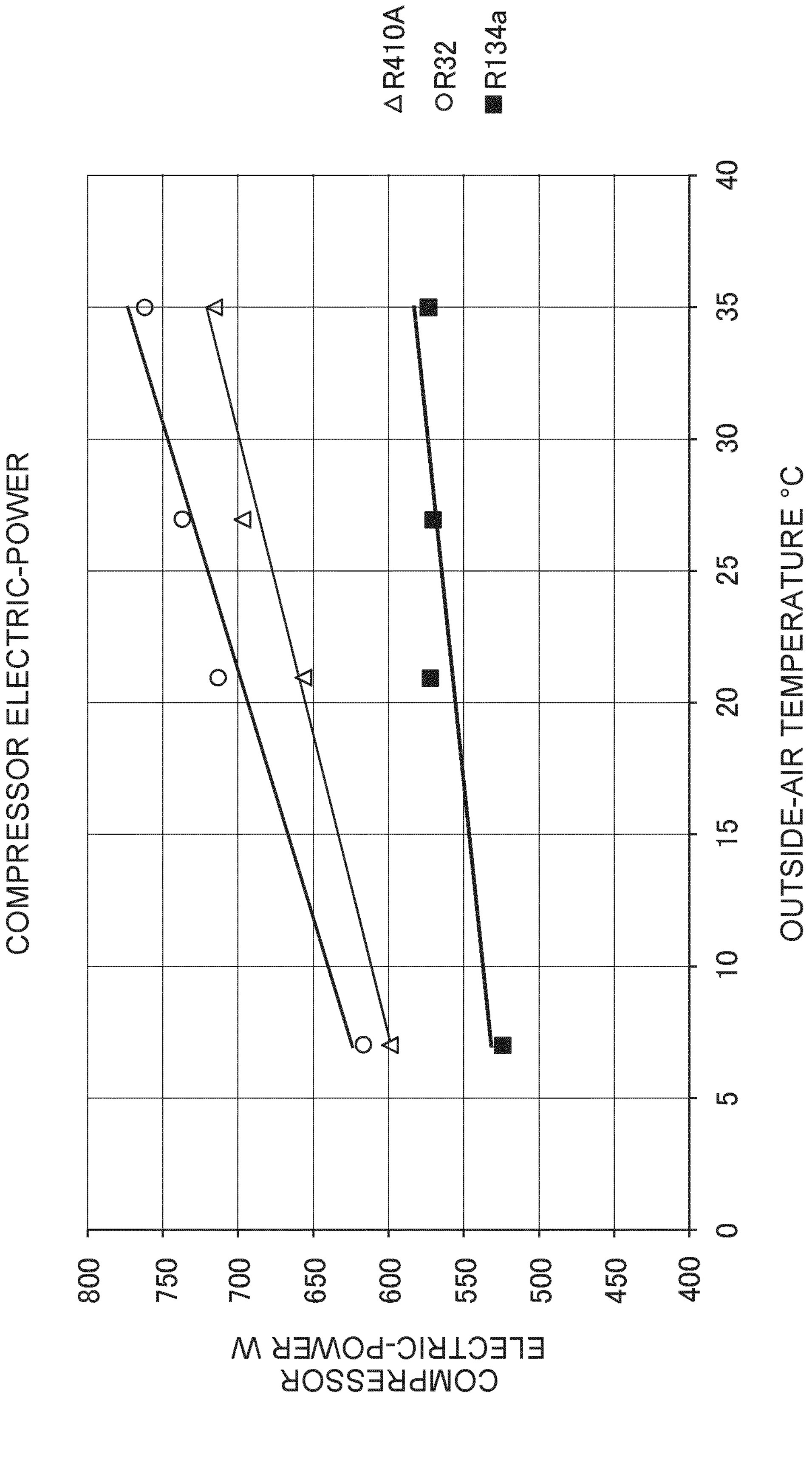
COMPRESSOR ELECTRIC-POWER
COMPRESSOR ELECTRIC-POWER W
OUTSIDE-AIR TEMPERATURE °C
△R410A
○R32
■R134a
800
750
700
650
600
550
500
450
400
0
5
10
15
20
25
30
35
40

FIG. 8

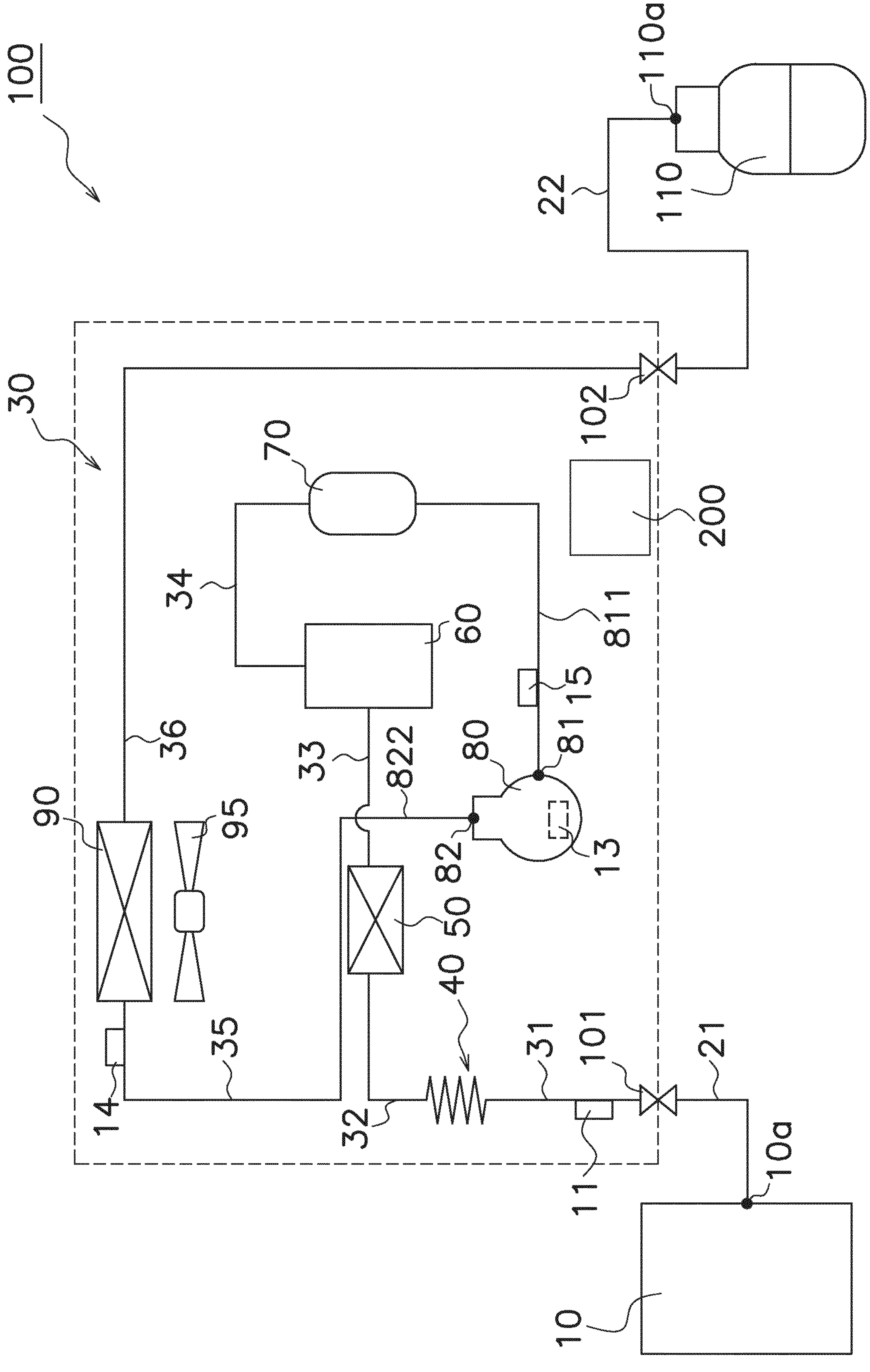
100
30
70
34
60
36
33
822
80
81
811
15
200
102
22
110
110a
90
95
82
13
50
40
35
31
101
21
14
32
11
10a
10

FIG. 9

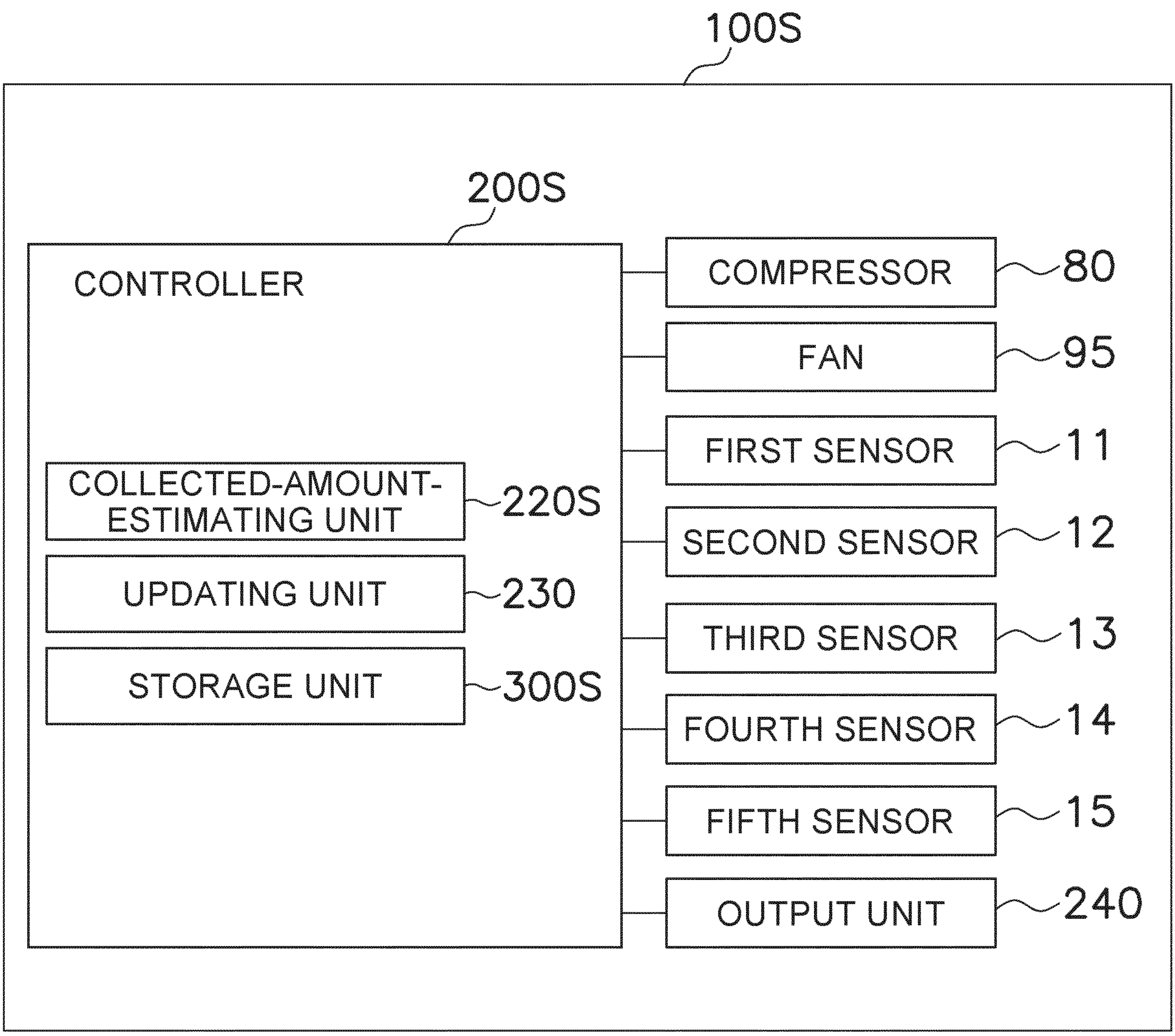
100S
200S
CONTROLLER
COLLECTED-AMOUNT-ESTIMATING UNIT
220S
UPDATING UNIT
230
STORAGE UNIT
300S
COMPRESSOR
80
FAN
95
FIRST SENSOR
11
SECOND SENSOR
12
THIRD SENSOR
13
FOURTH SENSOR
14
FIFTH SENSOR
15
OUTPUT UNIT
240

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2020/043841

A. CLASSIFICATION OF SUBJECT MATTER
F25B 45/00(2006.01)i
FI: F25B45/00 A

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)
F25B45/00

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2017-72284 A (MITSUBISHI ELECTRIC BUILDING TECHNO-SERVICE CO., LTD.) 13 April 2017 (2017-04-13) paragraphs [0018]-[0072], fig. 1-6	1-7, 13-15 8-12
Y A	JP 2003-14339 A (ASADA CORPORATION) 15 January 2003 (2003-01-15) paragraph [0011], fig. 1	1-7, 13-15 8-12
Y	JP 5-5581 A (TOSHIBA CORP.) 14 January 1993 (1993-01-14) paragraph [0008]	5-7, 13-15
Y	JP 2016-1097 A (MITSUBISHI ELECTRIC CORP.) 07 January 2016 (2016-01-07) paragraphs [0023]-[0024], fig. 2	5-7, 13-15
Y	JP 10-253203 A (MITSUBISHI ELECTRIC CORP.) 25 September 1998 (1998-09-25) paragraphs [0041]-[0043], fig. 1	7, 13-14
Y	JP 9-152233 A (NAKAJIMA JIDOSHA DENSO KK) 10 June 1997 (1997-06-10) paragraphs [0002]-[0025], fig. 1-3	13-14

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

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
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- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 January 2021 (06.01.2021)	19 January 2021 (19.01.2021)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2020/043841

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2015-148389 A (ASADA CORPORATION) 20 August 2015 (2015-08-20) paragraph [0007]	13-14

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/043841

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2017-72284 A	13 Apr. 2017	(Family: none)	
JP 2003-14339 A	15 Jan. 2003	(Family: none)	
JP 5-5581 A	14 Jan. 1993	(Family: none)	
JP 2016-1097 A	07 Jan. 2016	(Family: none)	
JP 10-253203 A	25 Sep. 1998	(Family: none)	
JP 9-152233 A	10 Jun. 1997	(Family: none)	
JP 2015-148389 A	20 Aug. 2015	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- WO 2020003509 A **[0002] [0169]**