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(54) **REFRIGERATION CYCLE DEVICE**

(57) When a flow rate of a refrigerant is to be adjusted based on a temperature of the refrigerant flowing through refrigerant flow paths, there is an issue in that a temperature sensor is required for each of the refrigerant flow paths. A refrigeration cycle device includes a heat exchanger main body (331), a plurality of flow rate adjustment units (332a to 332i), and a control unit. The heat exchanger main body (331) has a plurality of refrigerant flow paths (333a to 333i) including a first refrigerant flow path (333) and a second refrigerant flow path (333). The flow rate adjustment units (332) adjust flow rates of a refrigerant flowing through the refrigerant flow paths (333). The control unit adjusts the flow rates of the refrigerant flowing through the refrigerant flow paths (333) by controlling opening degrees of the flow rate adjustment units (332). The control unit controls the opening degrees of the flow rate adjustment units (332) based on a first value or a second value. The first value is a value representing overall efficiency of the refrigeration cycle. The second value is a value representing overall efficiency of the heat exchanger main body (331).

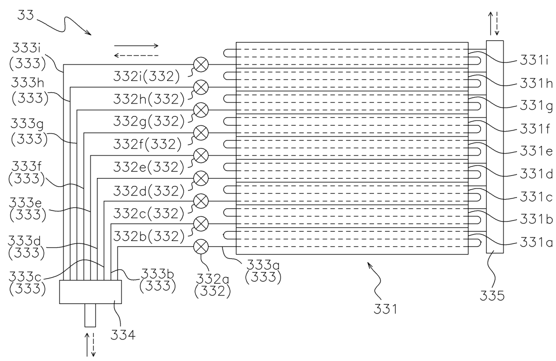

FIG. 2

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Description

TECHNICAL FIELD

[0001] The present invention relates to a refrigeration cycle device.

BACKGROUND ART

[0002] As described in PTL 1 (Japanese Unexamined Patent Application Publication No. 2008-128628), there is a technique for preventing, in a heat exchanger having a plurality of refrigerant flow paths, a refrigerant flowing through the heat exchanger from flowing unevenly, by adjusting a flow rate of the refrigerant based on a temperature of the refrigerant flowing through the refrigerant flow paths.

SUMMARY OF THE INVENTION

<Technical Problem>

[0003] When a flow rate of a refrigerant is to be adjusted, as described in PTL 1, based on a temperature of the refrigerant flowing through refrigerant flow paths, there is an issue in that a temperature sensor is required for each of the refrigerant flow paths.

<Solution to Problem>

[0004] A refrigeration cycle device according to a first aspect includes a heat exchanger, a plurality of flow rate adjustment units, and a control unit. The heat exchanger has a plurality of refrigerant flow paths including a first refrigerant flow path and a second refrigerant flow path. The plurality of flow rate adjustment units adjust flow rates of a refrigerant flowing through the respective refrigerant flow paths. The control unit adjusts the flow rates of the refrigerant flowing through the refrigerant flow paths by controlling opening degrees of the flow rate adjustment units. The control unit controls the opening degrees of the respective flow rate adjustment units based on a first value or a second value. The first value is a value representing overall efficiency of a refrigeration cycle. The second value is a value representing overall efficiency of the heat exchanger.

[0005] In the refrigeration cycle device according to the first aspect, the control unit controls the respective opening degrees of the flow rate adjustment units based on the first value or the second value. The first value is a value representing the overall efficiency of the refrigeration cycle. The second value is a value representing the overall efficiency of the heat exchanger. As a result, the refrigeration cycle device can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths by using sensors, the number of which is smaller than the number of the refrigerant flow paths, and can prevent the refrigerant flowing through the heat exchanger from flowing unevenly.

[0006] In a refrigeration cycle device according to a second aspect, which corresponds to the refrigeration cycle device according to the first aspect, the first value includes an electric power consumption value of a compressor that compresses the refrigerant or a pressure value of the refrigerant flowing through the heat exchanger.

[0007] With such a configuration, the refrigeration cycle device according to the second aspect can estimate an uneven flow state of the refrigerant flowing through the heat exchanger, and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths.

[0008] In a refrigeration cycle device according to a third aspect, which corresponds to the refrigeration cycle device according to either the first aspect or the second aspect, the second value includes an outlet temperature of the heat exchanger, after the refrigerant that has flowed out of the first refrigerant flow path and the refrigerant that has flowed out of the second refrigerant flow path have joined each other.

[0009] With such a configuration, the refrigeration cycle device according to the third aspect can estimate an uneven flow state of the refrigerant flowing through the heat exchanger, and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths.

[0010] In a refrigeration cycle device according to a fourth aspect, which corresponds to the refrigeration cycle device according to either the second aspect or the third aspect, the first value or the second value further includes a temperature of air that exchanges heat with the refrigerant in the heat exchanger.

[0011] With such a configuration, the refrigeration cycle device according to the fourth aspect can more accurately estimate an uneven flow state of the refrigerant flowing through the heat exchanger, and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow path.

[0012] In a refrigeration cycle device according to a fifth aspect, which corresponds to the refrigeration cycle device according to any one of the second aspect to the fourth aspect, the first value or the second value further includes a rotation speed of a fan that generates a flow of air that exchanges heat with the refrigerant in the heat exchanger.

[0013] With such a configuration, the refrigeration cycle device according to the fifth aspect can more accurately estimate an uneven flow state of the refrigerant flowing through the heat exchanger, and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths.

[0014] In a refrigeration cycle device according to a sixth aspect, which corresponds to the refrigeration cycle device according to any of the second aspect to the fifth aspect, the first value or the second value further includes a rotation speed of the compressor.

[0015] With such a configuration, the refrigeration cycle device according to the sixth aspect can more accurately estimate an uneven flow state of the refrigerant flowing through the heat exchanger, and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths.

[0016] In a refrigeration cycle device according to a seventh aspect, which corresponds to the refrigeration cycle device according to any of the second aspect to the sixth aspect, the first value or the second value further includes an opening degree of an expansion valve that adjusts the flow rate of the refrigerant.

[0017] With such a configuration, the refrigeration cycle device according to the seventh aspect can more accurately estimate an uneven flow state of the refrigerant flowing through the heat exchanger, and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths.

[0018] A refrigeration cycle device according to an eighth aspect, which corresponds to the refrigeration cycle device according to any of the first aspect to the seventh aspect, further includes a learning device. The learning device associates with each other and learns a combination of the opening degrees of the plurality of flow rate adjustment units and the first value or the second value when the opening degrees of the plurality of flow rate adjustment units correspond to the combination of the opening degrees. The learning device classifies the combination of the opening degrees in accordance with a level of a heat exchange capability of the heat exchanger, which is estimated from the first value or the second value. The control unit controls the opening degrees of the respective flow rate adjustment units by using the combination of the opening degrees classified, by the learning device, into a class at which the heat exchange capability of the heat exchanger is higher than a predetermined value.

[0019] In the refrigeration cycle device according to the eighth aspect, using machine learning makes it possible to efficiently calculate a combination of the opening degrees of the flow rate adjustment units, under which the heat exchange capability of the heat exchanger improves (under which the refrigerant flowing through the heat exchanger will be less likely to flow unevenly).

[0020] A refrigeration cycle device according to a ninth aspect, which corresponds to the refrigeration cycle device according to any of the first aspect to the seventh aspect, further includes a learning device. The learning device associates with each other and learns a combination of the opening degrees of the plurality of flow rate adjustment units and the first value or the second value when the opening degrees of the plurality of flow rate adjustment units correspond to the combination of the opening degrees. The learning device calculates such a combination of the opening degrees that improves the heat exchange capability of the heat exchanger, which is estimated from the first value or the second value. The control unit controls the opening degrees of the respective flow rate adjustment units by using the combination of the opening degrees calculated by the learning device.

[0021] In the refrigeration cycle device according to the ninth aspect, using machine learning makes it possible to efficiently calculate a combination of the opening degrees of the flow rate adjustment units, under which the heat exchange capability of the heat exchanger improves.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

Fig. 1 is a schematic configuration diagram of a refrigeration cycle device.
Fig. 2 is a schematic configuration diagram of an outdoor heat exchanger.
Fig. 3 is a control block diagram of an air conditioning device.
Fig. 4 is a control block diagram of a learning device.
Fig. 5 is a diagram for explaining learning processing in the learning device.
Fig. 6 is a flowchart for explaining flow rate adjustment processing.
Fig. 7 is a flowchart for explaining the flow rate adjustment processing.
Fig. 8 is a schematic configuration diagram of an indoor heat exchanger according to Modified Example 1E.

DESCRIPTION OF EMBODIMENTS

(1) Overall configuration

[0023] A refrigeration cycle device 1 constitutes a vapor compression type refrigeration cycle and conditions (cools or heats) air in a target space. In the present embodiment, the refrigeration cycle device 1 is a so-called multi-type air conditioning system for a building. Fig. 1 is a schematic configuration diagram of the refrigeration cycle device 1. As illustrated in Fig. 1, the refrigeration cycle device 1 mainly includes an air conditioning device 2 and a learning device 10.

[0024] The air conditioning device 2 includes an indoor unit 20 and an outdoor unit 30. The indoor unit 20 and the outdoor unit 30 are connected to each other via a liquid refrigerant connection pipe 51 and a gas refrigerant connection pipe 52 to constitute a refrigerant circuit 50. Furthermore, the indoor unit 20 and the outdoor unit 30 are communicably connected to each other by a communication line 81. Furthermore, the outdoor unit 30 and the learning device 10 are communicably connected to each other by a communication line 82.

[0025] Hereinafter, for example, when refrigerant flow paths 333a to 333i are not to be distinguished from each other, they may be referred to as refrigerant flow paths 333 or the like.

(2) Detailed configuration

(2-1) Indoor unit

[0026] The indoor unit 20 is installed in the target space where air is to be conditioned, such as inside a building in which the refrigeration cycle device 1 is installed. The indoor unit 20 is, for example, a ceiling-embedded type unit, a ceiling-suspended type unit, a floor-mounted type unit, or the like. As illustrated in Fig. 1, the indoor unit 20 mainly includes an indoor heat exchanger 21, an indoor fan 22, an indoor expansion valve 23, an indoor control unit 29, an indoor temperature sensor 61, a gas-side temperature sensor 62, and a liquid-side temperature sensor 63. Furthermore, the indoor unit 20 includes a liquid refrigerant pipe 53a that connects a liquid-side end of the indoor heat exchanger 21 and the liquid refrigerant connection pipe 51, and a gas refrigerant pipe 53b that connects a gas-side end of the indoor heat exchanger 21 and the gas refrigerant connection pipe 52.

(2-1-1) Indoor heat exchanger

[0027] Although there is no intention to limit its structure, the indoor heat exchanger 21 is, for example, a cross-fin type, fin-and-tube heat exchanger that includes a heat transfer tube (not illustrated) and a large number of fins (not illustrated). The indoor heat exchanger 21 causes heat to be exchanged between a refrigerant flowing through the indoor heat exchanger 21 and air in the target space.

[0028] The indoor heat exchanger 21 functions as an evaporator during cooling operation, and functions as a condenser during heating operation.

(2-1-2) Indoor fan

[0029] The indoor fan 22 causes air in the target space to be taken into the indoor unit 20 and to be supplied to the indoor heat exchanger 21, and then causes the air that has exchanged heat with the refrigerant in the indoor heat exchanger 21 to be supplied to the target space. The indoor fan 22 is, for example, a centrifugal fan such as a turbo fan or a sirocco fan. The indoor fan 22 is driven by an indoor fan motor 22m. A rotation speed of the indoor fan motor 22m can be controlled by an inverter.

(2-1-3) Indoor expansion valve

[0030] The indoor expansion valve 23 is a mechanism for adjusting pressure and a flow rate of the refrigerant flowing through the liquid refrigerant pipe 53a. The indoor expansion valve 23 is provided to the liquid refrigerant pipe 53a. In the present embodiment, the indoor expansion valve 23 is an electronic expansion valve in which its opening degree is adjustable.

(2-1-4) Sensor

[0031] The indoor temperature sensor 61 measures a temperature (a room temperature) of air in the target space. The indoor temperature sensor 61 is provided near an air suction port of the indoor unit 20.

[0032] The gas-side temperature sensor 62 measures a temperature of the refrigerant flowing through the gas refrigerant pipe 53b. The gas-side temperature sensor 62 is provided to the gas refrigerant pipe 53b.

[0033] The liquid-side temperature sensor 63 measures the temperature of the refrigerant flowing through the liquid refrigerant pipe 53a. The liquid-side temperature sensor 63 is provided to the liquid refrigerant pipe 53a.

[0034] The indoor temperature sensor 61, the gas-side temperature sensor 62, and the liquid-side temperature sensor 63 are, for example, thermistors.

(2-1-5) Indoor control unit

[0035] The indoor control unit 29 controls operation of each part constituting the indoor unit 20.

[0036] The indoor control unit 29 is electrically connected to various devices included in the indoor unit 20, the various devices including the indoor expansion valve 23 and the indoor fan motor 22m. Furthermore, the indoor control unit 29 is communicably connected to various sensors provided in the indoor unit 20, the various sensors including the indoor temperature sensor 61, the gas-side temperature sensor 62, and the liquid-side temperature sensor 63.

[0037] The indoor control unit 29 includes a control arithmetic device, a storage device, and a network interface device. The control arithmetic device is a processor such as a central processing unit (CPU) or a graphics processing unit (GPU). The storage device is a storage medium such as a random access memory (RAM), a read-only memory (ROM), or a flash memory. The control arithmetic device reads a program stored in the storage device, and performs predetermined arithmetic processing in accordance with the program, thereby controlling operation of each part constituting the indoor unit 20. Furthermore, the control arithmetic device can write calculation results into the storage device, and can read information stored in the storage device, in accordance with the program. The network interface device is configured to communicate with the outdoor unit 30 via the communication line 81. Furthermore, the indoor control unit 29 includes a timer.

[0038] The indoor control unit 29 is configured to be able to receive various signals transmitted from an operation remote controller (not illustrated). The various signals include, for example, signals for instructing start and stop of operation, and signals related to various settings. The signals related to various settings include, for example, signals related to a set temperature and set humidity. Furthermore, the indoor control unit 29 exchanges control signals, measurement signals, signals related to various settings, and the like with an outdoor control unit 39 in the outdoor unit 30 via the communication line 81.

[0039] The indoor control unit 29 and the outdoor control unit 39 cooperate with each other to function as a control unit 70. Functions of the control unit 70 will be described later.

(2-2) Outdoor unit

[0040] The outdoor unit 30 is installed outside the target space, such as on a roof floor of the building in which the refrigeration cycle device 1 is installed. As illustrated in Fig. 1, the outdoor unit 30 mainly includes a compressor 31, a flow path switching valve 32, an outdoor heat exchanger 33, an outdoor expansion valve 34, an accumulator 35, an outdoor fan 36, a liquid-side shutoff valve 37, a gas-side shutoff valve 38, the outdoor control unit 39, a suction pressure sensor 64, a discharge pressure sensor 65, an outdoor temperature sensor 66, a gas-side temperature sensor 67, and a liquid-side temperature sensor 68. Furthermore, the outdoor unit 30 includes a suction pipe 54a, a discharge pipe 54b, a first gas refrigerant pipe 54c, a liquid refrigerant pipe 54d, and a second gas refrigerant pipe 54e.

[0041] As illustrated in Fig. 1, the suction pipe 54a connects the flow path switching valve 32 and a suction side of the compressor 31. The suction pipe 54a is provided with the accumulator 35. The discharge pipe 54b connects a discharge side of the compressor 31 and the flow path switching valve 32. The first gas refrigerant pipe 54c connects the flow path switching valve 32 and a gas side of the outdoor heat exchanger 33. The liquid refrigerant pipe 54d connects a liquid side of the outdoor heat exchanger 33 and the liquid refrigerant connection pipe 51. The liquid refrigerant pipe 54d is provided with the outdoor expansion valve 34. The liquid-side shutoff valve 37 is provided at a connecting portion between the liquid refrigerant pipe 54d and the liquid refrigerant connection pipe 51. The second gas refrigerant pipe 54e connects the flow path switching valve 32 and the gas refrigerant connection pipe 52. The gas-side shutoff valve 38 is provided at a connecting portion between the second gas refrigerant pipe 54e and the gas refrigerant connection pipe 52.

(2-2-1) Compressor

[0042] As illustrated in Fig. 1, the compressor 31 is a device that intakes, from the suction pipe 54a, the refrigerant at low pressure in the refrigeration cycle, compresses the refrigerant with its compression mechanism (not illustrated), and discharges the compressed refrigerant to the discharge pipe 54b.

[0043] The compressor 31 is, for example, a displacement compressor of a rotary type, a scroll type, or the like. The compression mechanism in the compressor 31 is driven by a compressor motor 31m. A rotation speed of the compressor motor 31m can be controlled by an inverter.

(2-2-2) Flow path switching valve

[0044] The flow path switching valve 32 is a mechanism that switches a flow path of the refrigerant between a first state and a second state. In the first state, the flow path switching valve 32 causes the suction pipe 54a and the second gas refrigerant pipe 54e to communicate with each other, and the discharge pipe 54b and the first gas refrigerant pipe 54c to communicate with each other, as illustrated by solid lines inside the flow path switching valve 32 illustrated in Fig. 1. In the second state, the flow path switching valve 32 causes the suction pipe 54a and the first gas refrigerant pipe 54c to communicate with each other, and the discharge pipe 54b and the second gas refrigerant pipe 54e to communicate with each other, as illustrated by broken lines inside the flow path switching valve 32 illustrated in Fig. 1.

[0045] The flow path switching valve 32 sets the flow path of the refrigerant to the first state during the cooling operation. At this time, the refrigerant discharged from the compressor 31 flows through the outdoor heat exchanger 33, the outdoor expansion valve 34, the indoor expansion valve 23, and the indoor heat exchanger 21 in this order in the refrigerant circuit 50, and returns to the compressor 31. In the first state, the outdoor heat exchanger 33 functions as a condenser, and the indoor heat exchanger 21 functions as an evaporator.

[0046] The flow path switching valve 32 sets the flow path of the refrigerant to the second state during the heating operation. At this time, the refrigerant discharged from the compressor 31 flows through the indoor heat exchanger 21, the indoor expansion valve 23, the outdoor expansion valve 34, and the outdoor heat exchanger 33 in this order in the refrigerant circuit 50, and returns to the compressor 31. In the second state, the outdoor heat exchanger 33 functions as an evaporator, and the indoor heat exchanger 21 functions as a condenser.

(2-2-3) Outdoor heat exchanger

[0047] Fig. 2 is a schematic configuration diagram of the outdoor heat exchanger 33. As illustrated in Fig. 2, the outdoor heat exchanger 33 mainly includes a heat exchanger main body 331 and a plurality of flow rate adjustment units 332a to 332i.

(2-2-3-1) Heat exchanger main body

[0048] The heat exchanger main body 331 has the plurality of refrigerant flow paths 333a to 333i including a first refrigerant flow path 333 and a second refrigerant flow path 333. As illustrated in Fig. 2, the heat exchanger main body 331 is divided into a plurality of sections 331a to 331i, and the refrigerant flow paths 333a to 333i pass through the sections 331a to 331i, respectively. The heat exchanger main body 331 causes heat to be exchanged between the refrigerant flowing through the refrigerant flow paths 333 and outdoor air. The heat exchanger main body 331 functions as a condenser during the cooling operation, and functions as an evaporator during the heating operation.

(2-2-3-2) Flow rate adjustment unit

[0049] The flow rate adjustment units 332 adjust the flow rates of the refrigerant flowing through the refrigerant flow paths 333. Specifically, as illustrated in Fig. 2, the flow rate adjustment units 332a to 332i adjust the flow rates of the refrigerant flowing through the refrigerant flow paths 333a to 333i such that the temperature and the pressure of the refrigerant flowing through the refrigerant flow paths 333a to 333i become uniform. In other words, the flow rate adjustment units 332a to 332i adjust the flow rates of the refrigerant flowing through the refrigerant flow paths 333a to 333i such that the refrigerant flowing through the refrigerant flow paths 333a to 333i does not flow unevenly. The flow rate adjustment units 332 are configured to be able to adjust the opening degrees.

(2-2-3-3) Flow divider

[0050] As illustrated in Fig. 2, a flow divider 334 causes, during the heating operation, the refrigerant that has flowed from the outdoor expansion valve 34 side into the outdoor heat exchanger 33 (in a direction indicated by a solid-line arrow illustrated in Fig. 2) to be separated flows to separately flow into the refrigerant flow paths 333a to 333i. Furthermore, the flow divider 334 causes, during the cooling operation, separated flows of the refrigerant that has flowed from the compressor 31 side into the outdoor heat exchanger 33 (in a direction indicated by a broken-line arrow illustrated in Fig. 2) and that has been caused to separately flow into the refrigerant flow paths 333a to 333i by a header 335, which will be described later, to join each other.

(2-2-3-4) Header

[0051] As illustrated in Fig. 2, the header 335 causes, during the heating operation, separated flows of the refrigerant that has flowed from the outdoor expansion valve 34 side into the outdoor heat exchanger 33 (in the direction indicated by the solid-line arrow illustrated in Fig. 2) and that has been caused to separately flow into the refrigerant flow paths 333a to 333i by the flow divider 334 to join each other. Furthermore, the header 335 causes, during the cooling operation, the refrigerant that has flowed from the compressor 31 side into the outdoor heat exchanger 33 (in the direction indicated by the broken-line arrow illustrated in Fig. 2) to be separated flows to separately flow into the refrigerant flow paths 333a to 333i.

(2-2-4) Outdoor expansion valve

[0052] The outdoor expansion valve 34 is a mechanism for adjusting the pressure and the flow rate of the refrigerant flowing through the liquid refrigerant pipe 54d. In the present embodiment, the outdoor expansion valve 34 is an electronic expansion valve in which its opening degree is adjustable.

(2-2-5) Accumulator

[0053] The accumulator 35 is a container having a gas-liquid separation function for separating the inflowing refrigerant into a gas refrigerant and a liquid refrigerant. The refrigerant flowing into the accumulator 35 is separated into a gas refrigerant and a liquid refrigerant, and the gas refrigerant collected in an upper space flows into the compressor 31.

(2-2-6) Outdoor fan

[0054] The outdoor fan 36 is a fan that causes outdoor air to be taken into the outdoor unit 30 and to be supplied to the outdoor heat exchanger 33, and causes the air that has exchanged heat with the refrigerant in the outdoor heat exchanger 33 to be discharged outside the outdoor unit 30. The outdoor fan 36 is, for example, an axial-flow fan such as a propeller fan. The outdoor fan 36 is driven by an outdoor fan motor 36m. A rotation speed of the outdoor fan motor 36m can be controlled by an inverter.

(2-2-7) Sensor

[0055] The suction pressure sensor 64 is a sensor that measures suction pressure. The suction pressure sensor 64 is provided to the suction pipe 54a. The suction pressure is a low pressure value of the refrigeration cycle.

[0056] The discharge pressure sensor 65 is a sensor that measures discharge pressure. The discharge pressure sensor 65 is provided to the discharge pipe 54b. The discharge pressure is a high pressure value of the refrigeration cycle.

[0057] The outdoor temperature sensor 66 measures a temperature of air outside the target space (an outdoor temperature). The outdoor temperature sensor 66 is provided near an air suction port of the outdoor unit 30.

[0058] The gas-side temperature sensor 67 measures the temperature of the refrigerant flowing through the first gas refrigerant pipe 54c. The gas-side temperature sensor 67 is provided to the first gas refrigerant pipe 54c.

[0059] The liquid-side temperature sensor 68 measures the temperature of the refrigerant flowing through the liquid refrigerant pipe 54d. The liquid-side temperature sensor 63 is provided to the liquid refrigerant pipe 54d.

[0060] The outdoor temperature sensor 66, the gas-side temperature sensor 67, and the liquid-side temperature sensor 68 are, for example, thermistors.

(2-2-8) Liquid-side shutoff valve and gas-side shutoff valve

[0061] As illustrated in Fig. 1, the liquid-side shutoff valve 37 is a valve provided at the connecting portion between the liquid refrigerant pipe 54d and the liquid refrigerant connection pipe 51. The gas-side shutoff valve 38 is a valve provided at the connecting portion between the second gas refrigerant pipe 54e and the gas refrigerant connection pipe 52. The liquid-side shutoff valve 37 and the gas-side shutoff valve 38 are, for example, manually operated valves.

(2-2-9) Outdoor control unit

[0062] The outdoor control unit 39 controls operation of each part constituting the outdoor unit 30.

[0063] The outdoor control unit 39 is electrically connected to various devices included in the outdoor unit 30, the various devices including the compressor motor 31m, the flow path switching valve 32, the flow rate adjustment units 332, the outdoor expansion valve 34, and the outdoor fan motor 36m. Furthermore, the outdoor control unit 39 is communicably connected to various sensors provided in the outdoor unit 30, the various sensors including the suction pressure sensor 64, the discharge pressure sensor 65, the outdoor temperature sensor 66, the gas-side temperature sensor 67, and the liquid-side temperature sensor 68.

[0064] The outdoor control unit 39 includes a control arithmetic device, a storage device, and two network interface devices. The control arithmetic device is a processor such as a CPU or a GPU. The storage device is a storage medium such as a RAM, a ROM, or a flash memory. The control arithmetic device reads a program stored in the storage device, and performs predetermined arithmetic processing in accordance with the program, thereby controlling operation of each part constituting the outdoor unit 30. Furthermore, the control arithmetic device can write calculation results into the storage device, and can read information stored in the storage device, in accordance with the program. One of the network interface devices is configured to communicate with the indoor unit 20 via the communication line 81. Another one of the network interface devices is configured to communicate with the learning device 10 via the communication line 82. Furthermore, the outdoor control unit 39 includes a timer.

[0065] The outdoor control unit 39 exchanges control signals, measurement signals, signals related to various settings, and the like with the indoor control unit 29 in the indoor unit 20 via the communication line 81. Furthermore, the outdoor control unit 39 exchanges control signals, measurement signals, signals related to various settings, and the like with the learning control unit 19 in the learning device 10 via the communication line 82.

[0066] The outdoor control unit 39 and the indoor control unit 29 cooperate with each other to function as the control unit 70. The functions of the control unit 70 will be described later.

(2-3) Control unit

[0067] The control unit 70 includes the indoor control unit 29 and the outdoor control unit 39.

[0068] Fig. 3 is a control block diagram of the air conditioning device 2. As illustrated in Fig. 3, the control unit 70 is communicably connected to the indoor temperature sensor 61, the gas-side temperature sensor 62, the liquid-side temperature sensor 63, the suction pressure sensor 64, the discharge pressure sensor 65, the outdoor temperature sensor 66, the gas-side temperature sensor 67, and the liquid-side temperature sensor 68. The control unit 70 receives measurement signals transmitted from various sensors. Furthermore, the control unit 70 is electrically connected to the indoor expansion valve 23, the indoor fan motor 22m, the compressor motor 31m, the flow path switching valve 32, the flow rate adjustment units 332, the outdoor expansion valve 34, and the outdoor fan motor 36m. In response to control signals transmitted from the operation remote controller, the control unit 70 controls, based on measurement signals of various sensors, operation of various devices included in the air conditioning device 2, the various devices including the indoor expansion valve 23, the indoor fan motor 22m, the compressor motor 31m, the flow path switching valve 32, the flow rate adjustment units 332, the outdoor expansion valve 34, and the outdoor fan motor 36m.

[0069] The control unit 70 mainly performs the cooling operation and the heating operation.

(2-3-1) Cooling operation

[0070] When receiving from the operation remote controller an instruction of causing the indoor unit 20 to perform the cooling operation, the control unit 70 controls the flow path switching valve 32 such that a state as indicated by the solid lines illustrated in Fig. 1 is attained inside the flow path switching valve 32. At this time, the flow path of the refrigerant is in the first state.

[0071] The control unit 70 opens the outdoor expansion valve 34 in a step-wise manner and adjusts the opening degree of the indoor expansion valve 23 such that a degree of superheating of the refrigerant at a gas-side outlet of the indoor heat exchanger 21 reaches a predetermined target degree of superheating. The degree of superheating of the refrigerant at the gas-side outlet of the indoor heat exchanger 21 is calculated, for example, by subtracting an evaporation temperature converted from a measurement value (suction pressure) of the suction pressure sensor 64 from a measurement value of the gas-side temperature sensor 62.

[0072] Furthermore, the control unit 70 controls an operating capacity of the compressor 31 such that the evaporation temperature converted from the measurement value of the suction pressure sensor 64 approaches a predetermined target evaporation temperature. The operating capacity of the compressor 31 is controlled by controlling the rotation speed of the compressor motor 31m.

[0073] Furthermore, the control unit 70 adjusts, in cooperation with the learning device 10, the flow rates of the refrigerant flowing through the refrigerant flow paths 333a to 333i by controlling the opening degrees of the flow rate adjustment units 332a to 332i (hereinafter sometimes referred to as flow rate adjustment processing). The control unit 70 controls the opening degrees of the respective flow rate adjustment units 332a to 332i based on the first value. The first value is a value representing the overall efficiency of the refrigeration cycle. In the present embodiment, the first value includes a pressure value of the refrigerant flowing through the outdoor heat exchanger 33 (hereinafter sometimes referred to as an outdoor pressure value), a temperature of air that exchanges heat with the refrigerant in the outdoor heat exchanger 33 (hereinafter sometimes referred to as an outdoor temperature), and the rotation speed of the outdoor fan motor 36m (hereinafter sometimes referred to as an outdoor fan rotation speed). The outdoor pressure value during the cooling operation is a pressure value on a high pressure side. The outdoor pressure value during the cooling operation is acquired from, for example, the discharge pressure sensor 65. The outdoor temperature is acquired from, for example, the outdoor temperature sensor 66.

[0074] The control unit 70 receives, from the learning device 10, information (hereinafter sometimes referred to as opening degree information) regarding a setting range of the opening degrees of the flow rate adjustment units 332a to 332i, per predetermined time T2 (for example, 24 hours). The control unit 70 sets the opening degrees of the flow rate adjustment units 332a to 332i per predetermined time T1 (for example, 10 minutes) within the setting range according to the received opening degree information. In other words, the control unit 70 changes, per the predetermined time T1, the opening degrees of the flow rate adjustment units 332a to 332i within the setting range according to the opening degree information. The control unit 70 waits, each time the opening degrees of the flow rate adjustment units 332a to 332i are set, until the pressure and the temperature of the refrigerant and operation of the various devices become stationary (until the air conditioning device 2 reaches a stationary state), and, after the air conditioning device 2 has reached the stationary state, transmits the opening degrees of the flow rate adjustment units 332a to 332i and an outdoor pressure value at that time (hereinafter sometimes referred to as learning data 131) to the learning device 10. In the present embodiment, the control unit 70 determines that the air conditioning device 2 has reached the stationary state when the outdoor temperature and the outdoor fan rotation speed become stationary. In other words, the outdoor temperature and the outdoor fan rotation speed in the first value are used to determine whether or not the air conditioning device 2 has reached the stationary state.

[0075] As described above, the control unit 70 controls various devices such that the room temperature in the target space approaches a set temperature, thereby the refrigerant flowing through the refrigerant circuit 50 during the cooling operation, as described below.

[0076] When the compressor 31 is activated, a low-pressure gas refrigerant in the refrigeration cycle is taken into the compressor 31 and is compressed by the compressor 31 to become a high-pressure gas refrigerant in the refrigeration cycle.

[0077] The high-pressure gas refrigerant flows through the first gas refrigerant pipe 54c via the flow path switching valve 32, and is supplied to the outdoor heat exchanger 33. After flowing into the header 335, the high-pressure gas refrigerant supplied to the outdoor heat exchanger 33 is caused to be separated flows to separately flow into the refrigerant flow paths 333a to 333i. The refrigerant separately flowing through the refrigerant flow paths 333a to 333i exchanges heat with outdoor air supplied by the outdoor fan 36, condenses, and becomes a high-pressure liquid refrigerant in the heat exchanger main body 331. The refrigerant that has passed through the heat exchanger main body 331 and that flows through the refrigerant flow paths 333a to 333i is adjusted in flow rate by the flow rate adjustment units 332a to 332i so as not to flow unevenly. The separate flows of the refrigerant that has passed through the flow rate adjustment units 332a to 332i and that flows through the refrigerant flow paths 333a to 333i join each other in the flow divider 334, and the joined refrigerant flows out of the outdoor heat exchanger 33. The high-pressure liquid refrigerant that has passed through the outdoor heat exchanger 33 flows through the liquid refrigerant pipe 54d, passes through the outdoor expansion valve 34, and is supplied to the indoor unit 20.

[0078] The high-pressure liquid refrigerant supplied to the indoor unit 20 is decompressed to near suction pressure of the compressor 31 in the indoor expansion valve 23, becomes the refrigerant in a gas-liquid two-phase state, and is supplied to the indoor heat exchanger 21. In the indoor heat exchanger 21, the refrigerant in the gas-liquid two-phase state exchanges heat with the air in the target space, which is supplied to the indoor heat exchanger 21 by the indoor fan 22, evaporates, and becomes a low-pressure gas refrigerant. The low-pressure gas refrigerant is supplied to the outdoor unit 30 via the gas refrigerant connection pipe 52 and flows into the accumulator 35 via the flow path switching valve 32. The low-pressure gas refrigerant, which has flowed into the accumulator 35, is taken again into the compressor 31. The temperature of the air supplied to the indoor heat exchanger 21 lowers due to exchange of heat with the refrigerant flowing through the indoor heat exchanger 21, and the air cooled by the indoor heat exchanger 21 is blown into the target space.

(2-3-2) Heating operation

[0079] When receiving from the operation remote controller an instruction of causing the indoor unit 20 to perform the heating operation, the control unit 70 controls the flow path switching valve 32 such that a state as indicated by the broken lines illustrated in Fig. 1 is attained inside the flow path switching valve 32. At this time, the flow path of the refrigerant is in the second state.

[0080] The control unit 70 adjusts the opening degree of the indoor expansion valve 23 such that a degree of subcooling of the refrigerant at a liquid-side outlet of the indoor heat exchanger 21 reaches a predetermined target degree of subcooling. The degree of subcooling of the refrigerant at the liquid-side outlet of the indoor heat exchanger 21 is calculated, for example, by subtracting a measurement value of the liquid-side temperature sensor 63 from a condensation temperature converted from a measurement value (discharge pressure) of the discharge pressure sensor 65.

[0081] Furthermore, the control unit 70 adjusts an opening degree of the outdoor expansion valve 34 such that the refrigerant flowing into the outdoor heat exchanger 33 is decompressed to pressure at which the refrigerant can evaporate in the outdoor heat exchanger 33.

[0082] Furthermore, the control unit 70 controls the operating capacity of the compressor 31 such that the condensation temperature converted from the measurement value of the discharge pressure sensor 65 approaches a predetermined target condensation temperature. The operating capacity of the compressor 31 is controlled by controlling the rotation speed of the compressor motor 31m.

[0083] Furthermore, similarly to the cooling operation, the control unit 70 adjusts, in cooperation with the learning device 10, the flow rates of the refrigerant flowing through the refrigerant flow paths 333a to 333i by controlling the opening degrees of the flow rate adjustment units 332a to 332i. However, the outdoor pressure value during the heating operation is a pressure value on a low pressure side. The outdoor pressure value during the heating operation is acquired from, for example, the suction pressure sensor 64.

[0084] As described above, since the control unit 70 controls various devices such that the room temperature in the target space approaches a set temperature, the refrigerant flows through the refrigerant circuit 50 during the heating operation, as described below.

[0085] When the compressor 31 is activated, a low-pressure gas refrigerant in the refrigeration cycle is taken into the compressor 31 and is compressed by the compressor 31 to become a high-pressure gas refrigerant in the refrigeration cycle. The high-pressure gas refrigerant is supplied to the indoor heat exchanger 21 via the flow path switching valve 32, exchanges heat with the air in the target space, which is supplied by the indoor fan 22, condenses, and becomes a high-pressure liquid refrigerant. The temperature of the air supplied to the indoor heat exchanger 21 rises due to exchange of heat with the refrigerant flowing through the indoor heat exchanger 21, and the air heated by the indoor heat exchanger 21 is blown into the target space. The high-pressure liquid refrigerant that has passed through the indoor heat exchanger 21, passes through the indoor expansion valve 23, and is decompressed. The refrigerant decompressed in the indoor expansion valve 23 is supplied to the outdoor unit 30 via the liquid refrigerant connection pipe 51 and flows into the liquid refrigerant pipe 54d. The refrigerant flowing through the liquid refrigerant pipe 54d is decompressed to near suction pressure of the compressor 31, when passing through the outdoor expansion valve 34, becomes the refrigerant in a gas-liquid two-phase state, and flows into the outdoor heat exchanger 33. After flowing into the flow divider 334, the low-pressure refrigerant in the gas-liquid two-phase state, which has flowed into the outdoor heat exchanger 33, is caused to be separate flows to separately flow into the refrigerant flow paths 333a to 333i. The refrigerant, which has been caused to be separate flows to separately flow through the refrigerant flow paths 333a to 333i, is adjusted in flow rate by the flow rate adjustment units 332a to 332i so as not to flow unevenly. The refrigerant that has passed through the flow rate adjustment units 332a to 332i and that flows through the refrigerant flow paths 333a to 333i exchanges heat with outdoor air supplied by the outdoor fan 36 in the heat exchanger main body 331, evaporates, and becomes a low-pressure gas refrigerant. The separate flows of the refrigerant that has passed through the heat exchanger main body 331 and that flows through the refrigerant flow paths 333a to 333i join each other in the header 335, and the joined refrigerant flows out of the outdoor heat exchanger 33. The low-pressure gas refrigerant that has passed through the outdoor heat exchanger 33 flows into the accumulator 35 via the flow path switching valve 32. The low-pressure gas refrigerant that has flowed into the accumulator 35 is taken again into the compressor 31.

(2-4) Learning device

[0086] The learning device 10 learns the appropriate opening degrees of the flow rate adjustment units 332a to 332i in cooperation with the control unit 70 such that the refrigerant flowing through the refrigerant flow paths 333a to 333i does not flow unevenly. In the present embodiment, the learning device 10 is a computer installed in a server room or the like in a building. However, the learning device 10 may be installed in a cloud-based data center or the like. In this case, the communication line 82 includes a line connected to the Internet, for example. Fig. 4 is a control block diagram of the learning device 10. As illustrated in Fig. 4, the learning device 10 mainly includes a learning input unit 11, a learning display unit 12, a learning storage unit 13, a learning communication unit 14, and a learning control unit 19.

(2-4-1) Learning input unit

[0087] The learning input unit 11 includes a keyboard and a mouse. Various commands and various pieces of information for the learning device 10 can be input using the learning input unit 11.

(2-4-2) Learning display unit

[0088] The learning display unit 12 is a monitor. The learning display unit 12 can display, for example, the learning data 131, a learning situation, and the like.

(2-4-3) Learning storage unit

[0089] The learning storage unit 13 is a storage device such as a RAM, a ROM, or a hard disk drive (HDD). The learning storage unit 13 stores a program that the learning control unit 19 executes, data necessary for executing the program, and the like.

[0090] The learning storage unit 13 stores, in particular, the learning data 131 and a learning model 132 described later. Table 1 illustrated below indicates an example of the learning data 131 used during the cooling operation.

[Table 1]

Opening degree a	Opening degree b	...	Opening degree i	Outdoor pressure value
a1	b1	...	i1	200 kPa
a2	b2	...	i2	210 kPa
a3	b3	...	i3	190 kPa
a4	b4	...	i4	180 kPa
...	...	...	...	...

[0091] One record in the learning data 131 corresponds to a fact that the control unit 70 has set once the opening degrees of the flow rate adjustment units 332a to 332i. In Table 1, the items "Opening degree a" to "Opening degree i" respectively indicate the opening degrees of the flow rate adjustment units 332a to 332i, which the control unit 70 has set.

(2-4-4) Learning communication unit

[0092] The learning communication unit 14 is a network interface device for performing communications via the communication line 82.

(2-4-5) Learning control unit

[0093] The learning control unit 19 is a processor such as a CPU or a GPU. The learning control unit 19 reads and executes a program stored in the learning storage unit 13 to realize various functions of the learning device 10. Furthermore, the learning control unit 19 can write a calculation result into the learning storage unit 13, and can read information stored in the learning storage unit 13, in accordance with a program. Furthermore, the learning control unit 19 includes a timer.

[0094] The learning control unit 19 associates with each other and learns a combination of the opening degrees of the plurality of flow rate adjustment units 332a to 332i and an outdoor pressure value when the opening degrees of the plurality of flow rate adjustment units 332a to 332i correspond to the combination of the opening degrees. In other words, the learning control unit 19 creates the learning model 132 using the learning data 131 as illustrated in Table 1. The learning model 132 according to the present embodiment is a classification-type model. As the learning model 132 according to the present embodiment, for example, a neural network, logistic regression, a support vector machine, or the like can be used.

[0095] Specifically, the learning control unit 19 first estimates, as preprocessing, a level of the heat exchange capability of the outdoor heat exchanger 33 from an outdoor pressure value. In a case of the cooling operation, it is estimated that the smaller the outdoor pressure value (a pressure value on the high-pressure side), the higher the heat exchange capability of the outdoor heat exchanger 33. Therefore, the learning control unit 19 designates, for example, a predetermined percentage (for example, 20%), from among the records in the learning data 131, in ascending order of the outdoor pressure value and estimates that the heat exchange capability of the outdoor heat exchanger 33 is high in these records and that the heat exchange capability of the outdoor heat exchanger 33 is low in the other records. In a case of the heating operation, it is estimated that the larger the outdoor pressure value (the pressure value on the low pressure side), the higher the heat exchange capability of the outdoor heat exchanger 33. Therefore, the learning control unit 19 designates, for example, a predetermined percentage (for example, 20%), from among the records in the learning data 131, in descending order of the outdoor pressure values and estimates that the heat exchange capability of the outdoor heat exchanger 33 is high in these records and that the heat exchange capability of the outdoor heat exchanger 33 is low in the other records. Table 2 illustrated below indicates an example when the preprocessing is performed on the learning data 131 in Table 1.

[Table 2]

Opening degree a	Opening degree b	...	Opening degree i	Outdoor pressure value	Heat exchange capability (Outdoor heat exchanger)
a1	b1	...	i1	200 kPa	Low
a2	b2	...	i2	210 kPa	Low
a3	b3	...	i3	190 kPa	High
a4	b4	...	i4	180 kPa	High
...	...	...	...	...	...

[0096] Since Table 1 indicates the learning data 131 during the cooling operation, the smaller the outdoor pressure value, the higher the possibility that the heat exchange capability is "high", in Table 2.

[0097] Next, the learning control unit 19 classifies the combination of the opening degrees of the flow rate adjustment units 332a to 332i in accordance with the level of the heat exchange capability of the outdoor heat exchanger 33, which is estimated from the outdoor pressure value. In other words, the learning control unit 19 creates the learning model 132 using the combination of the opening degrees of the flow rate adjustment units 332a to 332i as an explanatory variable and the heat exchange capability as an objective variable, and classifies the combination of the opening degrees of the flow rate adjustment units 332a to 332i. Further, in other words, the learning control unit 19 creates the learning model 132 that divides an opening degree space (here, a nine-dimensional space where values of Opening degree a to Opening degree i serve as axes), in which each point represents a combination of the opening degrees of the flow rate adjustment units 332a to 332i, into a region in which the heat exchange capability is estimated to be "high" and a region in which the heat exchange capability is estimated to be "low".

[0098] Fig. 5 is a diagram for explaining learning processing in the learning device 10. Fig. 5 illustrates, for visualization purposes, only a two-dimensional plane formed by the axis of "Opening degree a" and the axis of "Opening degree b" in the nine-dimensional opening degree space.

[0099] In an upper left diagram in Fig. 5, four points corresponding to the values of "Opening degree a" and "Opening degree b" in each record in the learning data 131 are plotted. In the upper left diagram in Fig. 5, the points that are hatched indicate that the heat exchange capability is "high". The points that are not hatched indicate that the heat exchange capability is "low".

[0100] An upper center diagram in Fig. 5 illustrates a state in which the opening degree space is divided into a region R1 and a region R2 by a boundary BR1 that the learning model 132 has caused to appear. The (hatched) region R1 indicates a region in which the heat exchange capability is estimated to be "high". The region R2 indicates a region in which the heat exchange capability is estimated to be "low".

[0101] In response to a region in which the heat exchange capability is estimated to be "high" (the region R1) being determined, the learning control unit 19 transmits information about the region to the control unit 70 as opening degree information. In other words, the opening degree information is information about a combination of the opening degrees of the flow rate adjustment units 332a to 332i, which is classified by the learning device 10 into a class at which the heat exchange capability of the outdoor heat exchanger 33 is higher than a predetermined value.

[0102] Thereafter, the control unit 70 uses the opening degree information received from the learning device 10 to control, within a range of the region in which the heat exchange capability is estimated to be "high" (the region R1), the opening degrees of the respective flow rate adjustment units 332a to 332i. Each time the opening degrees of the flow rate adjustment units 332a to 332i have been set, the control unit 70 transmits the learning data 131 to the learning device 10. In an upper right diagram in Fig. 5, four points corresponding to records in the learning data 131 that has newly been received are plotted in the area R1. In the upper right diagram in Fig. 5, the point that is hatched indicates that the heat exchange capability is "high".

[0103] The learning control unit 19 creates the learning model 132 again based on the learning data 131 that has newly been created. A lower left diagram in Fig. 5 illustrates a state in which the opening degree space is divided into a region R3 and a region R4 by a boundary BR2 that the learning model 132 created again has caused to appear. The (hatched) region R3 indicates a region in which the heat exchange capability is estimated to be "high". The region R4 indicates a region in which the heat exchange capability is estimated to be "low".

(3) Flow rate adjustment processing

[0104] An example of the flow rate adjustment processing will be described with reference to a flowchart illustrated in

Fig. 6.

[0105] As illustrated in step S1, the control unit 70 starts the cooling operation or the heating operation in response to an instruction or the like from the operation remote controller.

[0106] As step S1 ends, as illustrated in step S2, the control unit 70 determines whether or not new opening degree information has been received from the learning device 10. As new opening degree information is received, the processing proceeds to step S3. If new opening degree information has not yet been received, the processing proceeds to step S4.

[0107] As the processing proceeds from step S2 to step S3, the control unit 70 updates the old opening degree information with the new opening degree information received from the learning device 10.

[0108] As the processing proceeds from step S2 to step S4, or as step S3 ends, the control unit 70 sets the opening degrees of the flow rate adjustment units 332a to 332i within a range of the opening degree information.

[0109] As step S4 ends, as illustrated in step S5, the control unit 70 waits until the air conditioning device 2 reaches the stationary state.

[0110] As step S5 ends, as illustrated in step S6, the control unit 70 transmits the learning data 131 to the learning device 10.

[0111] As step S6 ends, as illustrated in step S7, the control unit 70 waits for the predetermined time T1. The predetermined time T1 is, for example, 10 minutes. As the predetermined time T1 has elapsed, the processing proceeds to step S2, and the control unit 70 again determines whether or not new opening degree information has been received from the learning device 10.

[0112] Meanwhile, as illustrated in step S8, the learning control unit 19 determines whether or not the learning data 131 has been received from the air conditioning device 2. As the learning data 131 has been received, the processing proceeds to step S9. If the learning data 131 has not yet been received, the processing proceeds to step S10.

[0113] As the processing proceeds from step S8 to step S9, the learning control unit 19 accumulates the received learning data 131 in the learning storage unit 13.

[0114] As the processing proceeds from step S8 to step S10, or as step S9 ends, the learning control unit 19 determines whether or not the predetermined time T2 has elapsed. The predetermined time T2 is, for example, 24 hours. As the predetermined time T2 has elapsed, the processing proceeds to step S11. If the predetermined time T2 has not yet elapsed, the processing proceeds to step S8, and the learning control unit 19 determines again whether or not the learning data 131 has been received from the air conditioning device 2.

[0115] As the processing proceeds from step S10 to step S11, the learning control unit 19 creates the learning model 132 based on the learning data 131 that has been accumulated.

[0116] As step S11 ends, as illustrated in step S12, the learning control unit 19 transmits the opening degree information based on the created learning model 132 to the air conditioning device 2.

[0117] As step S12 ends, as illustrated in step S13, the learning control unit 19 deletes the learning data 131 that is old data, which has been used to create the learning model 132.

[0118] As step S13 ends, as illustrated in step S8 and step S9, the learning control unit 19 accumulates again the learning data 131 that is new data.

[0119] The control unit 70 and the learning control unit 19 continue this processing until the cooling operation or the heating operation is stopped by an instruction or the like from the operation remote controller.

(4) Feature

[0120] (4-1) In the related art, there is a technique for preventing, in a heat exchanger having a plurality of refrigerant flow paths, a refrigerant flowing through the heat exchanger from flowing unevenly, by adjusting a flow rate of the refrigerant based on a temperature of the refrigerant flowing through the refrigerant flow paths.

[0121] In such a technique of the related art, when a flow rate of a refrigerant is to be adjusted based on a temperature of the refrigerant flowing through the refrigerant flow paths, there is an issue in that a temperature sensor is required for each of the refrigerant flow paths.

[0122] The refrigeration cycle device 1 according to the present embodiment includes the heat exchanger main body 331, the plurality of flow rate adjustment units 332a to 332i, and the control unit 70. The heat exchanger main body 331 has the plurality of refrigerant flow paths 333a to 333i including the first refrigerant flow path 333 and the second refrigerant flow path 333. The plurality of flow rate adjustment units 332a to 332i adjust the flow rates of the refrigerant flowing through the refrigerant flow paths 333a to 333i, respectively. The control unit 70 adjusts the flow rates of the refrigerant flowing through the refrigerant flow paths 333 by controlling the opening degrees of the flow rate adjustment units 332. The control unit 70 controls the opening degrees of the respective flow rate adjustment units 332a to 332i based on the first value. The first value is a value representing the overall efficiency of the refrigeration cycle.

[0123] In the refrigeration cycle device 1 according to the present embodiment, the control unit 70 controls the opening degrees of the respective flow rate adjustment units 332a to 332i based on the first value. The first value is a value representing the overall efficiency of the refrigeration cycle. As a result, the refrigeration cycle device 1 can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths 333a to 333i by using sensors, the number of which is smaller than the number of the refrigerant flow paths 333, and can prevent the refrigerant flowing through the outdoor heat exchanger 33 from flowing unevenly.

(4-2) In the refrigeration cycle device 1 according to the present embodiment, the first value includes the pressure value of the refrigerant flowing through the indoor heat exchanger 21 (during the cooling operation) or the outdoor heat exchanger 33 (during the heating operation). As a result, the refrigeration cycle device 1 can estimate an uneven flow state of the refrigerant flowing through the outdoor heat exchanger 33, and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths 333a to 333i.
(4-3) In the refrigeration cycle device 1 according to the present embodiment, the first value further includes a temperature of air that exchanges heat with the refrigerant in the outdoor heat exchanger 33. As a result, the refrigeration cycle device 1 can more accurately estimate an uneven flow state of the refrigerant flowing through the outdoor heat exchanger 33 and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths 333a to 333i.
(4-4) In the refrigeration cycle device 1 according to the present embodiment, the first value further includes the rotation speed of the outdoor fan motor 36m in the outdoor heat exchanger 33. As a result, the refrigeration cycle device 1 can more accurately estimate an uneven flow state of the refrigerant flowing through the outdoor heat exchanger 33 and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths 333a to 333i.
(4-5) The refrigeration cycle device 1 according to the present embodiment further includes the learning device 10. The learning device 10 associates with each other and learns a combination of the opening degrees of the plurality of flow rate adjustment units 332a to 332i and the first value when the opening degrees of the plurality of flow rate adjustment units 332a to 332i correspond to the combination of the opening degrees. The learning device 10 classifies the combination of the opening degrees in accordance with a level of the heat exchange capability of the outdoor heat exchanger 33, which is estimated from the first value. The control unit 70 controls the opening degrees of the respective flow rate adjustment units 332a to 332i by using the combination of the opening degrees, which is classified, by the learning device 10, into a class at which the heat exchange capability of the outdoor heat exchanger 33 is higher than a predetermined value.

[0124] In the refrigeration cycle device 1 according to the present embodiment, using machine learning makes it possible to efficiently calculate a combination of the opening degrees of the flow rate adjustment units 332a to 332i, under which the heat exchange capability of the outdoor heat exchanger 33 improves (under which the refrigerant flowing through the outdoor heat exchanger 33 will be less likely to flow unevenly).

(5) Modified Examples

(5-1) Modified Example 1A

[0125] In the present embodiment, an outdoor pressure value is used as the first value for estimating the heat exchange capability of the outdoor heat exchanger 33. However, instead of an outdoor pressure value, an electric power consumption value of the compressor 31 may be used as the first value for estimating the heat exchange capability of the outdoor heat exchanger 33.
[0126] In both the cooling operation and the heating operation, it is estimated that the smaller the electric power consumption value of the compressor 31, the higher the heat exchange capability of the outdoor heat exchanger 33. Therefore, the learning control unit 19 designates, for example, a predetermined percentage (for example, 20%), from among the records in the learning data 131, in ascending order of the electric power consumption values of the compressor 31 and estimates that the heat exchange capability of the outdoor heat exchanger 33 is high in these records, and the heat exchange capability of the outdoor heat exchanger 33 is low in the other records.
[0127] When both the outdoor pressure value and the electric power consumption value of the compressor 31 are used as the first value, for example, one of them may be used to determine whether or not the air conditioning device 2 is in the stationary state.

(5-2) Modified Example 1B

[0128] In the present embodiment, the first value includes an outdoor pressure value, an outdoor temperature, and an outdoor fan rotation speed. However, the first value may further include the rotation speed of the compressor motor 31m and the opening degree of the outdoor expansion valve 34. The rotation speed of the compressor motor 31m and the opening degree of the outdoor expansion valve 34 are used, for example, to determine whether or not the air conditioning device 2 is in the stationary state.

[0129] As a result, the refrigeration cycle device 1 can more accurately estimate an uneven flow state of the refrigerant flowing through the outdoor heat exchanger 33, and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths 333a to 333i.

(5-3) Modified Example 1C

[0130] In the present embodiment, the control unit 70 controls the opening degrees of the respective flow rate adjustment units 332a to 332i based on the first value. However, the control unit 70 may control the opening degrees of the respective flow rate adjustment units 332a to 332i based on the second value. The second value is a value representing the overall efficiency of the outdoor heat exchanger 33. In the present modified example, the second value includes an outlet temperature of the outdoor heat exchanger 33 (hereinafter sometimes referred to as an outdoor outlet temperature) after the refrigerant flowed out of the first refrigerant flow path 333 and the refrigerant flowed out of the second refrigerant flow path 333 have joined each other, an outdoor temperature, and an outdoor fan rotation speed. As a result, the refrigeration cycle device 1 can estimate an uneven flow state of the refrigerant flowing through the outdoor heat exchanger 33 and can adjust the flow rates of the refrigerant flowing through the respective refrigerant flow paths 333a to 333i.

[0131] The outdoor outlet temperature during the cooling operation represents a condensation temperature. The outdoor outlet temperature during the cooling operation is acquired from, for example, the liquid-side temperature sensor 68. The outdoor outlet temperature during the heating operation is an evaporation temperature. The outdoor outlet temperature during the heating operation is acquired from, for example, the gas-side temperature sensor 67. The second value may further include the rotation speed of the compressor motor 31m and the opening degree of the outdoor expansion valve 34. Note that, for example, when the outdoor heat exchanger 33 has a plurality of flow dividers 334 (although there is one in the present embodiment) and the liquid-side temperature sensors 68 are installed at respective outlets, an average of measured values of the liquid-side temperature sensors 68 may be used as an outdoor outlet temperature during the cooling operation.

[0132] Similarly to a case of the first value, the control unit 70 receives opening degree information from the learning device 10 per predetermined time T2. The control unit 70 sets the opening degrees of the flow rate adjustment units 332a to 332i per predetermined time T1 within a setting range of the received opening degree information. The control unit 70 waits, each time the opening degrees of the flow rate adjustment units 332a to 332i have been set, until the air conditioning device 2 reaches the stationary state, and, after the air conditioning device 2 has reached the stationary state, transmits, to the learning device 10, the opening degrees of the flow rate adjustment units 332a to 332i and an outdoor outlet temperature at that time (which serve as the learning data 131). In the present modified example, the control unit 70 determines that the air conditioning device 2 has reached the stationary state when the outdoor temperature and the outdoor fan rotation speed become stationary. The control unit 70 may further determine that the air conditioning device 2 has reached the stationary state when the rotation speed of the compressor motor 31m and the opening degree of the outdoor expansion valve 34 become stationary.

[0133] The learning control unit 19 estimates a level of the heat exchange capability of the outdoor heat exchanger 33 from the outdoor outlet temperature. In a case of the cooling operation, it is estimated that the lower the outdoor outlet temperature, the higher the heat exchange capability of the outdoor heat exchanger 33. Therefore, the learning control unit 19 designates, for example, a predetermined percentage (for example, 20%), from among the records in the learning data 131, in ascending order of the outdoor outlet temperatures and estimates that the heat exchange capability of the outdoor heat exchanger 33 is high in these records, and that the heat exchange capability of the outdoor heat exchanger 33 is low in the other records. In a case of the heating operation, it is estimated that the higher the outdoor outlet temperature, the higher the heat exchange capability of the outdoor heat exchanger 33. Therefore, the learning control unit 19 designates, for example, a predetermined percentage (for example, 20%), from among the records in the learning data 131, in descending order of the outdoor outlet temperatures and estimates that the heat exchange capability of the outdoor heat exchanger 33 is high in these records and that the heat exchange capability of the outdoor heat exchanger 33 is low in the other records.

(5-4) Modified Example 1D

[0134] In the present embodiment, the learning control unit 19 uses the learning model 132 that is a classification type. However, the learning control unit 19 may use a learning model 133 that is a regression type. As a regression type learning model 133, for example, a neural network, linear regression, or the like can be used.

[0135] Hereinafter, an example of the flow rate adjustment processing in a case where the regression type learning model 133 is used will be described with reference to a flowchart illustrated in Fig. 7.

[0136] As a premise, when the control unit 70 controls the opening degrees of the respective flow rate adjustment units 332a to 332i based on the first value, the first value includes an outdoor pressure value, an outdoor temperature, and an outdoor fan rotation speed. When the control unit 70 controls the opening degrees of the respective flow rate adjustment units 332a to 332i based on the second value, the second value includes an outdoor outlet temperature, an outdoor temperature, and an outdoor fan rotation speed.

[0137] Furthermore, the learning control unit 19 associates with each other and learns in advance a combination of the opening degrees of the plurality of flow rate adjustment units 332a to 332i and the outdoor pressure value or the outdoor outlet temperature when the opening degrees of the plurality of flow rate adjustment units 332a to 332i correspond to the combination of the opening degrees. In other words, the learning control unit 19 creates the learning model 133 in advance using the combination of the opening degrees of the flow rate adjustment units 332a to 332i as an explanatory variable and the outdoor pressure value or the outdoor outlet temperature as an objective variable. Furthermore, the control unit 70 determines in advance initial values of the opening degrees of the flow rate adjustment units 332a to 332i when the cooling operation or the heating operation is to be started.

[0138] As illustrated in step S101, the control unit 70 starts the cooling operation or the heating operation in response to an instruction or the like from the operation remote controller.

[0139] As step S101 ends, as illustrated in step S102, the control unit 70 sets the opening degrees of the flow rate adjustment units 332a to 332i to the initial values.

[0140] As step S102 ends, as illustrated in step S103, the control unit 70 waits until the air conditioning device 2 reaches the stationary state. In the present modified example, the control unit 70 determines that the air conditioning device 2 has reached the stationary state when the outdoor temperature and the outdoor fan rotation speed become stationary.

[0141] As step S103 ends, as illustrated in step S104, the control unit 70 transmits the learning data 131 to the learning device 10. In other words, the control unit 70 transmits, to the learning device 10, the combination of the opening degrees of the flow rate adjustment units 332a to 332i and the outdoor pressure value or the outdoor outlet temperature when the air conditioning device 2 has reached the stationary state.

[0142] When the learning data 131 is received from the air conditioning device 2, as illustrated in step S105, the learning control unit 19 updates the learning model 133 by using the learning data 131.

[0143] As step S105 ends, as illustrated in step S106, the learning control unit 19 calculates, based on the combination of the opening degrees of the flow rate adjustment units 332a to 332i (hereinafter sometimes referred to as a reference opening degree) in the learning data 131 received from the learning device 10 and the learning model 133 that has been updated, such a combination of the opening degrees of the flow rate adjustment units 332a to 332i that improves the heat exchange capability of the outdoor heat exchanger 33, which is estimated from the outdoor pressure value or the outdoor outlet temperature. Specifically, the learning control unit 19 calculates most appropriate points (the most appropriate opening degrees of the flow rate adjustment units 332a to 332i), at which the heat exchange capability of the outdoor heat exchanger 33 is estimated to be highest, from among neighboring points to a point corresponding to the reference opening degree in the opening degree space. Furthermore, specifically, when the learning model 133 estimates an outdoor pressure value, a neighboring point at which a lowest outdoor pressure value is estimated during the cooling operation and a neighboring point at which a highest outdoor pressure value is estimated during the heating operation are set as most appropriate points. Furthermore, when the learning model 133 estimates an outdoor outlet temperature, a neighboring point at which a lowest outdoor outlet temperature is estimated during the cooling operation and a neighboring point at which a highest outdoor outlet temperature is estimated during the heating operation are set as most appropriate points.

[0144] As step S106 ends, as illustrated in step S107, the learning control unit 19 transmits the combination of the most appropriate opening degrees of the flow rate adjustment units 332a to 332i to the air conditioning device 2.

[0145] As the combination of the opening degrees of the flow rate adjustment units 332a to 332i is received from the learning device 10, as illustrated in step S108, the control unit 70 waits for a predetermined time T3. The predetermined time T3 is, for example, 10 minutes.

[0146] As step S108 ends, as illustrated in step S109, the control unit 70 controls the opening degrees of the respective flow rate adjustment units 332a to 332i by using the combination of the opening degrees, which is calculated by the learning device 10. In other words, the control unit 70 sets the combination of the opening degrees, which is received from the learning device 10, in the flow rate adjustment units 332a to 332i.

[0147] As step S109 ends, as illustrated in step S103, the control unit 70 waits until the air conditioning device 2 reaches the stationary state again.

[0148] The control unit 70 and the learning control unit 19 continue this processing until the cooling operation or the heating operation is stopped by an instruction or the like from the operation remote controller.

(5-5) Modified Example 1E

[0149] In the present embodiment, the control unit 70 controls the opening degrees of the respective flow rate adjustment units 332a to 332i such that the refrigerant flowing through the refrigerant flow paths 333a to 333i in the outdoor heat exchanger 33 does not flow unevenly. However, in a case where the indoor heat exchanger 21 includes, similarly to the outdoor heat exchanger 33, a plurality of flow rate adjustment units 212a to 212i, and a plurality of refrigerant flow paths 213a to 213i, the control unit 70 may further control opening degrees of the respective flow rate adjustment units 212a to 212i such that the refrigerant flowing through the refrigerant flow paths 213a to 213i in the indoor heat exchanger 21 does not flow unevenly.

(5-5-1) Configuration of indoor heat exchanger

[0150] Fig. 8 is a schematic configuration diagram of the indoor heat exchanger 21 according to the present modified example. As illustrated in Fig. 8, the indoor heat exchanger 21 mainly includes a heat exchanger main body 211 and the plurality of flow rate adjustment units 212a to 212i.

[0151] The heat exchanger main body 211 has the plurality of refrigerant flow paths 213a to 213i including a first refrigerant flow path 213 and a second refrigerant flow path 213. As illustrated in Fig. 8, the heat exchanger main body 211 is divided into a plurality of sections 211a to 211i, and the refrigerant flow paths 213a to 213i pass through the sections 211a to 211i, respectively. The heat exchanger main body 211 causes heat to be exchanged between the refrigerant flowing through the refrigerant flow paths 213 and air in the target space. The heat exchanger main body 211 functions as an evaporator during the cooling operation and functions as a condenser during the heating operation.

[0152] The flow rate adjustment units 212 adjust the flow rates of the refrigerant flowing through the refrigerant flow paths 213. Specifically, as illustrated in Fig. 8, the flow rate adjustment units 212a to 212i adjust the flow rates of the refrigerant flowing through the refrigerant flow paths 213a to 213i such that the temperature and the pressure of the refrigerant flowing through the refrigerant flow paths 213a to 213i become uniform. In other words, the flow rate adjustment units 212a to 212i adjust the flow rates of the refrigerant flowing through the refrigerant flow paths 213a to 213i such that the refrigerant flowing through the refrigerant flow paths 213a to 213i does not flow unevenly. The flow rate adjustment units 212 are configured to be able to adjust the opening degrees.

[0153] As illustrated in Fig. 8, a flow divider 214 causes, during the heating operation, the refrigerant that has flowed from the compressor 31 side into the indoor heat exchanger 21 (in a direction indicated by a solid-line arrow illustrated in Fig. 8) to be separated flows to separately flow into the refrigerant flow paths 213a to 213i. Furthermore, the flow divider 214 causes, during the cooling operation, separated flows of the refrigerant that has flowed from the indoor expansion valve 23 side into the indoor heat exchanger 21 (in a direction indicated by a broken-line arrow illustrated in Fig. 8) and that has been caused to separately flow into the refrigerant flow paths 213a to 213i by a header 215, which will be described later, to join each other.

[0154] As illustrated in Fig. 8, the header 215 causes, during the heating operation, separated flows of the refrigerant that has flowed from the compressor 31 side into the indoor heat exchanger 21 (in the direction indicated by the solid-line arrow illustrated in Fig. 8) and that has been caused to separately flow into the refrigerant flow paths 213a to 213i by the flow divider 214 to join each other. Furthermore, the header 215 causes, during the cooling operation, the refrigerant that has flowed from the indoor expansion valve 23 side into the indoor heat exchanger 21 (in the direction indicated by the broken-line arrow illustrated in Fig. 8) to be separated flows to separately flow into the refrigerant flow paths 213a to 213i.

(5-5-2) Flow rate adjustment processing

[0155] The control unit 70 adjusts, in cooperation with the learning device 10, the flow rates of the refrigerant flowing through the refrigerant flow paths 213a to 213i by controlling the opening degrees of the flow rate adjustment units 212a to 212i.

(5-5-2-1) Flow rate adjustment processing based on first value

[0156] When the control unit 70 controls the opening degrees of the respective flow rate adjustment units 212a to 212i based on the first value, the first value can include a pressure value of the refrigerant flowing through the indoor heat exchanger 21 (hereinafter sometimes referred to as an indoor pressure value), a temperature of air that exchanges heat with the refrigerant in the indoor heat exchanger 21 (hereinafter sometimes referred to as an indoor temperature), and the rotation speed of the indoor fan motor 22m (hereinafter sometimes referred to as an indoor fan rotation speed). The first value may further include the rotation speed of the compressor motor 31m and the opening degree of the indoor expansion valve 23.

[0157] The indoor pressure value during the cooling operation is a pressure value on the low pressure side. The indoor pressure value during the cooling operation is acquired from, for example, the suction pressure sensor 64. The indoor temperature is acquired from, for example, the indoor temperature sensor 61. In a case of the cooling operation, it is estimated that the larger the indoor pressure value, the higher the heat exchange capability of the indoor heat exchanger

21.

[0158] The indoor pressure value during the heating operation is a pressure value on the high pressure side. The indoor pressure value during the heating operation is acquired from, for example, the discharge pressure sensor 65. In a case of the heating operation, it is estimated that the smaller the indoor pressure value, the higher the heat exchange capability of the indoor heat exchanger 21.

[0159] In both the cooling operation and the heating operation, the control unit 70 can determine that the air conditioning device 2 has reached the stationary state when the indoor temperature and the indoor fan rotation speed become stationary. The control unit 70 may further determine that the air conditioning device 2 has reached the stationary state when the rotation speed of the compressor motor 31m and the opening degree of the indoor expansion valve 23 become stationary.

(5-5-2-2) Flow rate adjustment processing based on second value

[0160] When the control unit 70 controls the opening degrees of the respective flow rate adjustment units 212a to 212i based on the second value, the second value can include an outlet temperature of the indoor heat exchanger 21 (hereinafter sometimes referred to as an indoor outlet temperature) after the refrigerant flowing out of the first refrigerant flow path 213 and the refrigerant flowing out of the second refrigerant flow path 213 have joined each other, an indoor temperature, and an indoor fan rotation speed. The second value may further include the rotation speed of the compressor motor 31m and the opening degree of the indoor expansion valve 23.

[0161] The indoor outlet temperature during the cooling operation is an evaporation temperature. The indoor outlet temperature during the cooling operation is acquired from, for example, the gas-side temperature sensor 62. In a case of the cooling operation, it is estimated that the higher the indoor outlet temperature, the higher the heat exchange capability of the indoor heat exchanger 21.

[0162] The indoor outlet temperature during the heating operation is a condensation temperature. The indoor outlet temperature during the heating operation is acquired from, for example, the liquid-side temperature sensor 63. In a case of the heating operation, it is estimated that the lower the indoor outlet temperature, the higher the heat exchange capability of the indoor heat exchanger 21.

[0163] In both the cooling operation and the heating operation, the control unit 70 can determine that the air conditioning device 2 has reached the stationary state when the indoor temperature and the indoor fan rotation speed become stationary. The control unit 70 may further determine that the air conditioning device 2 has reached the stationary state when the rotation speed of the compressor motor 31m and the opening degree of the indoor expansion valve 23 become stationary.

[0164] (5-6) While the embodiment of the present disclosure has been described above, it will be understood that various changes in form and detail may be made therein without departing from the spirit and scope of the present disclosure as set forth in the appended claims.

REFERENCE SIGNS LIST

[0165]

1	Refrigeration cycle device
10	Learning device
23	Indoor expansion valve (expansion valve)
31	Compressor
34	Outdoor expansion valve (expansion valve)
70	Control unit
211, 331	Heat exchanger main body (heat exchanger)
212, 332	Flow rate adjustment unit
213, 333	Refrigerant flow path

CITATION LIST

PATENT LITERATURE

[0166] PTL 1: Japanese Unexamined Patent Application Publication No. 2008-128628

Claims

1. A refrigeration cycle device (1) comprising:

   a heat exchanger (331, 211) having a plurality of refrigerant flow paths (333a to 333i, 213a to 213i) including a first refrigerant flow path (333, 213) and a second refrigerant flow path (333, 213);
   a plurality of flow rate adjustment units (332a to 332i, 212a to 212i) that adjust flow rates of a refrigerant flowing through the respective refrigerant flow paths; and
   a control unit (70), wherein
   the control unit
   adjusts the flow rates of the refrigerant flowing through the refrigerant flow paths by controlling opening degrees of the flow rate adjustment units, and
   controls the opening degrees of the respective flow rate adjustment units based on a first value that is a value representing overall efficiency of a refrigeration cycle or a second value that is a value representing overall efficiency of the heat exchanger.

2. The refrigeration cycle device (1) according to claim 1, wherein the first value includes an electric power consumption value of a compressor (31) that compresses the refrigerant or a pressure value of the refrigerant flowing through the heat exchanger.

3. The refrigeration cycle device (1) according to claim 1 or 2, wherein the second value includes an outlet temperature of the heat exchanger, after the refrigerant that has flowed out of the first refrigerant flow path and the refrigerant that has flowed out of the second refrigerant flow path have joined each other.

4. The refrigeration cycle device (1) according to claim 2 or 3, wherein the first value or the second value further includes a temperature of air that exchanges heat with the refrigerant in the heat exchanger.

5. The refrigeration cycle device (1) according to any one of claims 2 to 4, wherein the first value or the second value further includes a rotation speed of a fan (36, 22) that generates a flow of air that exchanges heat with the refrigerant in the heat exchanger.

6. The refrigeration cycle device (1) according to any one of claims 2 to 5, wherein the first value or the second value further includes a rotation speed of the compressor.

7. The refrigeration cycle device (1) according to any one of claims 2 to 6, wherein the first value or the second value further includes an opening degree of an expansion valve (34, 23) that adjusts the flow rate of the refrigerant.

8. The refrigeration cycle device (1) according to any one of claims 1 to 7,

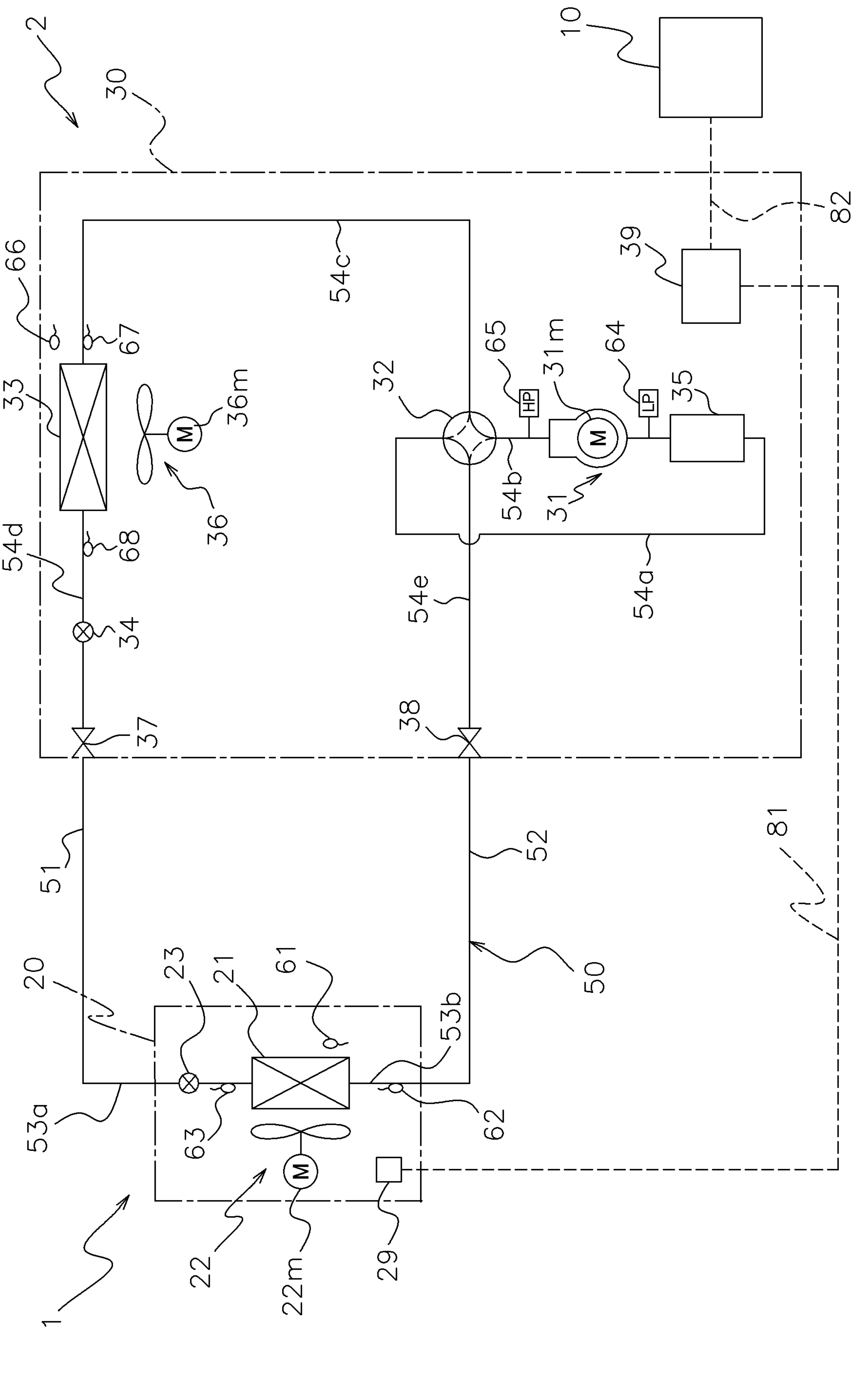
   further comprising a learning device (10) that associates with each other and learns a combination of the opening degrees of the plurality of flow rate adjustment units and the first value or the second value when the opening degrees of the plurality of flow rate adjustment units correspond to the combination of the opening degrees, wherein
   the learning device classifies the combination of the opening degrees in accordance with a level of a heat exchange capability of the heat exchanger, the level of the heat exchange capability being estimated from the first value or the second value, and
   the control unit controls the opening degrees of the respective flow rate adjustment units by using the combination of the opening degrees classified, by the learning device, into a class at which the heat exchange capability of the heat exchanger is higher than a predetermined value.

9. The refrigeration cycle device (1) according to any one of claims 1 to 7,

   further comprising a learning device (10) that associates with each other and learns a combination of the opening degrees of the plurality of flow rate adjustment units and the first value or the second value when the opening degrees of the plurality of flow rate adjustment units correspond to the combination of the opening degrees, wherein
   the learning device calculates the combination of the opening degrees, the combination improving the heat exchange capability of the heat exchanger, the heat exchange capability being estimated from the first value

or the second value, and

the control unit controls the opening degrees of the respective flow rate adjustment units by using the combination of the opening degrees calculated by the learning device.


2
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10
82
39
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36m
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36
54b
31
54d
68
54e
54a
34
37
38
51
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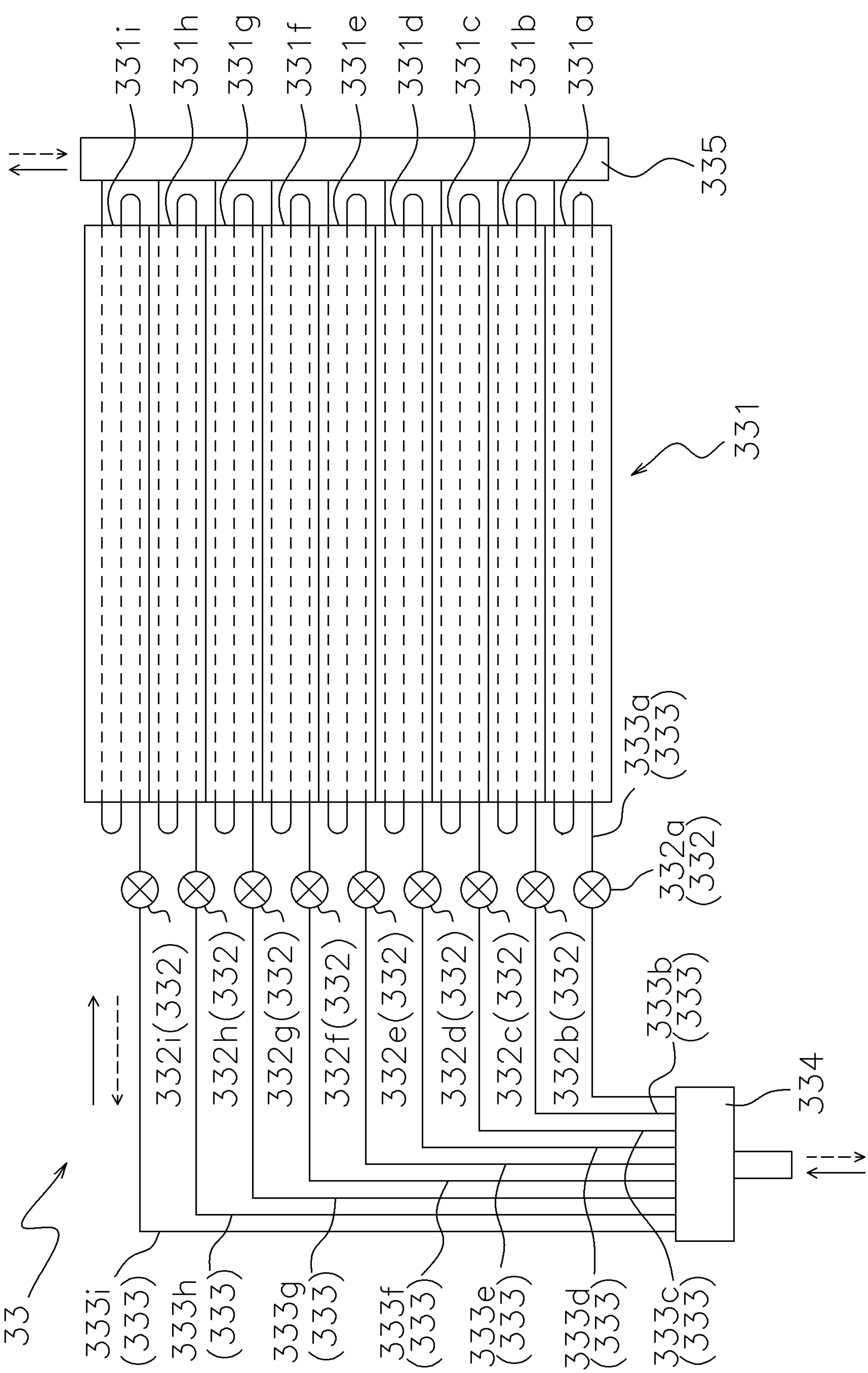
21
61
53b
53a
63
62
M
22
22m
29
1

FIG. 1



331i
331h
331g
331f
331e
331d
331c
331b
331a
335
331
333a (333)
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332c(332)
332d(332)
332e(332)
332f(332)
332g(332)
332h(332)
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333b (333)
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333c (333)

FIG. 2

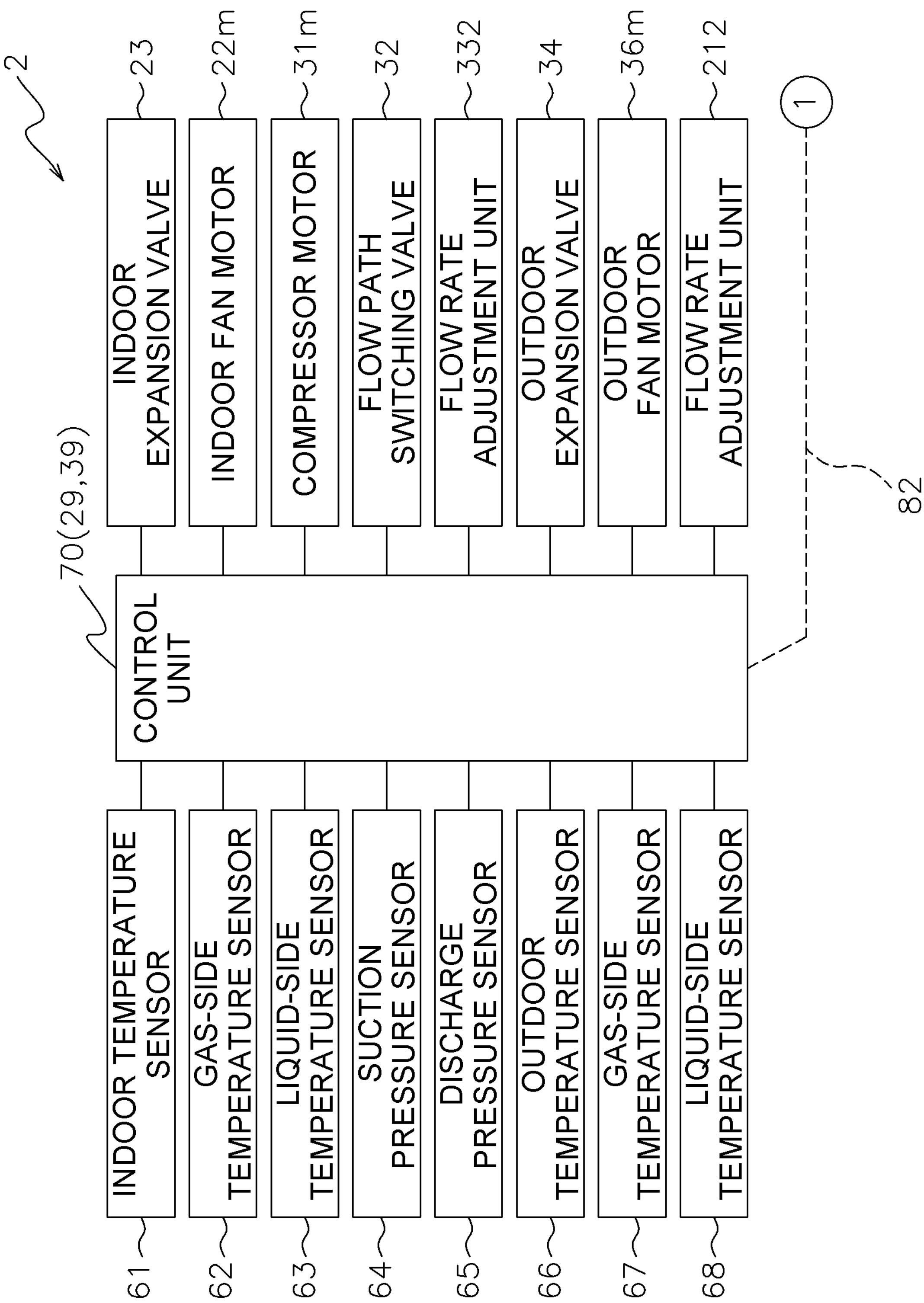

2
70(29,39)
CONTROL UNIT
INDOOR EXPANSION VALVE
23
INDOOR FAN MOTOR
22m
COMPRESSOR MOTOR
31m
FLOW PATH SWITCHING VALVE
32
FLOW RATE ADJUSTMENT UNIT
332
OUTDOOR EXPANSION VALVE
34
OUTDOOR FAN MOTOR
36m
FLOW RATE ADJUSTMENT UNIT
212
1
82
INDOOR TEMPERATURE SENSOR
61
GAS-SIDE TEMPERATURE SENSOR
62
LIQUID-SIDE TEMPERATURE SENSOR
63
SUCTION PRESSURE SENSOR
64
DISCHARGE PRESSURE SENSOR
65
OUTDOOR TEMPERATURE SENSOR
66
GAS-SIDE TEMPERATURE SENSOR
67
LIQUID-SIDE TEMPERATURE SENSOR
68

FIG. 3

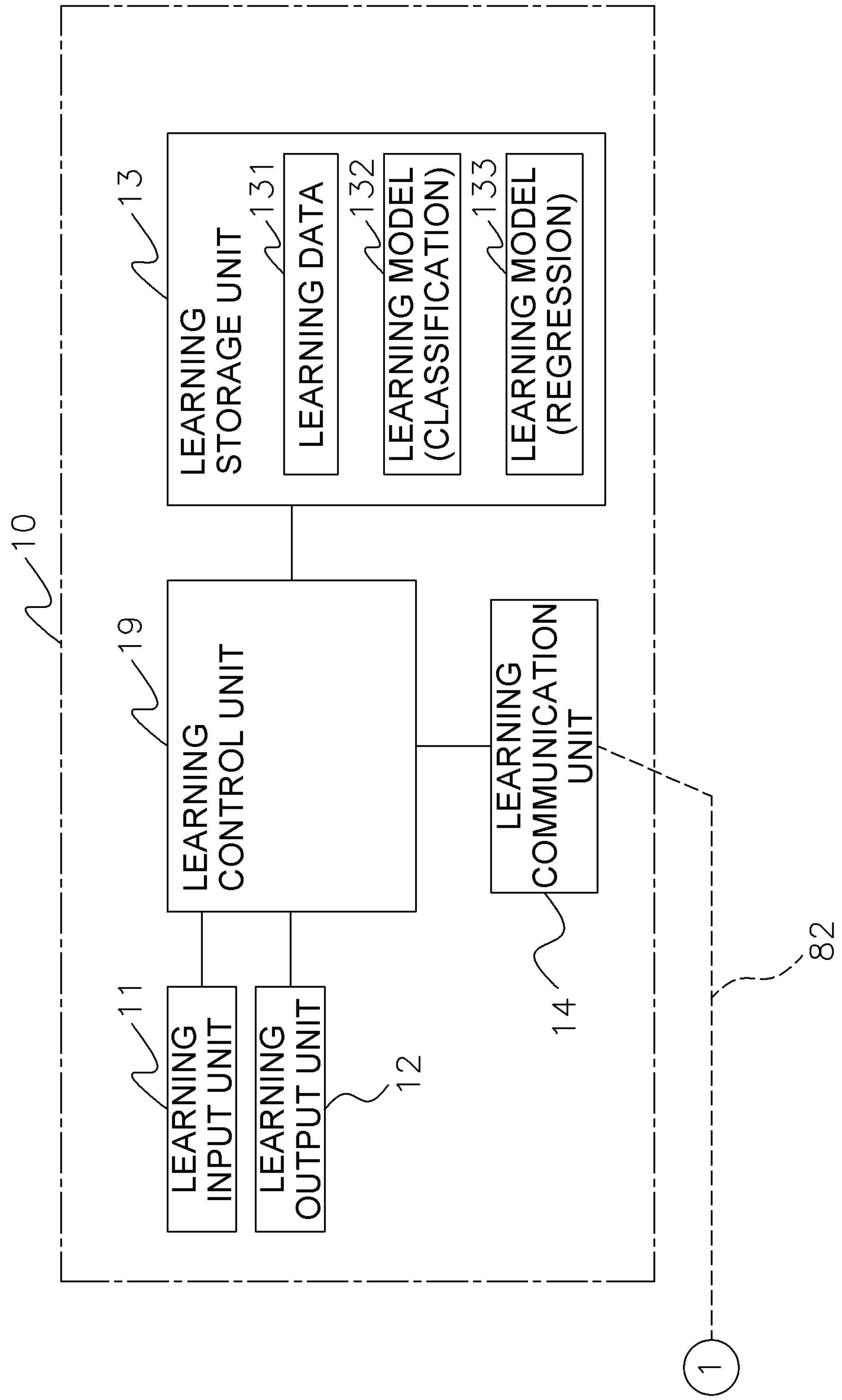

10
LEARNING STORAGE UNIT
13
LEARNING DATA
131
LEARNING MODEL (CLASSIFICATION)
132
LEARNING MODEL (REGRESSION)
133
LEARNING CONTROL UNIT
19
LEARNING COMMUNICATION UNIT
14
82
LEARNING INPUT UNIT
11
LEARNING OUTPUT UNIT
12
1

FIG. 4

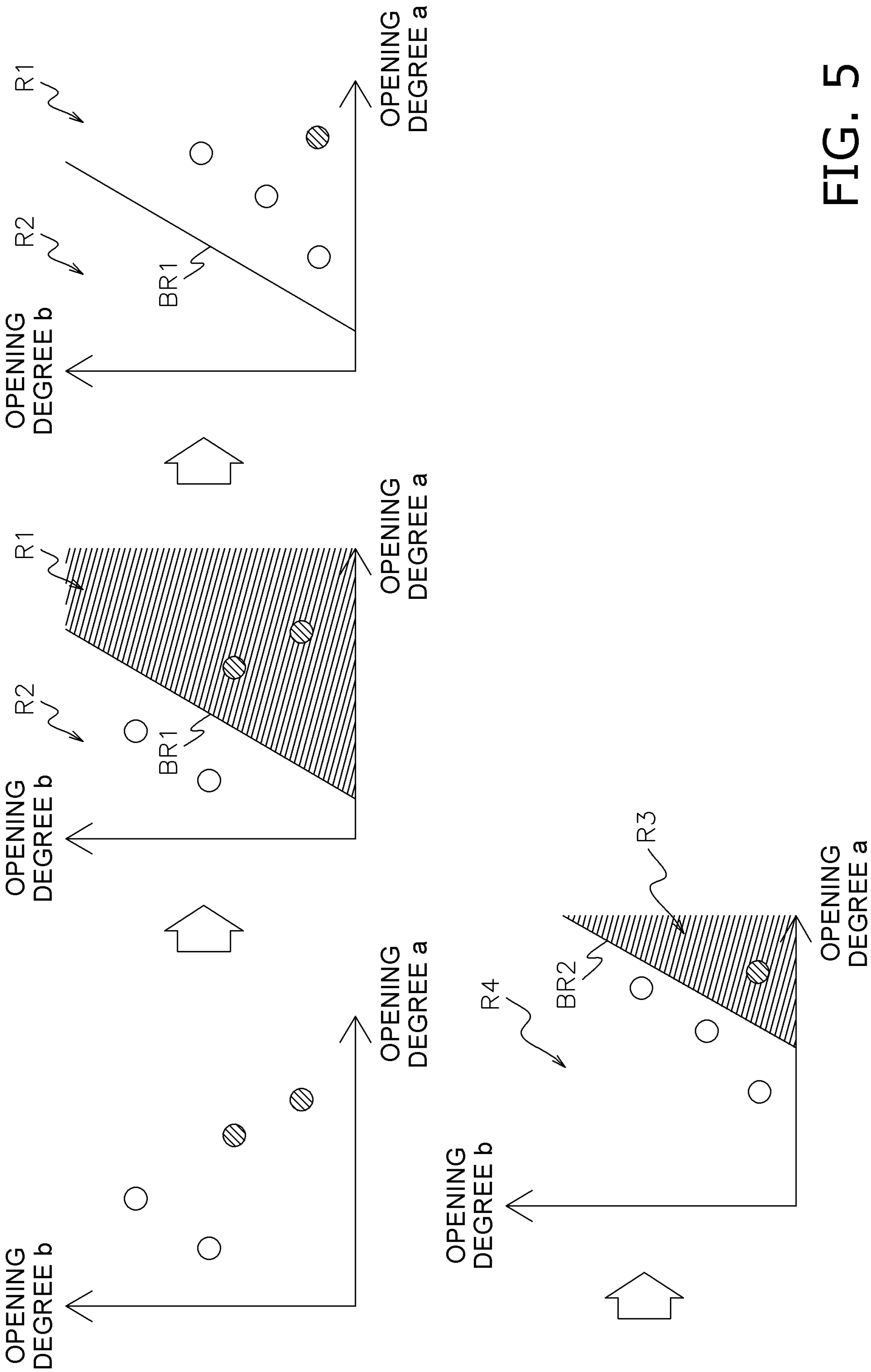


FIG. 5

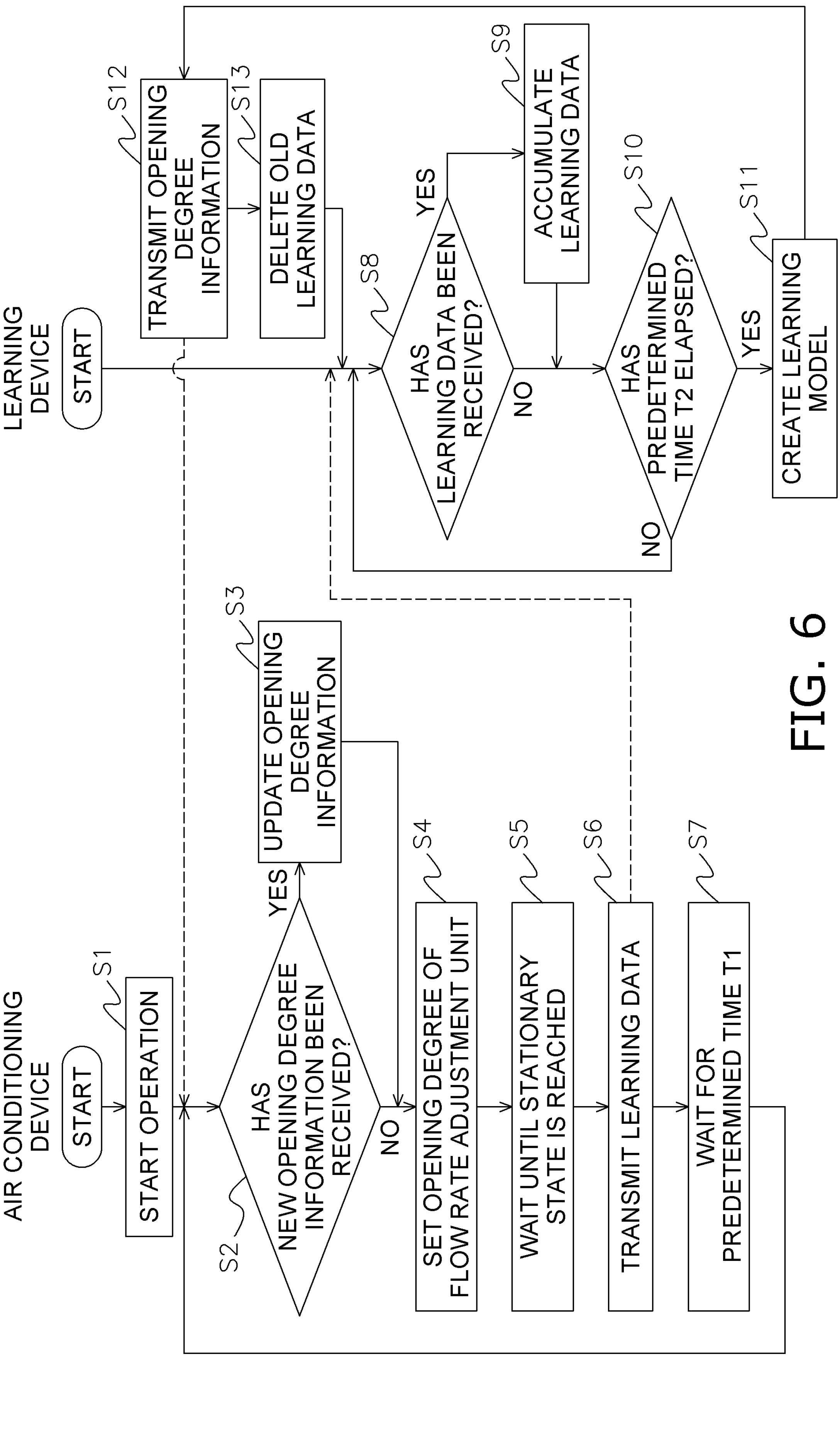

AIR CONDITIONING DEVICE
START
S1
START OPERATION
S2
HAS NEW OPENING DEGREE INFORMATION BEEN RECEIVED?
YES
NO
S3
UPDATE OPENING DEGREE INFORMATION
S4
SET OPENING DEGREE OF FLOW RATE ADJUSTMENT UNIT
S5
WAIT UNTIL STATIONARY STATE IS REACHED
S6
TRANSMIT LEARNING DATA
S7
WAIT FOR PREDETERMINED TIME T1
LEARNING DEVICE
START
S12
TRANSMIT OPENING DEGREE INFORMATION
S13
DELETE OLD LEARNING DATA
S8
HAS LEARNING DATA BEEN RECEIVED?
YES
NO
S9
ACCUMULATE LEARNING DATA
S10
HAS PREDETERMINED TIME T2 ELAPSED?
YES
NO
S11
CREATE LEARNING MODEL

FIG. 6

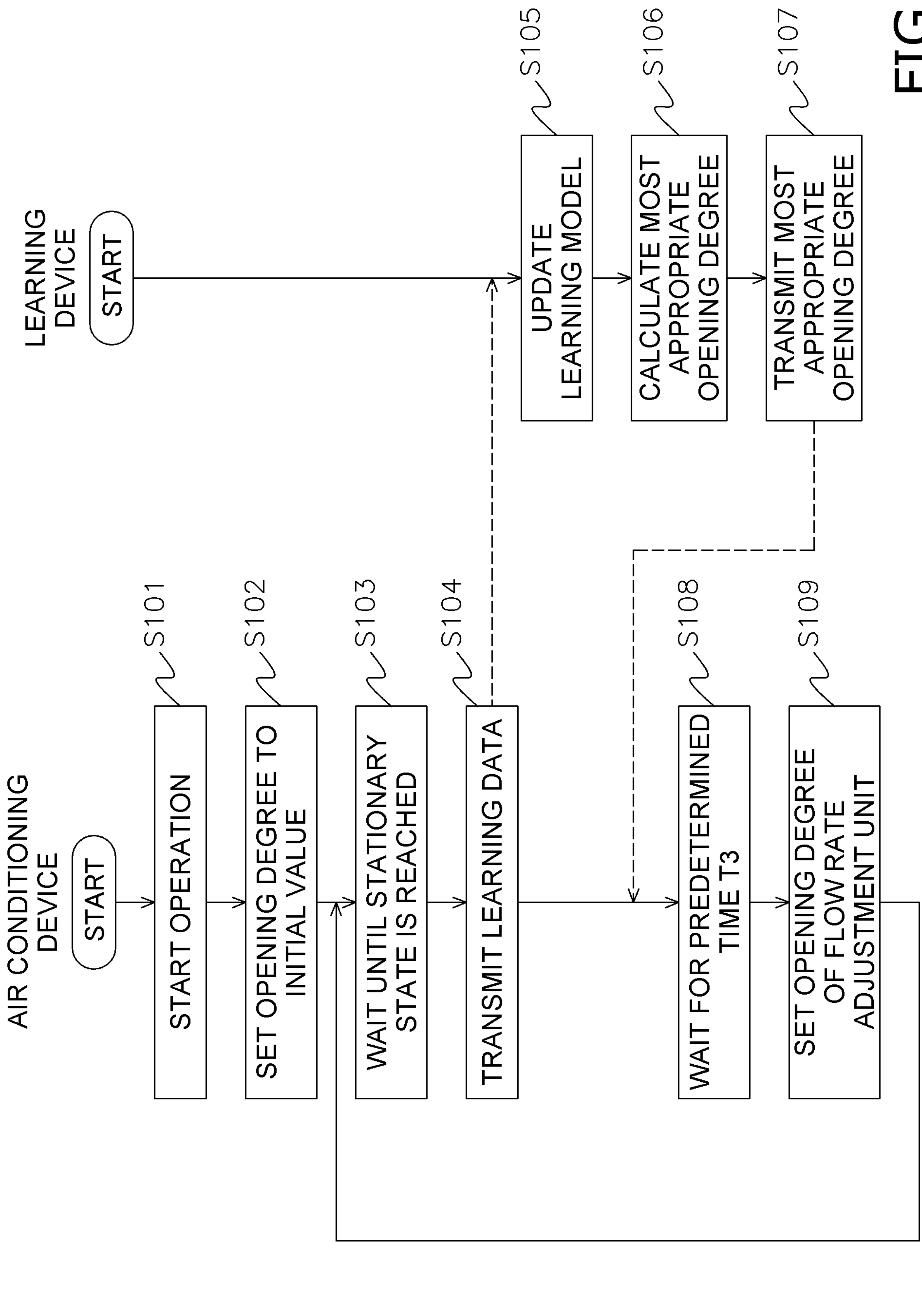
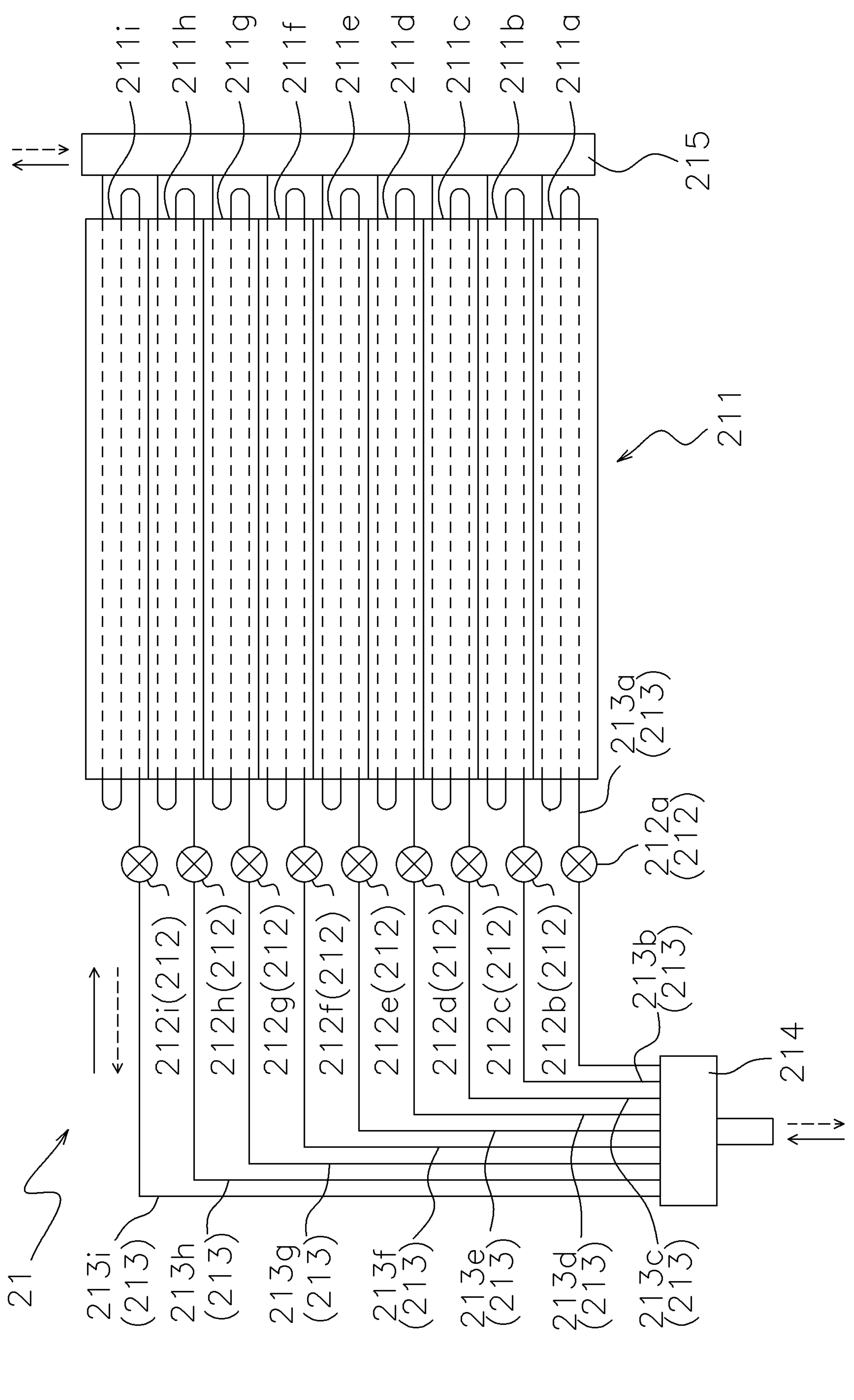

AIR CONDITIONING DEVICE
START
START OPERATION
S101
SET OPENING DEGREE TO INITIAL VALUE
S102
WAIT UNTIL STATIONARY STATE IS REACHED
S103
TRANSMIT LEARNING DATA
S104
WAIT FOR PREDETERMINED TIME T3
S108
SET OPENING DEGREE OF FLOW RATE ADJUSTMENT UNIT
S109
LEARNING DEVICE
START
UPDATE LEARNING MODEL
S105
CALCULATE MOST APPROPRIATE OPENING DEGREE
S106
TRANSMIT MOST APPROPRIATE OPENING DEGREE
S107

FIG. 7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213b (213)
214
21
213i (213)
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213g (213)
213f (213)
213e (213)
213d (213)
213c (213)

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/029573

A. CLASSIFICATION OF SUBJECT MATTER

F25B 5/02(2006.01)i; ***F25B 6/02***(2006.01)i; ***F25B 1/00***(2006.01)i; ***F24F 11/62***(2018.01)i; ***F24F 11/86***(2018.01)i
FI: F25B5/02 B; F24F11/86; F24F11/62; F25B1/00 304T; F25B6/02 Z

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)

F25B5/02; F25B6/02; F25B1/00; F24F11/62; F24F11/86

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 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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	JP 2008-128628 A (HITACHI APPLIANCES INC.) 05 June 2008 (2008-06-05) paragraphs [0022]-[0043]	1-9
Y	JP 2016-44826 A (HITACHI APPLIANCES INC.) 04 April 2016 (2016-04-04) paragraphs [0013], [0014]	1-9
Y	WO 2014/103407 A1 (MITSUBISHI ELECTRIC CORP.) 03 July 2014 (2014-07-03) paragraphs [0077]-[0080]	1-9
Y	WO 2017/068909 A1 (MITSUBISHI ELECTRIC CORP.) 27 April 2017 (2017-04-27) claim 7	3-9
Y	JP 2010-164219 A (MITSUBISHI ELECTRIC CORP.) 29 July 2010 (2010-07-29) paragraph [0002]	5-9
Y	US 2020/0292200 A1 (CARRIER CORP.) 17 September 2020 (2020-09-17) paragraphs [0003]-[0044]	8-9

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

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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
18 August 2022	**27 September 2022**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/029573

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2008-128628 A	05 June 2008	(Family: none)	
JP 2016-44826 A	04 April 2016	(Family: none)	
WO 2014/103407 A1	03 July 2014	(Family: none)	
WO 2017/068909 A1	27 April 2017	US 2019/0049154 A1 claim 7	
JP 2010-164219 A	29 July 2010	(Family: none)	
US 2020/0292200 A1	17 September 2020	(Family: none)	

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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