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(71) Applicant: **Daikin Industries, Ltd.**

**Osaka-shi, Osaka 530-8323 (JP)**

(72) Inventors:

- **TAKENAKA, Kei**  
**Osaka-shi, Osaka 530-8323 (JP)**

• **NUNO, Hayato**

**Osaka-shi, Osaka 530-8323 (JP)**

• **ITOU, Hiroshi**

**Osaka-shi, Osaka 530-8323 (JP)**

• **TSUTSUMI, Tomohiko**

**Osaka-shi, Osaka 530-8323 (JP)**

• **UGAI, Kouji**

**Osaka-shi, Osaka 530-8323 (JP)**

(74) Representative: **Hoffmann Eitle**

**Patent- und Rechtsanwälte PartmbB**

**Arabellastraße 30**

**81925 München (DE)**

(54) **AIR CONDITIONING SYSTEM**

(57) Some known air conditioning systems occasionally make a user discomfort due to abnormal noise resulting from a collision of dew water with outside air in an air supply pipe when condensation occurs in the air supply pipe in an air-supplying operation. An air conditioning system (100) includes an air supply fan (54), an air supply pipe (35), a heater (52), and a control unit (16). The control unit (16) controls the air supply fan (54) and the heater (52). The control unit (16) switches an air-sup-

plying operation to a first air-supplying operation and a second air-supplying operation. The first air-supplying operation involves heating outside air with the heater (52) and supplying the heated outside air into a room, in accordance with a concentration of a predetermined gas in the room. The second air-supplying operation involves supplying outside air into the room without heating the outside air, in accordance with the concentration of the predetermined gas in the room.

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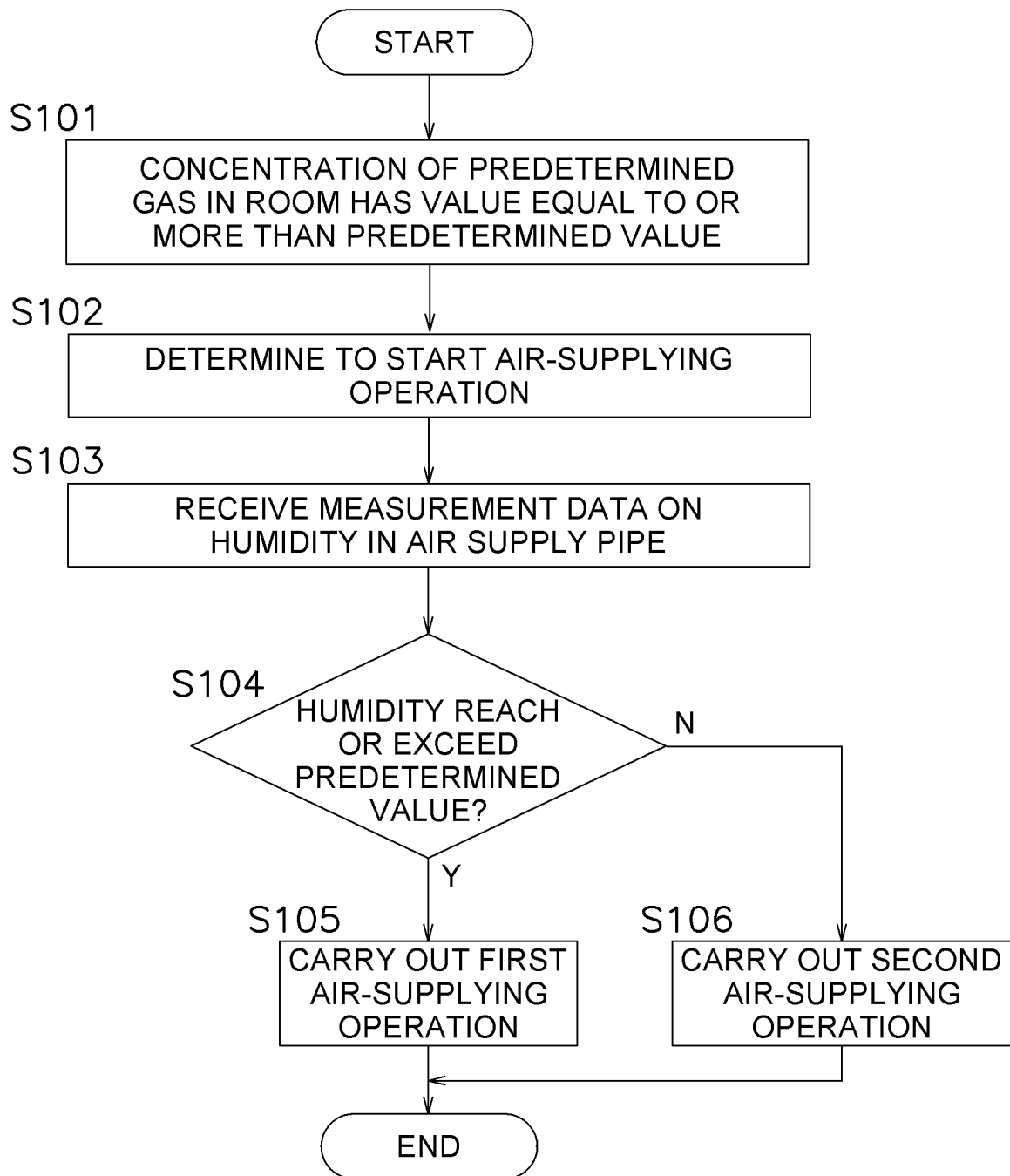


FIG. 6

## Description

### TECHNICAL FIELD

**[0001]** Embodiments disclosed herein relate to an air conditioning system configured to carry out an air-supplying operation, based on a concentration of a predetermined gas in a room.

### BACKGROUND ART

**[0002]** Some known air conditioners are configured to carry out a humidifying operation and a ventilating operation of introducing, into a room, outside air that is not humidified, but heated. Patent Literature 1 (JP 2010-043848 A) discloses that a ventilating operation of introducing, into a room, outside air that is not humidified, but heated enables a reduction in harmful substances such as pollen in the air.

### SUMMARY OF THE INVENTION

<Technical Problem>

**[0003]** Patent Literature 1 discloses a heated ventilating operation mode of supplying heated outside air into a room and an unheated ventilating operation mode of supplying unheated outside air into the room. However, Patent Literature 1 has no disclosure about how to carry out a ventilating operation in accordance with a measurement value of a concentration of a predetermined gas in the room.

<Solution to Problem>

**[0004]** A first aspect is directed to an air conditioning system including an air supply fan, an air supply pipe, a heater, and a control unit. The air supply fan is configured to supply outside air into a room. The air supply pipe serves as a path for conveying outside air to the room. The heater is configured to heat outside air before being introduced into the air supply pipe or outside air in the air supply pipe on an upstream side of the air supply pipe. The control unit is configured to control the air supply fan and the heater. The control unit is configured to change alternatively from a first air-supplying operation to a second air-supplying operation. The first air-supplying operation involves heating outside air with the heater and supplying the heated outside air into the room, in accordance with a concentration of a predetermined gas in the room. The second air-supplying operation involves supplying outside air into the room without heating the outside air, in accordance with the concentration of the predetermined gas in the room.

**[0005]** In the air conditioning system according to the first aspect, the control unit carries out the first air-supplying operation of heating outside air with the heater if necessary, thereby drying the inside of the air supply

pipe. There is a possibility that, if dew water is retained in the air supply pipe, humidified air passes through the air supply pipe while making noise (bubbling sound) unless the inside of the air supply pipe is dried. Drying the inside of the air supply pipe enables a reduction in noise to be made when air passes through the air supply pipe.

**[0006]** A second aspect is directed to the air conditioning system according to the first aspect, in which the control unit determines whether to carry out the first air-supplying operation or the second air-supplying operation upon establishment of an air-supplying operation condition concerning the concentration of the predetermined gas, in a state in which the air-supplying operation stops.

**[0007]** A third aspect is directed to the air conditioning system according to the first or second aspect, in which a number of rotations of the air supply fan during the first air-supplying operation is in a range from 80% or more to 120% or less relative to a number of rotations of the air supply fan during the second air-supplying operation.

**[0008]** A fourth aspect is directed to the air conditioning system according to any of the first to third aspects, in which the control unit changes a number of rotations of the air supply fan during the first air-supplying operation or the second air-supplying operation, by automatic control or in accordance with a user setting. In a case of the automatic control, the control unit increases the number of rotations of the air supply fan as the concentration of the predetermined gas increases.

**[0009]** In the air conditioning system according to the fourth aspect, in the case of the automatic control, the control unit increases the number of rotations of the air supply fan as the concentration of the predetermined gas increases. In the case where the concentration of the predetermined gas is high, the control unit quickly reduces the concentration of the predetermined gas.

**[0010]** A fifth aspect is directed to the air conditioning system according to any of the first to fourth aspects, further including a humidity sensor. The humidity sensor is configured to measure a humidity of outside air before being introduced into the air supply pipe, a humidity of outside air in the air supply pipe, or a humidity of outside air led out of the air supply pipe. The control unit selects the first air-supplying operation on condition that the humidity measured by the humidity sensor has a value equal to or more than a predetermined humidity value, and selects the second air-supplying operation on condition that the humidity measured by the humidity sensor has a value less than the predetermined humidity value.

**[0011]** In the air conditioning system according to the fifth aspect, the control unit selects the air-supplying operation in accordance with the measurement value of the humidity sensor. The control unit therefore accurately determines where to carry out the air-supplying operation.

**[0012]** A sixth aspect is directed to the air conditioning system according to the fifth aspect, in which the control unit increases a number of rotations of the air supply fan on condition that the humidity measured by the humidity sensor is high, in the first air-supplying operation.

**[0013]** In the air conditioning system according to the sixth aspect, the control unit increases the number of rotations of the air supply fan when the humidity in the air supply pipe is high. Therefore, the inside of the air supply pipe is dried quickly when the humidity in the air supply pipe is high.

**[0014]** A seventh aspect is directed to the air conditioning system according to any of the first to sixth aspects, further including an outdoor unit. The outdoor unit is installed outside the room and is connected to the air supply pipe. The outdoor unit includes a humidifying unit configured to humidify outside air and supply the humidified outside air into the room. The humidifying unit includes the air supply fan and the heater for use in an air-supplying operation.

**[0015]** In the air conditioning system according to the seventh aspect, the humidifying unit is used in both the humidifying operation and the air-supplying operation. This configuration therefore eliminates a necessity of double facilities.

**[0016]** An eighth aspect is directed to the air conditioning system according to any of the first to seventh aspects, further including a gas sensor configured to measure the concentration of the predetermined gas in the room.

**[0017]** A ninth aspect is directed to the air conditioning system according to the eighth aspect, further including an indoor unit. The indoor unit is installed in the room, is connected to the air supply pipe, and is configured to supply, into the room, outside air flowing thereinto through the air supply pipe.

**[0018]** A tenth aspect is directed to the air conditioning system according to the ninth aspect, in which the gas sensor is disposed in the indoor unit.

**[0019]** An eleventh aspect is directed to the air conditioning system according to the ninth aspect, in which the gas sensor is installed separately from the indoor unit in the room.

**[0020]** A twelfth aspect is directed to the air conditioning system according to the eleventh aspect, in which the gas sensor and the control unit are connected via an external network.

**[0021]** A thirteenth aspect is directed to the air conditioning system according to any of the ninth to twelfth aspects, in which the indoor unit includes an indoor heat exchanger.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0022]**

FIG. 1 is an external view of an air conditioner 1 according to a first embodiment.

FIG. 2 is a diagram of a refrigerant circuit 2 and an air supply path 3 in the air conditioner 1 (of an air conditioning system 100) according to the first embodiment.

FIG. 3A is a front view of an indoor unit 10 according

to the first embodiment.

FIG. 3B is a side view of the indoor unit 10 according to the first embodiment.

FIG. 3C is a side view of the indoor unit 10 according to the first embodiment seen from slightly below.

FIG. 4 is a diagram of an air supply pipe 19 in a casing 11 according to the first embodiment.

FIG. 5 is a block diagram of a control configuration according to the first embodiment.

FIG. 6 is a flowchart of a method for controlling a humidifying operation according to the first embodiment.

FIG. 7 is a schematic diagram of an air conditioning system 100a according to Modification 1A.

FIG. 8 is a schematic diagram of an air conditioning system 100b according to Modification 1B.

FIG. 9 is a schematic diagram of an air conditioning system 100c according to Modification 1C.

FIG. 10 is a diagram of a refrigerant circuit 2 and an air supply path 3 in an air conditioner 1d (of an air conditioning system 100d) according to Modification 1D.

FIG. 11 is a diagram of a refrigerant circuit 2 and an air supply path 3 in an air conditioner 1f (of an air conditioning system 100f) according to Modification 1F.

FIG. 12 is a diagram of a refrigerant circuit 2 and an air supply path 3 in an air conditioner 1g (of an air conditioning system 100g) according to Modification 1G.

## DESCRIPTION OF EMBODIMENTS

<First Embodiment>

(1) General Configuration of Air Conditioning System 100

**[0023]** An air conditioning system 100 according to a first embodiment includes an air conditioner 1, a control unit 16, and a gas sensor 15. The air conditioner 1 includes an indoor unit 10, an outdoor unit 20, a refrigerant pipe 2a, a refrigerant pipe 2b, and an air supply pipe 35. The refrigerant pipes 2a and 2b connect the indoor unit 10 and the outdoor unit 20. FIG. 1 illustrates an external appearance of the air conditioner 1. FIG. 2 illustrates a refrigerant circuit 2 and an air supply path 3 in the air conditioner 1.

**[0024]** As illustrated in FIGS. 1, 2, and 3A to 3C, the indoor unit 10 includes an indoor heat exchanger 14, an indoor expansion valve 17, and an indoor fan 12. The indoor unit 10 is installed in a room.

**[0025]** The outdoor unit 20 includes an outdoor refrigerant circuit unit 6 and a humidifying unit 5. The outdoor unit 20 is installed outside the room. Typically, the outdoor unit 20 is installed outdoors.

**[0026]** The outdoor refrigerant circuit unit 6 includes a compressor 21, an accumulator 22, a four-way switching valve 23, an outdoor heat exchanger 24, an outdoor ex-

pansion valve 25, pipes connecting these components to one another, and an outdoor heat exchanger fan 26.

**[0027]** The air conditioner 1 according to the first embodiment is capable of carrying out an air conditioning operation involving, for example, air cooling, air heating, dehumidification, humidification, and air supply for the room where the indoor unit 10 is installed.

**[0028]** The air conditioner 1 according to the first embodiment carries out a cooling operation and a heating operation, using the refrigerant circuit 2. The air conditioner 1 switches to the cooling operation and the heating operation in such a manner that the four-way switching valve 23 changes a refrigerant flowing direction.

**[0029]** During the cooling operation, when the refrigerant is discharged from the compressor 21, then the refrigerant flows through the four-way switching valve 23, the outdoor heat exchanger 24, the outdoor expansion valve 25, the indoor heat exchanger 14, the four-way switching valve 23, and the accumulator 22 in this order. Thereafter, the refrigerant is sucked into the compressor 21 again. During the cooling operation, the outdoor heat exchanger 24 functions as a radiator to heat outside air, while the indoor heat exchanger 14 functions as an evaporator to cool indoor air.

**[0030]** During the heating operation, when the refrigerant is discharged from the compressor 21, then the refrigerant flows through the four-way switching valve 23, the indoor heat exchanger 14, the outdoor expansion valve 25, the outdoor heat exchanger 24, the four-way switching valve 23, and the accumulator 22 in this order. Thereafter, the refrigerant is sucked into the compressor 21 again. During the heating operation, the indoor heat exchanger 14 functions as a radiator to heat indoor air, while the outdoor heat exchanger 24 functions as an evaporator to cool outside air.

**[0031]** The air conditioner 1 carries out the air-supplying operation, using the air supply path 3. The air supply path 3 includes an air supply path 58 and an air supply fan 54 of the outdoor unit 20, the air supply pipe 35, and an air supply pipe 19 of the indoor unit 10. The air supply fan 54 rotates to provide outside air into the outdoor unit 20 through an air intake port 7c for air supply in the humidifying unit 5 of the outdoor unit 20. When the outside air is taken into the outdoor unit 20, then the outside air passes through the air supply path 58 and the air supply fan 54 in the outdoor unit 20. The outside air also passes through the air supply pipe 35 via which the outdoor unit 20 communicates with the indoor unit 10. The outside air passes through the air supply pipe 19 of the indoor unit 10. Thereafter, the outside air is blown out into the casing 11 through a blow-out port 19a of the air supply pipe 19, and then is supplied into the room from the casing 11.

## (2) Specific Configuration of Air Conditioning System 100

### (2-1) Indoor unit 10

**[0032]** FIG. 3A is a front view of the indoor unit 10 from

which a front panel 42 is removed. FIG. 3B is a left side view of the indoor unit 10. FIG. 3C is a left side view of the indoor unit 10 seen slightly from below. The indoor unit 10 includes the casing 11, the indoor fan 12, the gas sensor 15, the control unit 16, the indoor heat exchanger 14, a flap 18, and the indoor air supply pipe 19.

#### (2-1-1) Casing 11

**[0033]** In the indoor unit 10 according to the first embodiment, the casing 11 accommodates therein the indoor fan 12, the gas sensor 15, the first control unit 16a, the indoor heat exchanger 14, and the indoor air supply pipe 19. The flap 18 is mounted to a lower side of the casing 11.

**[0034]** The casing 11 has a rear surface hung on a wall of the room. The refrigerant pipe 2a, the refrigerant pipe 2b, the air supply pipe 35, and the like are connected to the indoor unit 10 through the rear surface of the casing 11. The refrigerant pipe 2a, the refrigerant pipe 2b, the air supply pipe 35, and the like are also connected through the wall to the outdoor unit 20 installed outside the room.

**[0035]** The casing 11 has an upper surface in which an intake port 41 for indoor air is bored.

#### (2-1-2) Indoor fan 12

**[0036]** As illustrated in FIG. 3B, the indoor fan 12 is located at the center in the casing 11. The indoor fan 12 is a cross-flow fan. In FIG. 3B, the indoor fan 12 rotates clockwise to generate a clockwise airflow.

**[0037]** Indoor air is taken into the casing 11 through the intake port 41 in the upper surface of the casing 11. The indoor air then passes through the indoor heat exchanger 14. Thereafter, the indoor air is blown out into the room through an opening, where flaps 18a and 18b are mounted, in the casing 11. The indoor fan 12 rotates to blow out air for stirring indoor air.

#### (2-1-3) Indoor heat exchanger 14

**[0038]** As illustrated in FIG. 3B, the indoor heat exchanger 14 is disposed in a space outside the indoor fan 12 in the casing 11. Indoor air is taken into the casing 11 through the intake port 41 in the upper surface of the casing 11. The indoor air then passes through the indoor heat exchanger 14 where the indoor air is subjected to heat exchange. Thereafter, the indoor air is blown out into the room through the opening, where the flaps 18a and 18b are mounted, in the casing 11. The air passing through the indoor heat exchanger 14 is heated or cooled to heat or cool the room.

#### (2-1-4) Flap 18

**[0039]** The flap 18 is mounted to the lower side of the casing 11. The flap 18 according to the first embodiment

includes the two flaps 18a and 18b. As illustrated in FIG. 3C, the flap 18 is normally closed during a stop of the air conditioner 1. During the operation of the air conditioner 1, as illustrated in FIG. 1, the flaps 18a and 18b are open. Air is thus blown out through, for example, a clearance between the flap 18a and the flap 18b, a clearance between the casing 11 and the flap 18a, and the like. Each of the flaps 18a and 18b has a changeable opening angle for changing an angle of air to be blown out.

(2-1-5) Air supply path and air supply pipe 19 for outside air in indoor unit 10

**[0040]** The air supply path in the indoor unit 10 is defined such that air flows through the air supply pipe 19 and, after flowing out of the air supply pipe 19 through the blow-out port 19a, flows from the inside of the casing 11 toward the room.

**[0041]** The air supply pipe 19 has a shape illustrated in FIG. 4. The air supply pipe 19 has a first end serving as a connection port 19b. The connection port 19b is connected to the air supply pipe 35 connecting the outdoor unit 20 and the indoor unit 10. The air supply pipe 19 has a second end serving as the blow-out port 19a. The blow-out port 19a is located on the left side of the indoor unit 10 and is located opposite the indoor heat exchanger 14. The air supply pipe 19 has a flat central portion between the connection port 19b and the blow-out port 19a. The central portion is located near the left side face of the indoor unit 10.

**[0042]** Outside air is taken into the outdoor unit 20 and then is supplied into the indoor unit 10 through the air supply pipe 35. In the indoor unit 10, air flows through the air supply pipe 19 and then is blown out through the blow-out port 19a toward the indoor heat exchanger 14.

**[0043]** In the air-supplying operation, the air supply fan 54 of the outdoor unit 20 rotates. The air supply fan 54 may be disposed at any position on the air supply path 3. For example, the air supply fan 54 may be disposed in the indoor unit 10.

(2-2) Outdoor unit 20

**[0044]** As described in "(1) General Configuration of Air Conditioning System 100" above, the outdoor unit 20 includes the humidifying unit 5 and the outdoor refrigerant circuit unit 6. The outdoor refrigerant circuit unit 6 has already been described in "(1) General Configuration of Air Conditioning System 100" above; therefore, the description thereof will not be given below. In the following, the humidifying unit 5 is mainly described.

(2-2-1) Humidifying unit 5

**[0045]** The air conditioner 1 according to the first embodiment is capable of carrying out the humidifying operation or the air-supplying operation, using the humidifying unit 5.

**[0046]** The humidifying unit 5 includes the air supply path 58 in the humidifying unit 5 and an air path 57 for water adsorption. The air supply path 58 in the humidifying unit 5 constitutes a part of the entire air supply path 3.

**[0047]** The humidifying unit 5 includes a humidifying rotor 51, a heater 52, the air supply fan 54, and an adsorption fan 59.

**[0048]** Air flows on the air path 57 for water adsorption as follows. Air outside the casing of the outdoor unit 20 is taken into the outdoor unit 20 through an air intake port 7a for adsorption in the casing by the rotation of the adsorption fan 59. The air then passes the humidifying rotor 51 and the adsorption fan 59. Thereafter, the air is discharged from the outdoor unit 20 through an air exhaust port 7b for adsorption in the casing.

**[0049]** The humidifying rotor 51 is a ceramic rotor of a honeycomb structure and has an outer shape in a substantially disk form. The humidifying rotor 51 is rotatable and is driven to rotate by a rotor drive motor. The humidifying rotor 51 has a main portion obtained by firing an adsorbent such as zeolite. An adsorbent such as zeolite has a property of adsorbing water in the air when coming into contact with the air and desorbing the water when being heated. In the first embodiment, the adsorbent is zeolite. The adsorbent may alternatively be, for example, silica gel or alumina.

**[0050]** On the air path 57 for water adsorption, when outside air passes the humidifying rotor 51, the humidifying rotor 51 adsorbs water from the outside air.

**[0051]** On the other hand, air flows on the air supply path 58 in the humidifying unit 5 as follows. Air outside the casing of the outdoor unit 20 is taken into the outdoor unit 20 through the air intake port 7c for air supply in the casing by the rotation of the air supply fan 54. The air then passes the humidifying rotor 51, the heater 52, the humidifying rotor 51, and the air supply fan 54. Thereafter, the air reaches the air supply pipe 35 connecting the outdoor unit 20 and the indoor unit 10.

**[0052]** The heater 52 is disposed above the humidifying rotor 51 and is disposed opposite the humidifying rotor 51. The heater 52 heats air to be sent to the humidifying rotor 51. The humidifying rotor 51 is thus heated.

**[0053]** The humidifying operation to be carried out by the air conditioner 1 according to the first embodiment is summarized as follows. On the air path 57 for water adsorption, the humidifying rotor 51 adsorbs water from outside air. The humidifying rotor 51, which has adsorbed water, rotates such that the water-adsorbed portion moves toward the air supply path 58. On the air supply path 58, air for humidification is heated by the heater 52. The air thus contains the water which the humidifying rotor 51 has adsorbed. The resultant air is then supplied into the indoor unit 10 via the air supply path 58.

**[0054]** Without the use of the water adsorption and desorption function of the humidifying rotor 51, the humidifying unit is simply used for the air-supplying operation with ease. For a change from the humidifying operation

to the air-supplying operation, for example, the adsorption fan 59 stops, the humidifying rotor 51 hardly rotates, or the heater 52 does not heat air. By such a method, air is not humidified in the air-supplying operation.

#### (2-3) Air supply pipe 35

**[0055]** The air supply pipe 35 connects the indoor unit 10 and the outdoor unit 20 (specifically, the humidifying unit 5). The air supply pipe 35 constitutes a part of the air supply path 3 for supplying outside air into the room.

#### (2-4) Humidity sensor 36

**[0056]** The humidity sensor 36 is configured to measure a humidity of air passing through the air supply pipe 35. The humidity sensor 36 is disposed on the air supply path 3. In the first embodiment, the humidity sensor 36 is disposed near the blow-out port 19a of the air supply pipe 19 in the indoor unit 10. The humidity sensor 36 may be disposed at any position as long as it is capable of measuring a humidity of outside air before being introduced into the air supply pipe 35, a humidity of outside air in the air supply pipe 35, or a humidity of outside air led out of the air supply pipe 35. In any case, the humidity sensor 36 may be disposed at any position as long as it is capable of measuring a humidity of air passing through the air supply pipe 35.

#### (2-5) Gas sensor 15

**[0057]** The gas sensor 15 is disposed in the indoor unit 10 of the air conditioner 1. The indoor unit 10 includes the gas sensor 15. The gas sensor 15 is a carbon dioxide (CO<sub>2</sub>) gas sensor. The air conditioner 1 according to the first embodiment includes the CO<sub>2</sub> gas sensor 15. During the cooling operation or heating operation without air exchange in the room, the CO<sub>2</sub> gas sensor 15 measures a concentration of CO<sub>2</sub> gas in the room. When the concentration of the CO<sub>2</sub> gas is high, outside air is taken into the room, using the air supply path 3. The air conditioner 1 according to the first embodiment thus reduces the concentration of the CO<sub>2</sub> gas in the room.

**[0058]** The gas sensor 15 is an optical gas sensor. The gas sensor 15 includes a light emitter and a light receiver. The light emitter includes a light source configured to emit infrared light. The light receiver includes a detector and a filter. The principle of the gas sensor is a non-dispersive infrared absorption method (NDIR). The volume of gas is determined based on the principle that resonance of molecular energy by interatomic vibration causes absorption of light in a frequency (wavelength) specific to gas molecules. The gas sensor may alternatively be of a hot thermistor type.

**[0059]** As illustrated in FIG. 3A, the gas sensor 15 is disposed in the casing 11. The gas sensor 15 is located near a front surface of the casing 11 on an upper right end side of the casing 11. The gas sensor 15 may be

disposed at any position as long as it is capable of measuring a concentration of gas in indoor air.

**[0060]** The gas sensor 15 measures a concentration of gas in a place where the gas sensor 15 is disposed. In the first embodiment, the gas sensor 15 is disposed in the casing 11 of the indoor unit 10 of the air conditioner 1. Therefore, the gas sensor 15 measures a concentration of gas in indoor air within a heightwise range between 1.5 m or more and 2 m or less from a floor.

#### (2-6) Control unit 16

**[0061]** The control unit 16 includes the first control unit 16a and a second control unit 16b. The first control unit 16a is disposed in the indoor unit 10. The second control unit 16b is disposed in the outdoor unit 20. The first control unit 16a and the second control unit 16b cooperate to serve as the control unit 16 for controlling the respective components of the air conditioner 1. Each of the first control unit 16a and the second control unit 16b is practicable using a computer. Each of the first control unit 16a and the second control unit 16b includes a central processing unit (CPU) and a storage unit. FIG. 5 is a block diagram of a schematic control configuration of the control unit 16. The control unit 16 controls the heating operation, the cooling operation, the humidifying operation, and the air-supplying operation to be carried out by the air conditioner 1. The control unit 16 controls the indoor fan 12, the four-way switching valve 23, the compressor 21, the outdoor heat exchanger fan 26, the outdoor expansion valve 25, the humidity sensor 36, the air supply fan 54, the humidifying rotor 51, the heater 52, the adsorption fan 59, the indoor expansion valve 17, and the gas sensor 15.

**[0062]** The first control unit 16a is located on a right end side in the casing 11. However, the control unit 16a may be located at any position.

#### (3) Methods for Controlling Humidifying Operation and Air-supplying Operation

##### (3-1) Method for controlling humidifying operation

**[0063]** In the first embodiment, the humidifying operation is carried out in accordance with a user's instruction. More specifically, the user issues an instruction as follows, for example. The user presses a humidifying operation start button on a remote controller. The remote controller sends the user's instruction to the indoor unit 10 by infrared communication. Upon reception of the user's instruction, the control unit 16 controls the respective components such as the humidifying rotor 51. The air conditioner 1 may automatically carry out the humidifying operation in accordance with the humidity in the room.

**[0064]** In the humidifying operation, as described in "(2-2-1) Humidifying unit 5" above, first, the humidifying rotor 51 adsorbs water from outside air by the rotation of the adsorption fan 59. Next, the outside air (air) is taken

into the outdoor unit 20 by the rotation of the air supply fan 54. The air is heated by the heater 52. The heated air contains the water which the humidifying rotor 51 has adsorbed. The resultant air reaches the indoor unit 10 through the air supply pipe 35. The air is thus supplied into the room.

### (3-2) Method for controlling air-supplying operation

#### (3-2-1) Problem of air-supplying operation

**[0065]** In the air-supplying operation, outside air is taken into the outdoor unit 20 through the air intake port 7c for air supply by the rotation of the air supply fan 54 of the humidifying unit 5. The air then reaches the indoor unit 10 via the air supply path 3. The air is thus supplied into the room.

**[0066]** The air-supplying operation has the following problem. When condensation occurs in the air supply pipe 35 connecting the indoor unit 10 and the outdoor unit 20, abnormal noise resulting from a collision of dew water with air flowing at a relatively high flow rate in the air supply pipe (the air flow rate increases since the air supply pipe has a relatively small inner diameter) makes a user discomfort during the use of the air conditioner 1 in the room.

**[0067]** In order to address the problem of the air-supplying operation, the air conditioner 1 carries out a drying operation if necessary. The drying operation is an air-supplying operation for drying the inside of the air supply pipe 35 to remove the dew water. During the drying operation, therefore, the heater 52 is driven to heat air. The heater 52 may be disposed at any position on the air supply path 58 in the humidifying unit 5 as long as it is capable of heating air passing through the air supply pipe 35.

#### (3-2-2) Air-supplying operation

**[0068]** With reference to a flowchart of FIG. 6, next, a description will be given of the air-supplying operation according to the first embodiment.

**[0069]** The control unit 16 according to the first embodiment continuously or intermittently monitors the concentration of the predetermined gas in the room. Specifically, the gas sensor 15 measures the concentration of the predetermined gas in the room and transmits a result of the measurement to the control unit 16 on a regular basis. When the concentration of the predetermined gas in the room exceeds the predetermined value (S101), the control unit 16 determines to carry out the air-supplying operation (S102).

**[0070]** In the first embodiment, the control unit 16 determines to carry out the air-supplying operation, in accordance with the concentration of the predetermined gas. The air-supplying operation may alternatively be carried out in accordance with a user's instruction.

**[0071]** The predetermined gas according to the first

embodiment is carbon dioxide (CO<sub>2</sub>) gas. The gas sensor 15 according to the first embodiment is a CO<sub>2</sub> gas sensor. The gas sensor 15 measures the concentration of the CO<sub>2</sub> gas and transmits a result of the measurement to the control unit 16. The control unit 16 starts the air-supplying operation when the acquired concentration of the CO<sub>2</sub> gas has a value equal to or more than the predetermined value. In Japan, a CO<sub>2</sub> gas concentration in the open air is about 410 ppm (as of 2018). For example, when the measured concentration of the CO<sub>2</sub> gas has a value equal to or more than the predetermined value set at 1000 ppm, the control unit 16 starts the air-supplying operation.

**[0072]** When the concentration of the predetermined gas in the room reaches or exceeds the predetermined value in step S101 and the control unit 16 determines to start the air-supplying operation, the processing proceeds to step S103. In step S103, the control unit 16 receives measurement data from the humidity sensor 36. The humidity sensor 36 may always (including "intermittently") measure the humidity. The humidity sensor 36 may measure the humidity in accordance with an instruction from the control unit 16. In any case, the control unit 16 receives the data on the humidity measured by the humidity sensor 36, in step S103.

**[0073]** In step S104, the control unit 16 determines whether the value of the humidity measured by the humidity sensor 36 exceeds a predetermined value. The predetermined value is, for example, 80% in a case of a relative humidity. When the humidity in the air supply pipe 35 has a value equal to or more than the predetermined value, the processing proceeds to step S105 in which the control unit 16 carries out the first air-supplying operation (the drying operation). In the first air-supplying operation, the air supply fan 54 rotates, and the heater 52 is driven. Air heated by the heater 52 is supplied into the air supply pipe 35 to dry the inside of the air supply pipe. In addition, the indoor unit 10 sends air into the room.

**[0074]** When the humidity in the air supply pipe 35 has a value less than the predetermined value, the processing proceeds to step S106 in which the control unit 16 carries out the second air-supplying operation. In the second air-supplying operation, the air supply fan 54 rotates, but the heater 52 is not driven. Air is supplied into the air supply pipe 35 without being heated. In other words, the second air-supplying operation is different from the drying operation.

**[0075]** A number of rotations of the air supply fan 54 during the first air-supplying operation may be equal to or different from the number of rotations of the air supply fan 54 during the second air-supplying operation. In the first embodiment, the number of rotations of the air supply fan 54 during the first air-supplying operation is in a range from 80% or more to 120% or less relative to the number of rotations of the air supply fan 54 during the second air-supplying operation.

**[0076]** The control unit 16 may change the number of

rotations of the air supply fan 54 during the first air-supplying operation or the second air-supplying operation, by automatic control or in accordance with a user setting. In a case of the automatic control, the control unit 16 may increase the number of rotations of the air supply fan as the concentration of the predetermined gas increases.

**[0077]** The control unit 16 may increase the number of rotations of the air supply fan 54 on condition that the humidity measured by the humidity sensor 36 is high, in the first air-supplying operation. The inside of the air supply pipe 35 is therefore dried quickly.

#### (4) Features

##### **[0078]** (4-1)

The air conditioning system 100 according to the first embodiment includes the outdoor unit 20, the air supply pipe 35, and the control unit 16. The outdoor unit 20 includes the air supply fan 54 and the heater 52. Air is taken into the outdoor unit by the rotation of the air supply fan 54, and then is introduced into the room through the air supply pipe 35. In the outdoor unit 20, the heater 52 heats the air provided by the air supply fan. The air supply pipe 35 serves as a path for conveying the outside air sent from the outdoor unit 20, to the room. The control unit 16 acquires the concentration of the predetermined gas in the room, controls the air supply fan 54, based on the acquired concentration of the predetermined gas, and carries out the air-supplying operation of supplying outside air into the room.

**[0079]** In the air conditioning system 100, the control unit 16 switches the air-supplying operation to the first air-supplying operation and the second air-supplying operation. The first air-supplying operation involves heating outside air with the heater 52 and supplying the heated outside air into the room. The second air-supplying operation involves supplying outside air into the room without heating the outside air.

**[0080]** Condensation may occur in the air supply pipe 35 when the humidity in the air supply pipe 35 is high. In such a case, abnormal noise may result from a collision of dew water with air in the air supply pipe 35. In the air conditioning system 100 according to the first embodiment, the control unit 16 carries out the first air-supplying operation to dry the inside of the air supply pipe 35. When the inside of the air supply pipe 35 is dried, dew water is reduced, which may lead to a reduction in abnormal noise.

**[0081]** In the air conditioning system 100 according to the first embodiment, the control unit 16 carries out the second air-supplying operation as appropriate. During the second air-supplying operation, air to be supplied is not heated. This configuration therefore eliminates unnecessary supply of warm air into the room.

##### **[0082]** (4-2)

In the air conditioning system 100 according to the first embodiment, when the concentration of the predetermined gas has a value equal to or more than the prede-

termined value (S101), the air-supplying operation starts (S102). When the air-supplying operation starts, the control unit 16 determines whether the humidity in the air supply pipe has a value equal to or more than the predetermined value (S103, S 104), for determining whether to carry out the first air-supplying operation (S105) or the second air-supplying operation (S106).

##### **[0083]** (4-3)

In the air conditioning system 100 according to the first embodiment, the air supply pipe 35 is used during both the air-supplying operation and the humidifying operation. The air supply fan 54 and the heater 52 are also used during both the air-supplying operation and the humidifying operation. This configuration needs no additional components for the air-supplying operation which are different from the components for the humidifying operation. This configuration is therefore efficient.

##### **[0084]** (4-4)

The air conditioning system 100 according to the first embodiment also includes the indoor unit 10. The indoor unit 10 is connected to the air supply pipe 35. The gas sensor 15 is disposed in the indoor unit 10.

**[0085]** The gas sensor 15 disposed in the indoor unit 10 therefore cooperates with the control unit 16 with ease.

##### **[0086]** (4-5)

The air conditioning system 100 according to the first embodiment includes the refrigerant circuit 2. The indoor unit 10 according to the first embodiment includes the indoor heat exchanger 14.

**[0087]** The air conditioning system 100 according to the first embodiment may be configured to carry out an air conditioning operation including a heating operation, a cooling operation, and the like in addition to the humidifying operation and the air-supplying operation. The indoor fan 12, the flap 18, and the like are usable in the humidifying operation, the air-supplying operation, the heating operation, the cooling operation, and the like.

#### (5) Modifications

##### (5-1) Modification 1A

**[0088]** In the air conditioning system 100 according to the first embodiment, the gas sensor 15 is disposed in the casing 11 of the indoor unit 10. The gas sensor 15 may be installed separately from the indoor unit 10 or the air conditioner 1.

**[0089]** As illustrated in FIG. 7, in an air conditioner 1a according to Modification 1A, a gas sensor 15a is installed separately from an indoor unit 10. The gas sensor 15a is capable of communicating with a first control unit 16a of the indoor unit 10a in a wireless manner. The gas sensor 15a may communicate with the first control unit 16a of the indoor unit 10a in a wired manner. The gas sensor 15a is configured to measure a concentration of a predetermined gas in the room. The gas sensor 15a transmits a result of the measurement to the first control unit 16a. The control unit 16 controls an air-supplying

operation by the air conditioner 1a, based on the measurement result.

**[0090]** In Modification 1A, the gas sensor 15a is separate from the indoor unit 10a. This configuration relatively increases the degree of freedom in selecting the position of the gas sensor 15a in the room. For example, in a case where the room is a bedroom, the gas sensor 15a may be installed near the user. In addition, the expensive gas sensor 15a may be installed after the indoor unit 10a is installed.

#### (5-2) Modification 1B

**[0091]** In the air conditioning system 100a according to Modification 1A, the gas sensor 15a is installed separately from the indoor unit 10a and is capable of directly communicating with the first control unit 16a of the indoor unit 10a. As illustrated in FIG. 8, in an air conditioning system 100b according to Modification 1B, a gas sensor 15b is installed separately from an indoor unit 10b and is capable of communicating with a first control unit 16a of the indoor unit 10b via a network. The network may have thereon a server 40. The server 40 includes a processor 401 and a storage unit 402. The server 40 may be configured to accumulate measurement data acquired from the gas sensor 15b, to control the gas sensor 15b, and to transmit the measurement data to an air conditioner 1b.

**[0092]** Even when the air conditioner 1b according to Modification 1B especially has no function of connection to the gas sensor 15b, the air conditioner 1b is controllable using the measurement data acquired from the gas sensor 15b as long as the air conditioner 1b has a function of network connection.

#### (5-3) Modification 1C

**[0093]** In an air conditioning system 100c according to Modification 1C, a control unit 16 includes a third control unit 16c. As illustrated in FIG. 9, the third control unit 16c is provided in a server 40c. The server 40c includes a processor 401c and a storage unit 402c. The server 40c is connectable to an air conditioner 1c and a gas sensor 15c via a network so as to communicate with the air conditioner 1c and the gas sensor 15c. The third control unit 16c controls an air-supplying operation by the air conditioner 1c, based on a concentration of a predetermined gas measured by the gas sensor 15c.

**[0094]** At this time, the third control unit 16c may directly control the air conditioner 1 or may cause a first control unit 16a or/and a second control unit 16b of the air conditioner 1 to control the air conditioner 1c.

#### (5-4) Modification 1D

**[0095]** The air conditioner 1 according to the first embodiment includes the humidifying unit 5. As illustrated in FIG. 10, an air conditioner 1d (of an air conditioning

system 100d) according to Modification 1D includes no humidifying unit. The air conditioner 1d according to Modification 1D includes an air supply unit 5d. The air conditioner 1d according to Modification 1D is similar in configuration to the air conditioner 1 according to the first embodiment except the configuration described above.

**[0096]** The air supply unit 5d according to Modification 1D includes an air supply path 58d. The air supply path 58d connects to an air intake port 7cd for air supply. An air supply fan 54d and a heater 52d are disposed on the air supply path 58d. Outside air is taken into an outdoor unit 20d through the air intake port 7cd for air supply, by the rotation of the air supply fan 54d. In the outdoor unit 20d, the air passes the air supply path 58d toward an air supply pipe 35. The air is then supplied into the room. In the air supply path 58d, the air is appropriately heated by the heater 52d. During a first air-supplying operation, the inside of an air supply pipe 35 is dried using the air heated by the heater 52d. The air conditioner 1d (of the air conditioning system 100d) according to Modification 1D also carries out an air-supplying operation under control similar to that illustrated in FIG. 6.

#### (5-5) Modification 1E

**[0097]** The air conditioner 1 according to the first embodiment and the air conditioner 1d according to Modification 1D each include the refrigerant circuit 2 that enables the cooling operation and the heating operation. An air conditioner according to Modification 1E includes no refrigerant circuit. In other words, the air conditioner according to Modification 1E does not include an outdoor refrigerant circuit unit and an indoor unit. The air conditioner according to Modification 1E includes an air supply unit 5c, an air supply pipe 35, a humidity sensor 36, a control unit 16, and a gas sensor 15b. The air supply pipe 35 closer to the room has a configuration that enables direct air supply from the air supply pipe 35 into the room. The gas sensor 15b is independently installed in the room as in Modification 1B. The control unit 16 is disposed in the air supply unit 5a.

**[0098]** The air conditioner according to Modification 1E also carries out an air-supplying operation under control similar to that illustrated in FIG. 6.

#### (5-6) Modification 1F

**[0099]** In Modification 1D, the heater 52d is disposed on the air supply path 58d. As illustrated in FIG. 11, in Modification 1F, a heater 52f is disposed near an air supply unit 5f on an air supply pipe 35. In other words, the heater 52f is configured to heat outside air at a position near an inlet of the air supply pipe 35. Modification 1F is similar in configuration to Modification 1D except this configuration. Also in a case where the heater 52f is disposed as described above, a first air-supplying operation is carried out to heat air passing through the air supply pipe 35.

## (5-7) Modification 1G

**[0100]** In the air conditioner 1 according to the first embodiment, the humidity sensor 36 is disposed near the blow-out port 19a of the air supply pipe 19 in the indoor unit 10. The humidity sensor 36 may be disposed at any position as long as it is capable of measuring the humidity of air passing through the air supply pipe 35. In an air conditioner 1g according to Modification 1G, as illustrated in FIG. 12, a humidity sensor 36g is disposed in an air supply pipe 35. The air conditioner 1g according to Modification 1G is similar in configuration to the air conditioner 1 according to the first embodiment except the configuration described above.

## (5-8) Modification 1H

**[0101]** In the first embodiment, the gas sensor 15 is a CO<sub>2</sub> gas sensor as an example. The gas sensor may be a sensor for measuring other kinds of gas. According to Modification 1H, the gas sensor is a sensor for measuring a volatile organic compound (VOC). Examples of the VOC may include, but not limited to, formaldehyde, toluene, xylene, ethylbenzene, styrene, acetaldehyde, and a combination thereof.

**[0102]** The gas sensor may also be an indoor air quality (IAQ) sensor.

**[0103]** While various embodiments of the present disclosure have been described herein above, it is to be appreciated that various changes in form and detail may be made without departing from the spirit and scope of the present disclosure presently or hereafter claimed.

## REFERENCE SIGNS LIST

**[0104]**

- 1, 1a to 1d, 1f: air conditioner
- 2: refrigerant circuit
- 3: air supply path
- 5: humidifying unit
- 6: outdoor refrigerant circuit unit
- 10, 10a, 10b: indoor unit
- 14: indoor heat exchanger
- 15, 15a, 15b: gas sensor
- 16: control unit
- 19: indoor air supply pipe
- 20: outdoor unit
- 35: air supply pipe
- 36: humidity sensor
- 51: humidifying rotor
- 52: heater
- 54: air supply fan
- 59: adsorption fan
- 100, 100a to 100d, 100f: air conditioning system

## CITATION LIST

## PATENT LITERATURE

- 5 **[0105]** Patent Literature 1: JP 2010-043848 A

## Claims

- 10 **1.** An air conditioning system (100) comprising:

an air supply fan (54) configured to supply outside air into a room;  
 an air supply pipe (35) serving as a path for conveying outside air to the room;  
 a heater (52) configured to heat outside air before being introduced into the air supply pipe or outside air in the air supply pipe on an upstream side of the air supply pipe; and  
 a control unit (16) configured to control the air supply fan and the heater,  
 wherein  
 the control unit is configured to change alternatively from

a first air-supplying operation of heating outside air with the heater and supplying the heated outside air into the room, in accordance with a concentration of a predetermined gas in the room; to  
 a second air-supplying operation of supplying outside air into the room without heating the outside air, in accordance with the concentration of the predetermined gas in the room.

2. The air conditioning system according to claim 1, wherein  
 the control unit determines whether to carry out the first air-supplying operation or the second air-supplying operation upon establishment of an air-supplying operation condition concerning the concentration of the predetermined gas, in a state in which the air-supplying operation stops.

3. The air conditioning system according to claim 1 or 2, wherein  
 a number of rotations of the air supply fan during the first air-supplying operation is in a range from 80% or more to 120% or less relative to the number of rotations of the air supply fan during the second air-supplying operation.

4. The air conditioning system according to any one of claims 1 to 3, wherein

the control unit changes a number of rotations of the air supply fan during the first air-supplying

- operation or the second air-supplying operation, by automatic control or in accordance with a user setting, and  
in a case of the automatic control, the control unit increases the number of rotations of the air supply fan as the concentration of the predetermined gas increases.
5. The air conditioning system according to any one of claims 1 to 4, further comprising
- a humidity sensor (36) configured to measure a humidity of outside air before being introduced into the air supply pipe, a humidity of outside air in the air supply pipe, or a humidity of outside air led out of the air supply pipe, wherein  
the control unit selects the first air-supplying operation on condition that the humidity measured by the humidity sensor has a value equal to or more than a predetermined humidity value, and selects the second air-supplying operation on condition that the humidity measured by the humidity sensor has a value less than the predetermined humidity value.
6. The air conditioning system according to claim 5, wherein  
the control unit increases a number of rotations of the air supply fan on condition that the humidity measured by the humidity sensor is high, in the first air-supplying operation.
7. The air conditioning system according to any one of claims 1 to 6, further comprising
- an outdoor unit (20) installed outside the room and connected to the air supply pipe, wherein
- the outdoor unit includes a humidifying unit configured to humidify outside air and supply the humidified outside air into the room, and  
the humidifying unit includes the air supply fan and the heater for use in the air-supplying operation.
8. The air conditioning system according to any one of claims 1 to 7, further comprising  
a gas sensor (15, 15a) configured to measure the concentration of the predetermined gas in the room.
9. The air conditioning system according to claim 8, further comprising  
an indoor unit (10) installed in the room, connected to the air supply pipe, and configured to supply, into the room, outside air flowing therein through the
- air supply pipe.
10. The air conditioning system according to claim 9, wherein  
the gas sensor (15) is disposed in the indoor unit.
11. The air conditioning system according to claim 9, wherein  
the gas sensor (15a) is installed separately from the indoor unit in the room.
12. The air conditioning system according to claim 11, wherein  
the gas sensor and the control unit are connected via an external network.
13. The air conditioning system according to any one of claims 9 to 12, wherein  
the indoor unit includes an indoor heat exchanger (14).

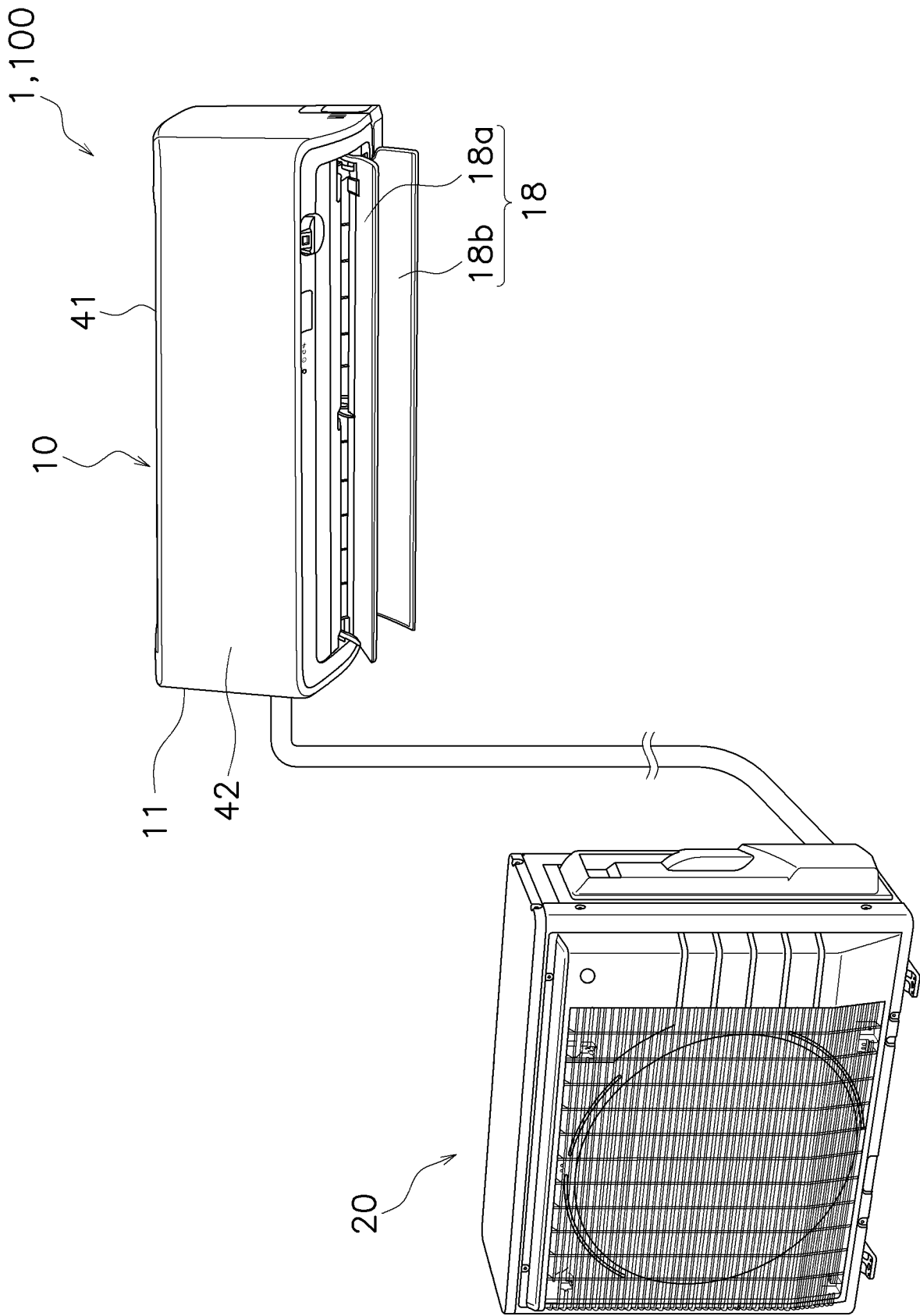


FIG. 1

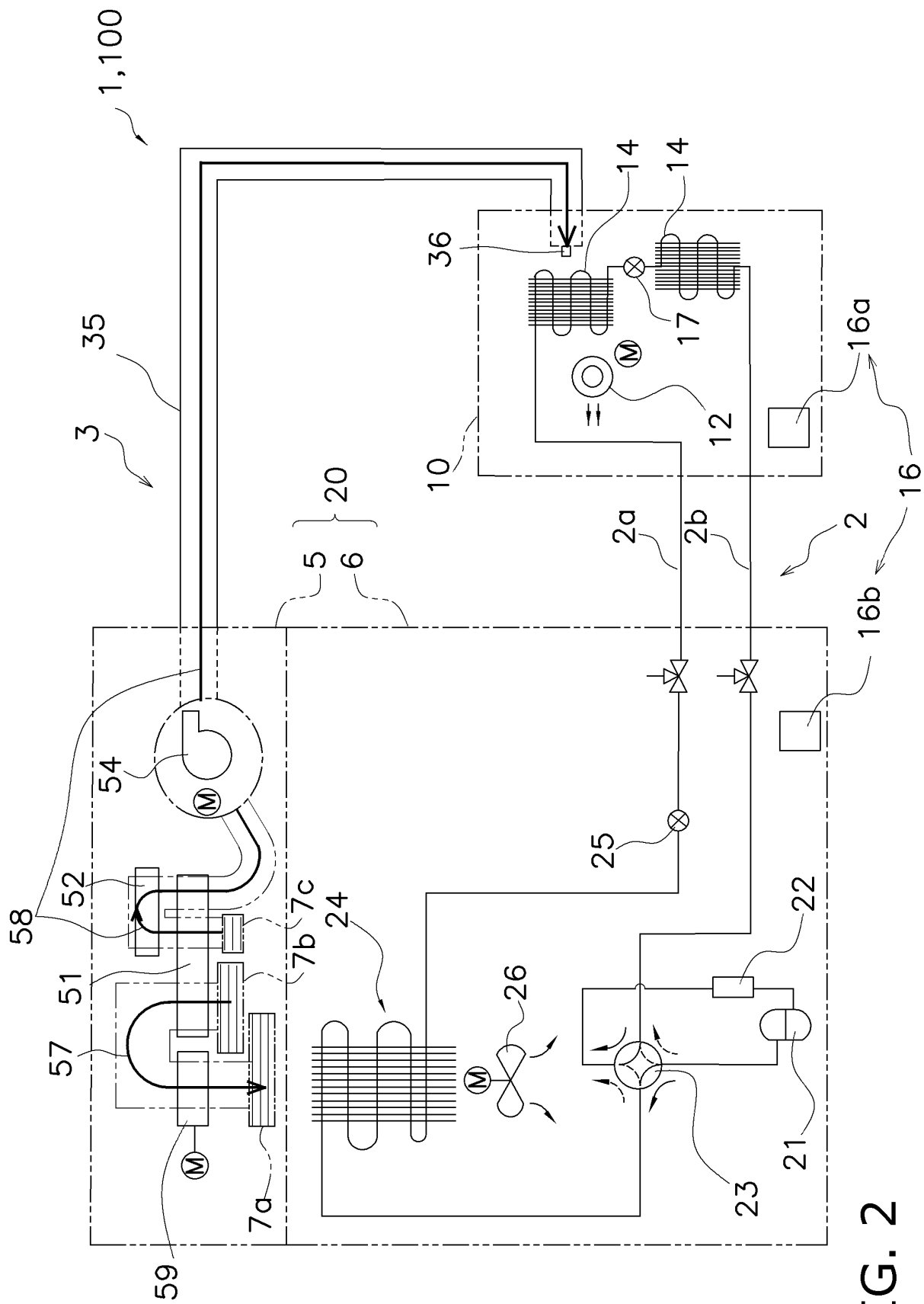


FIG. 2

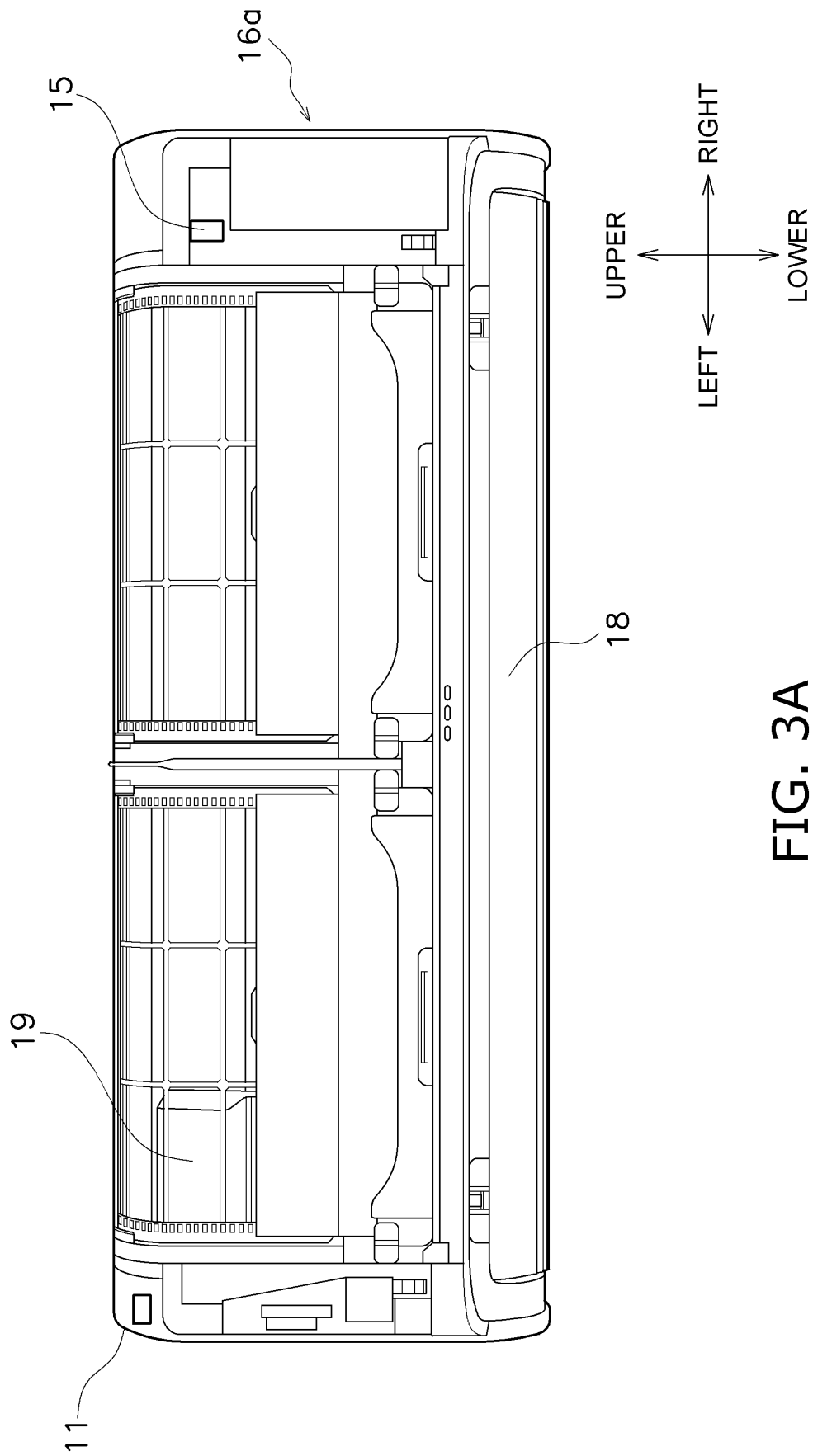


FIG. 3A

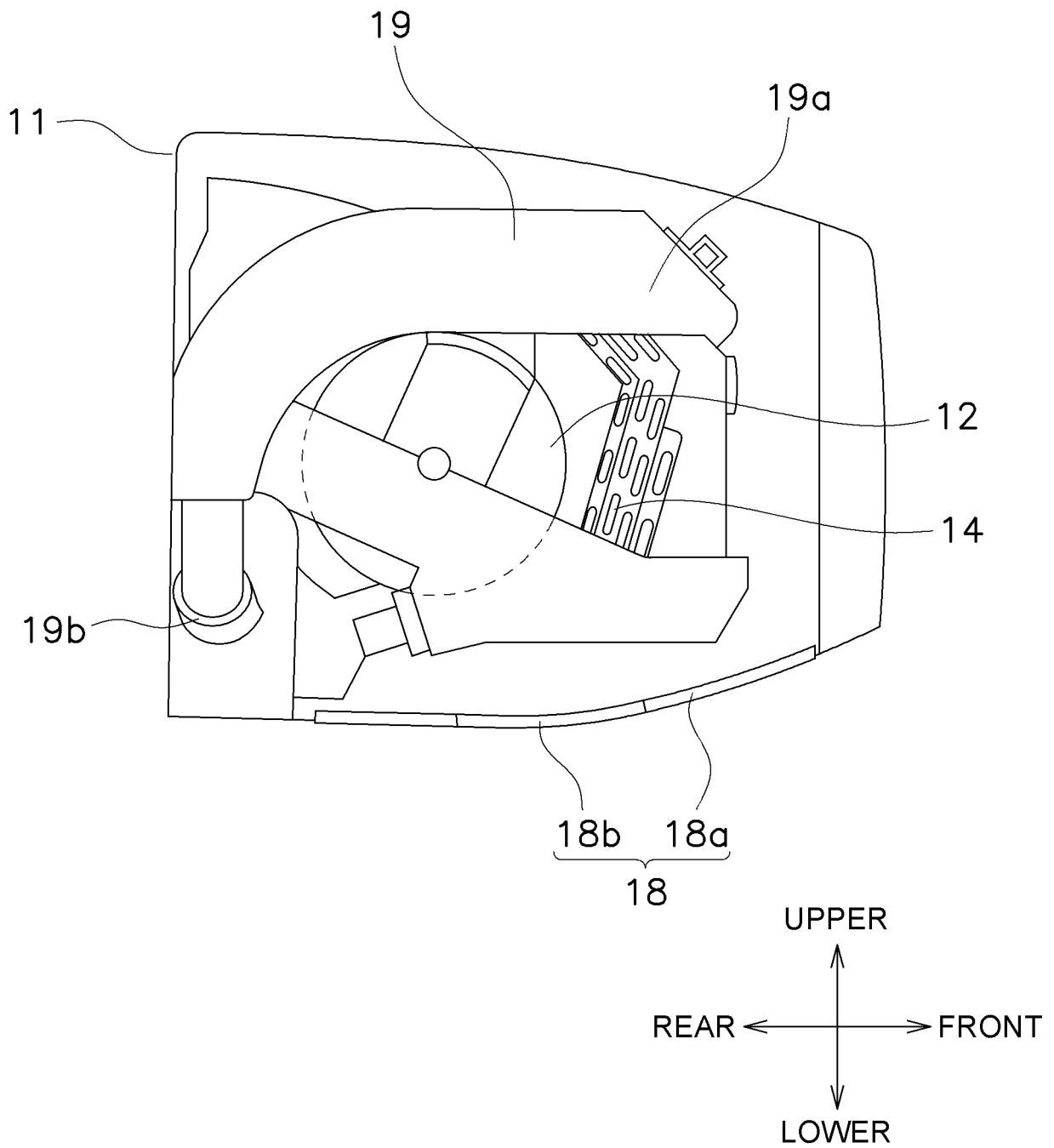


FIG. 3B

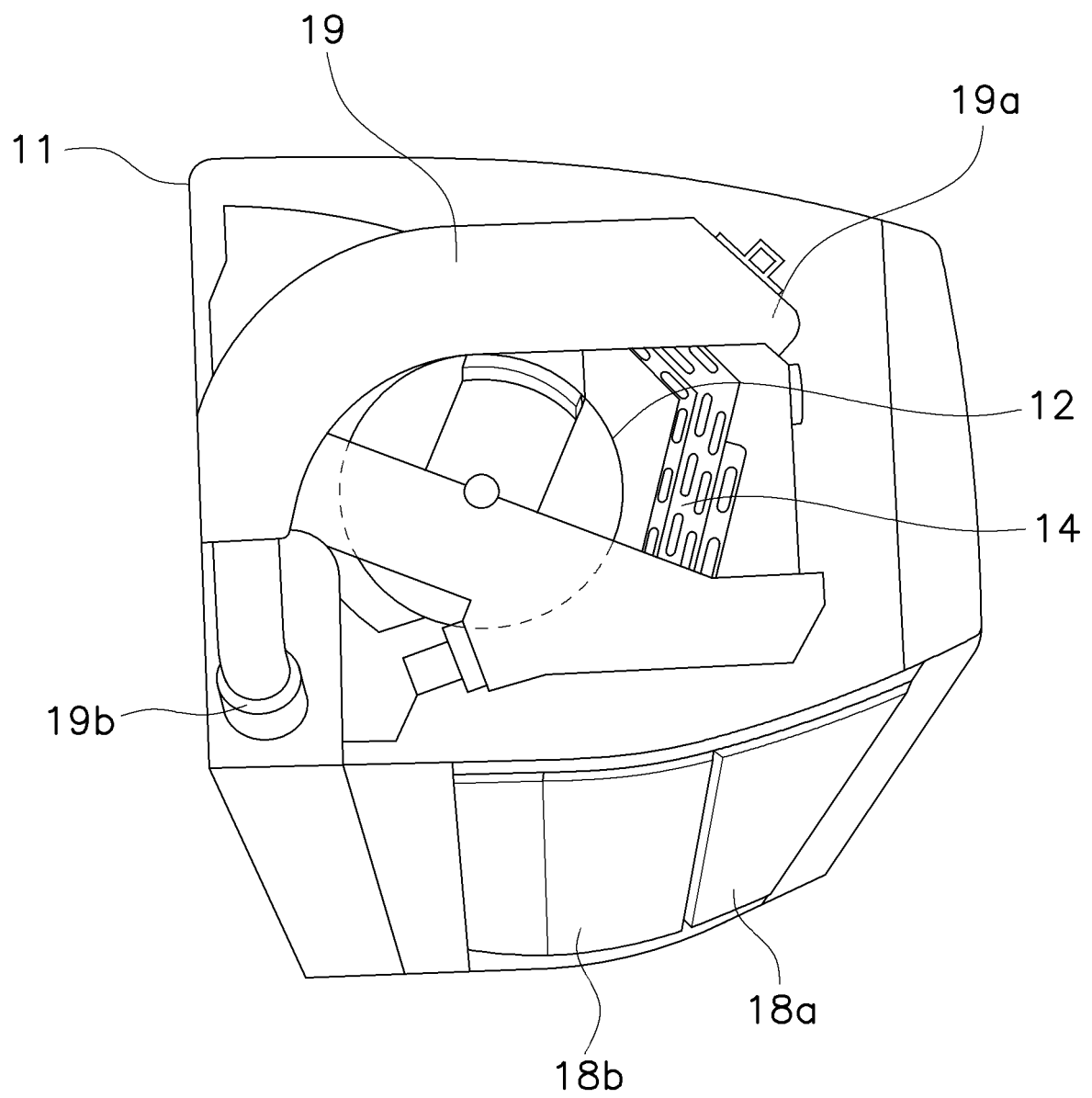


FIG. 3C

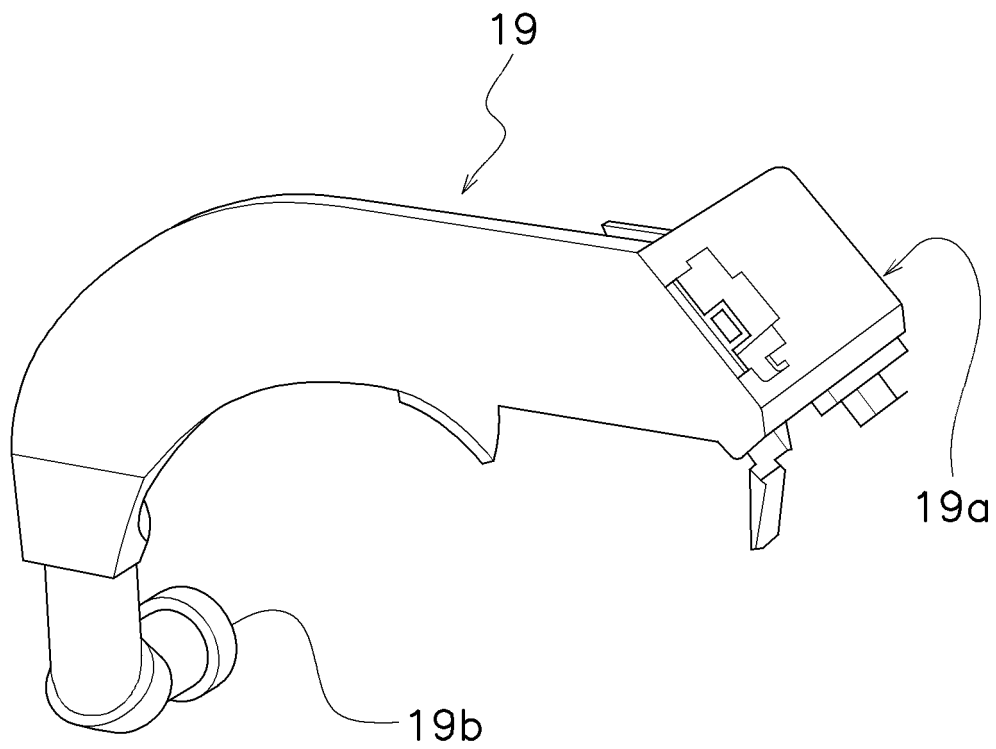


FIG. 4

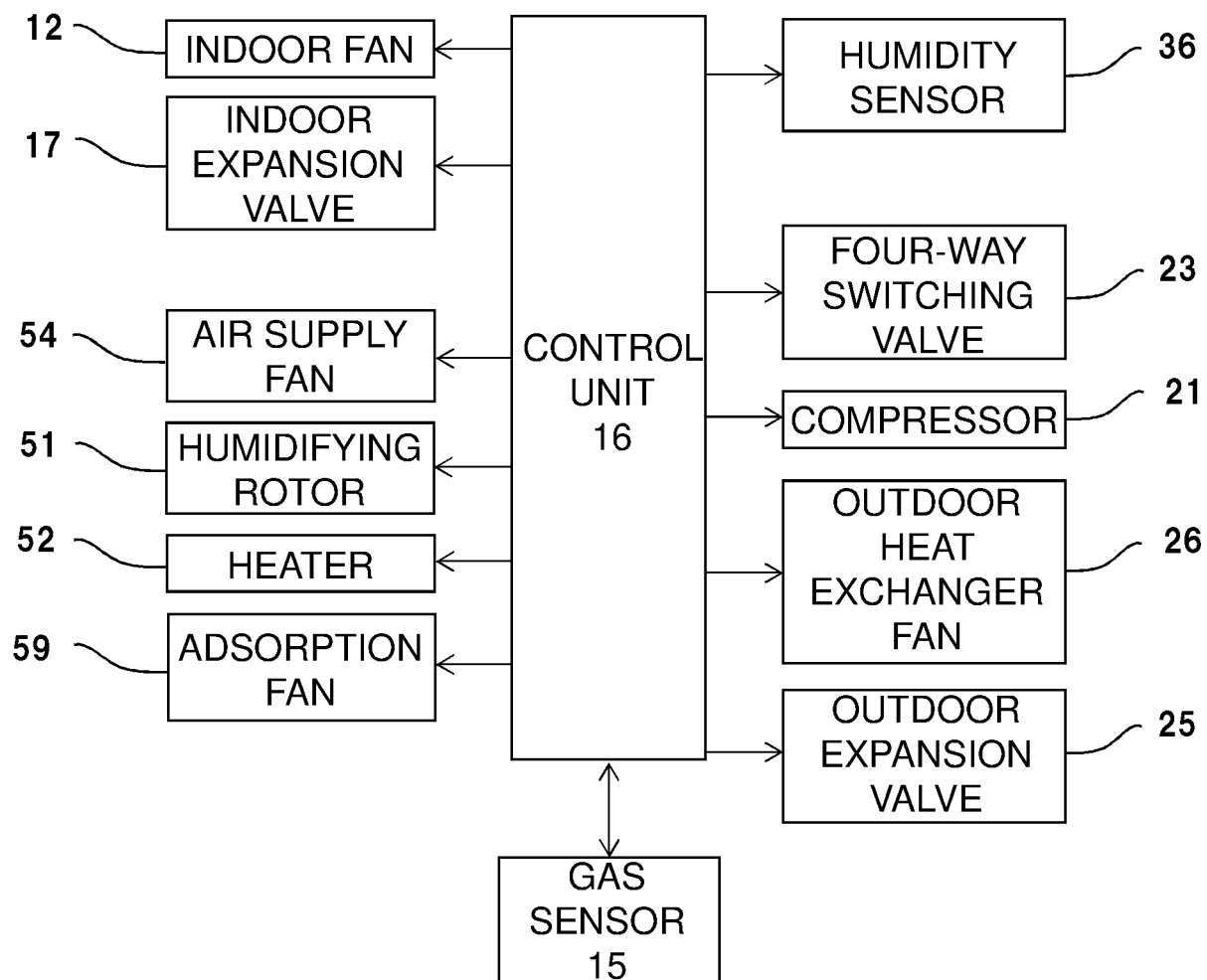


FIG. 5

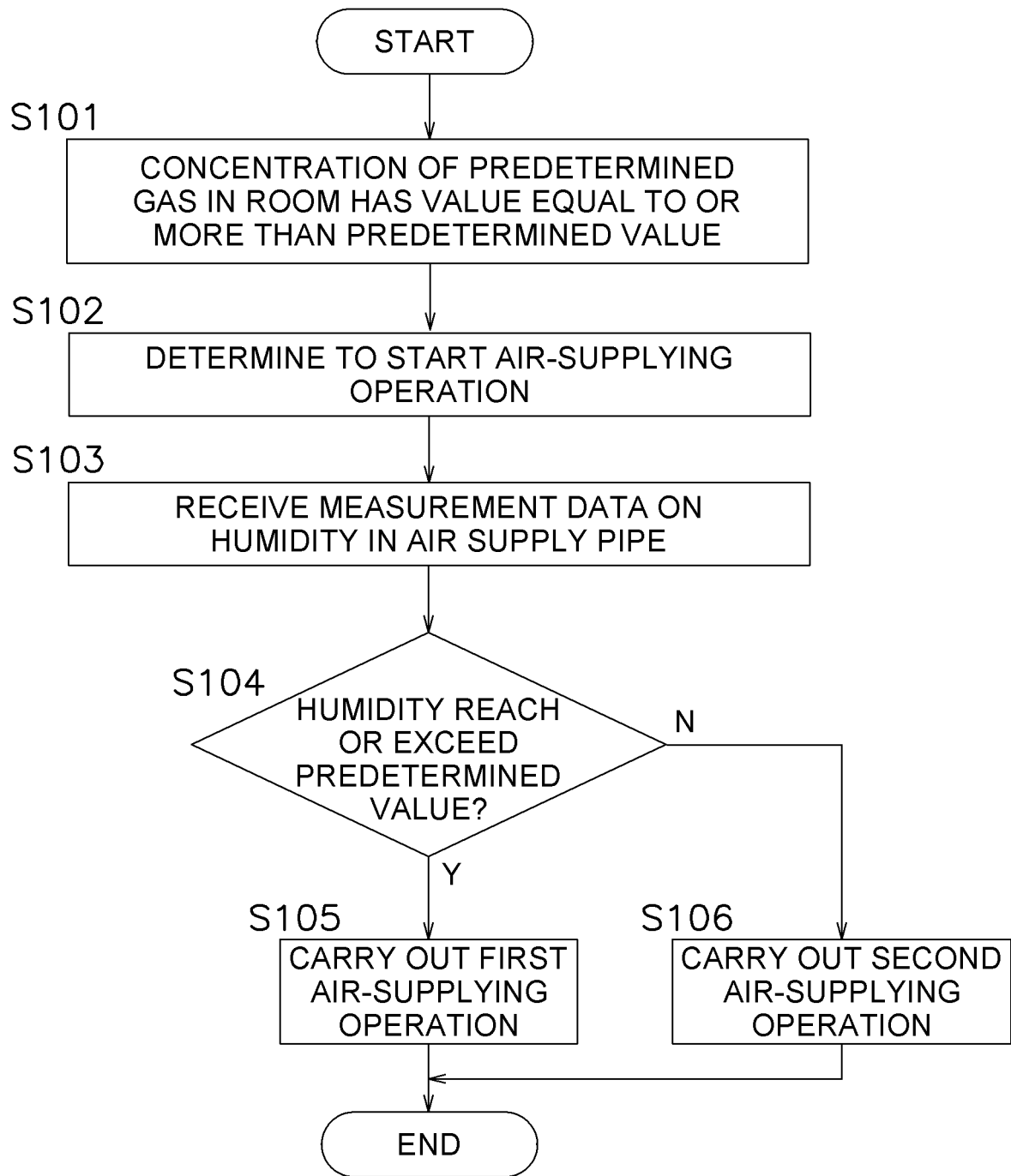


FIG. 6

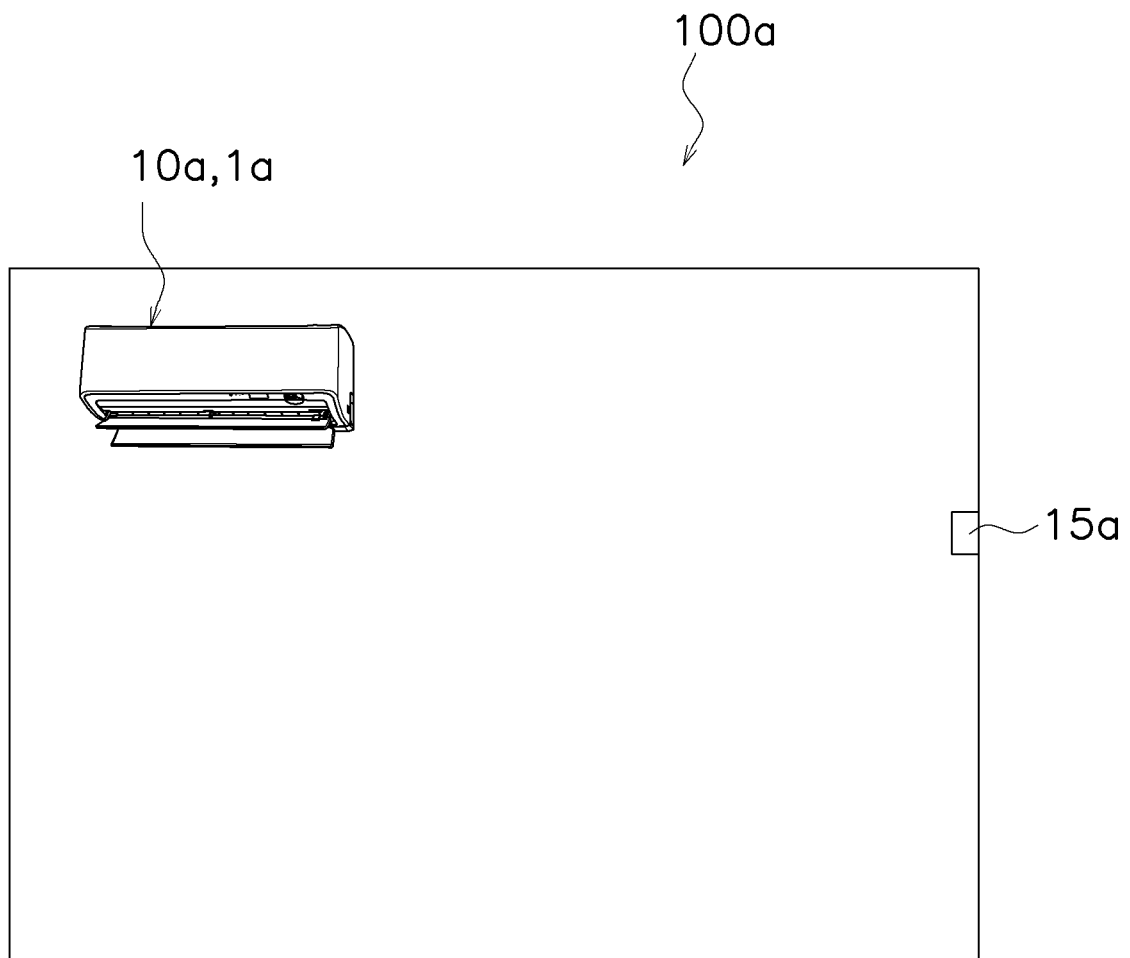


FIG. 7

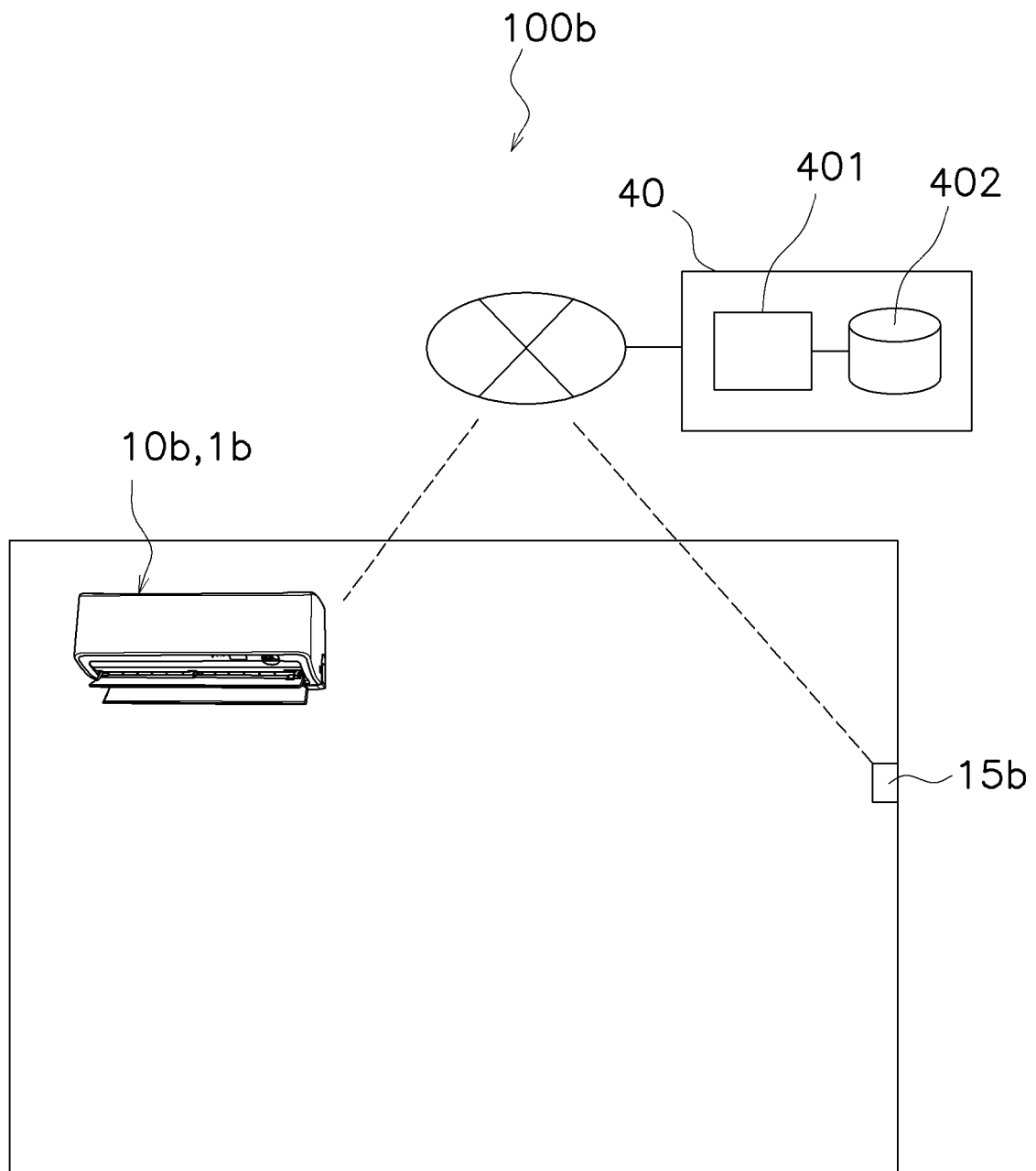


FIG. 8

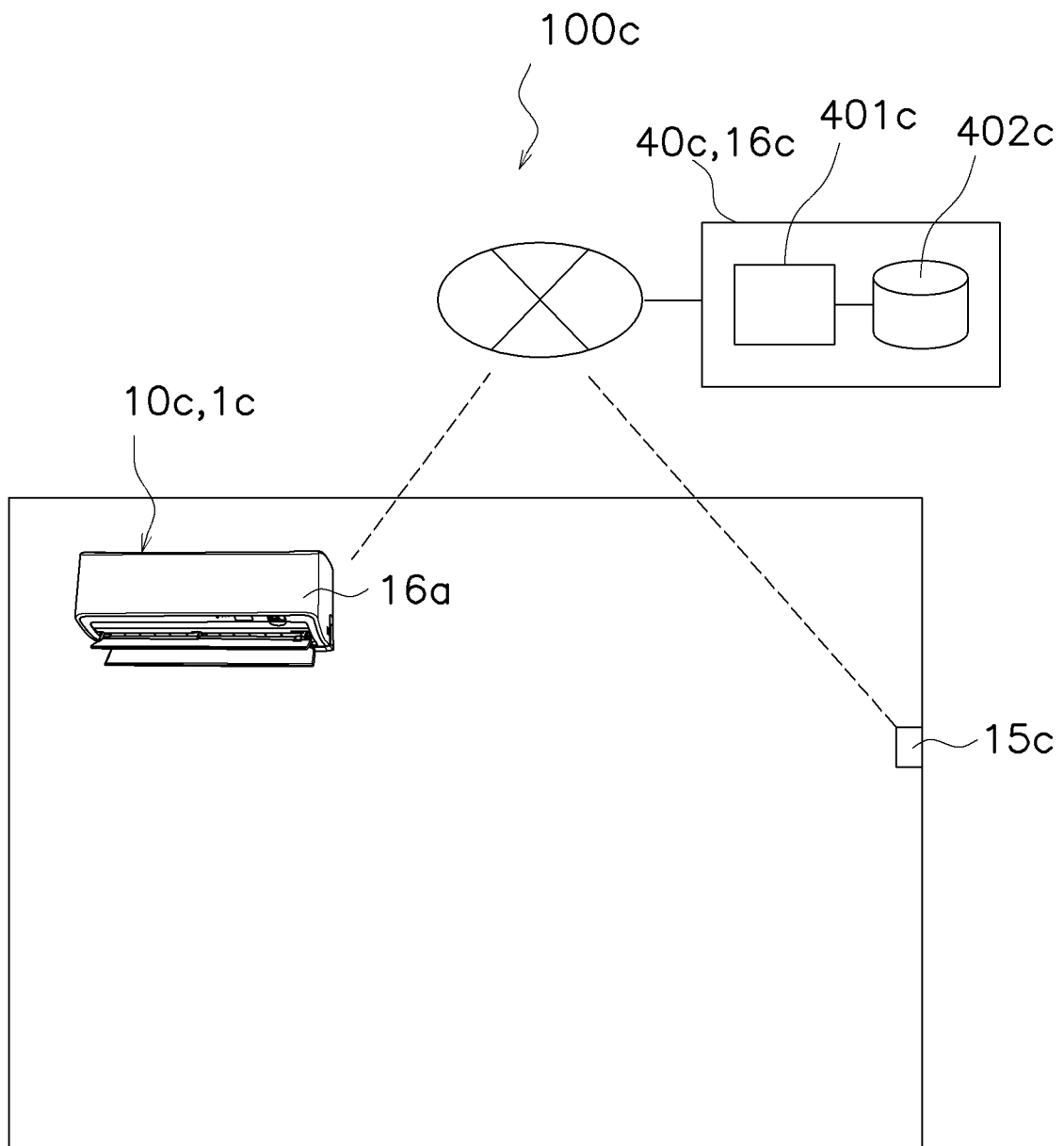


FIG. 9

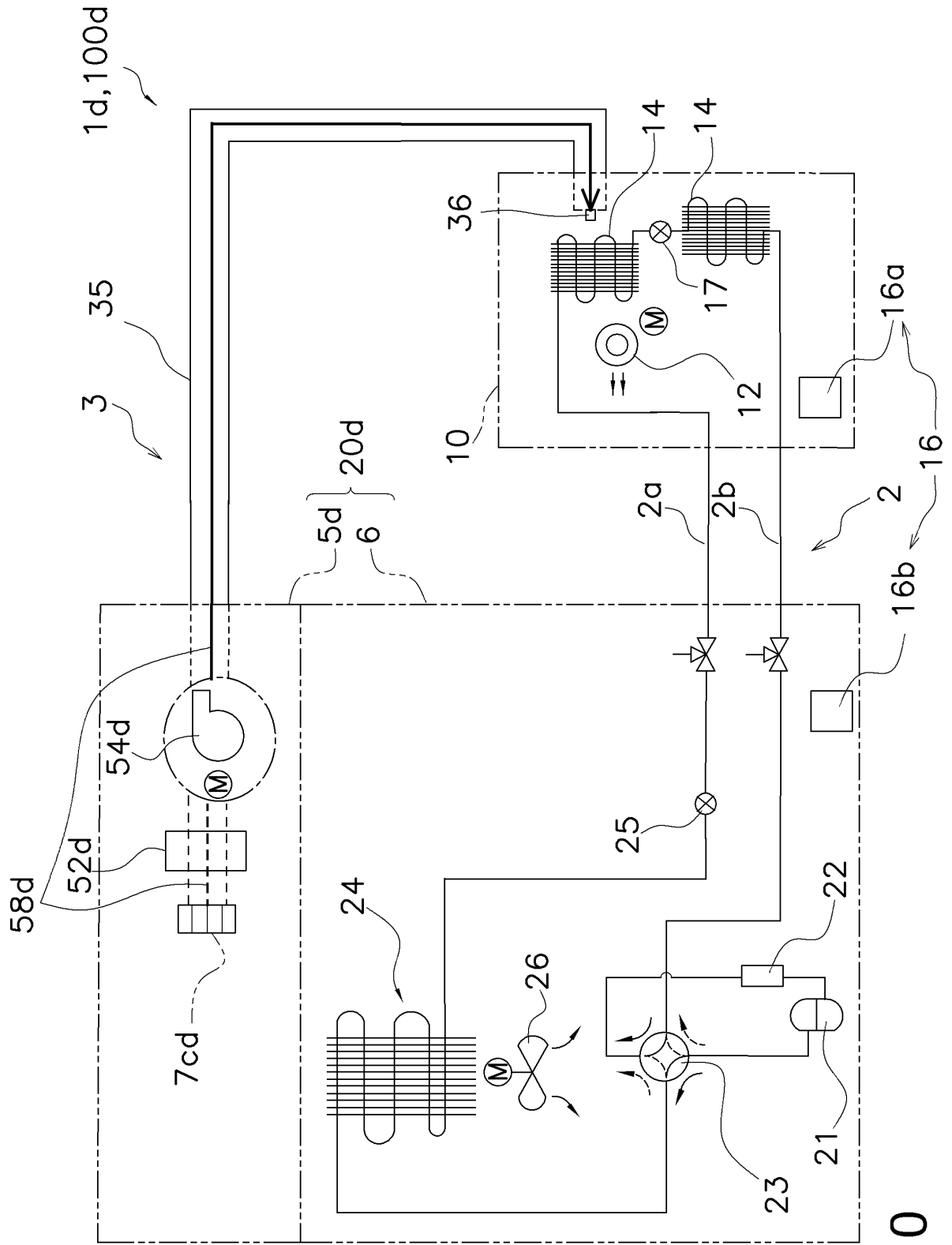


FIG. 10

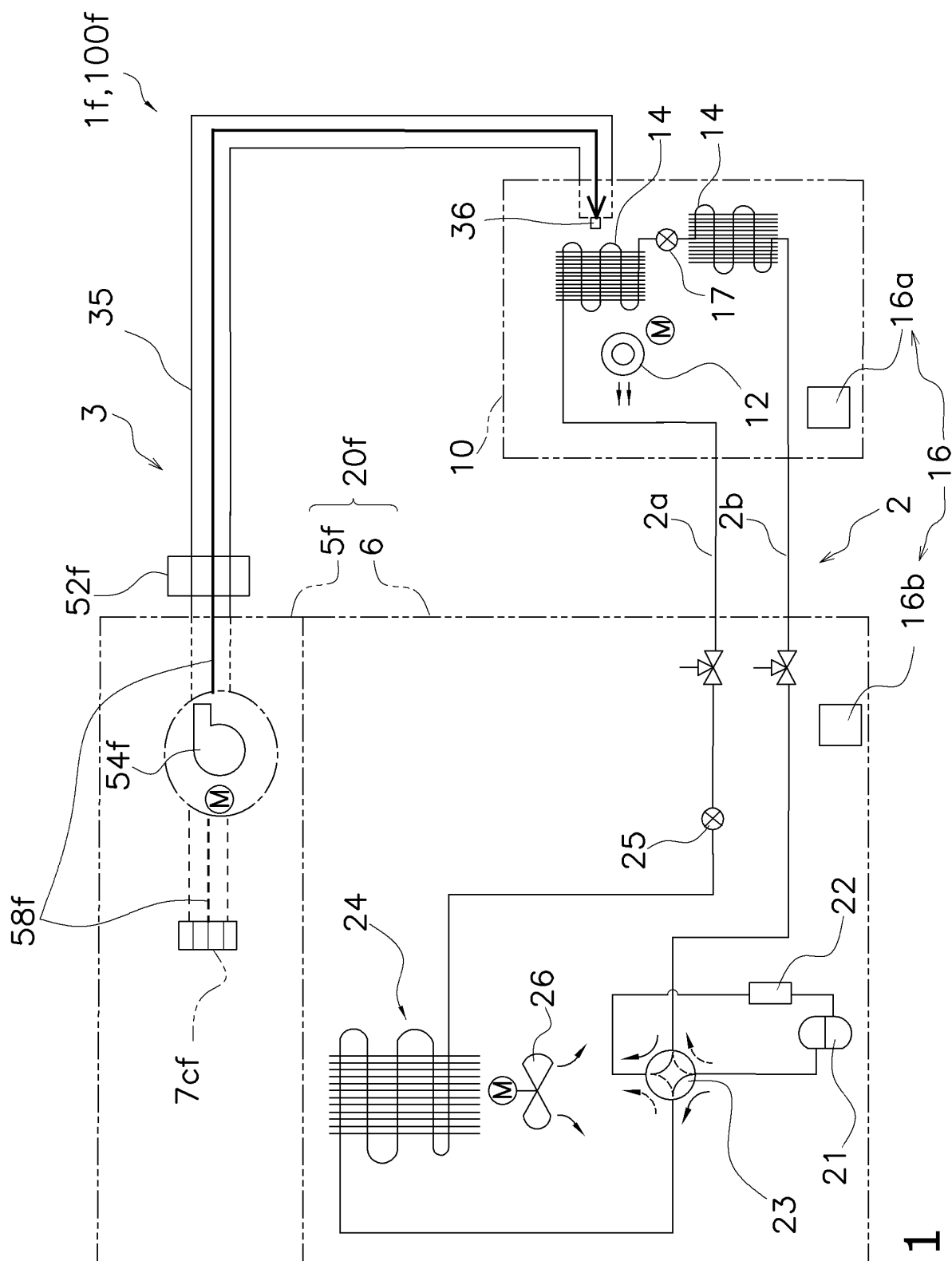


FIG. 11

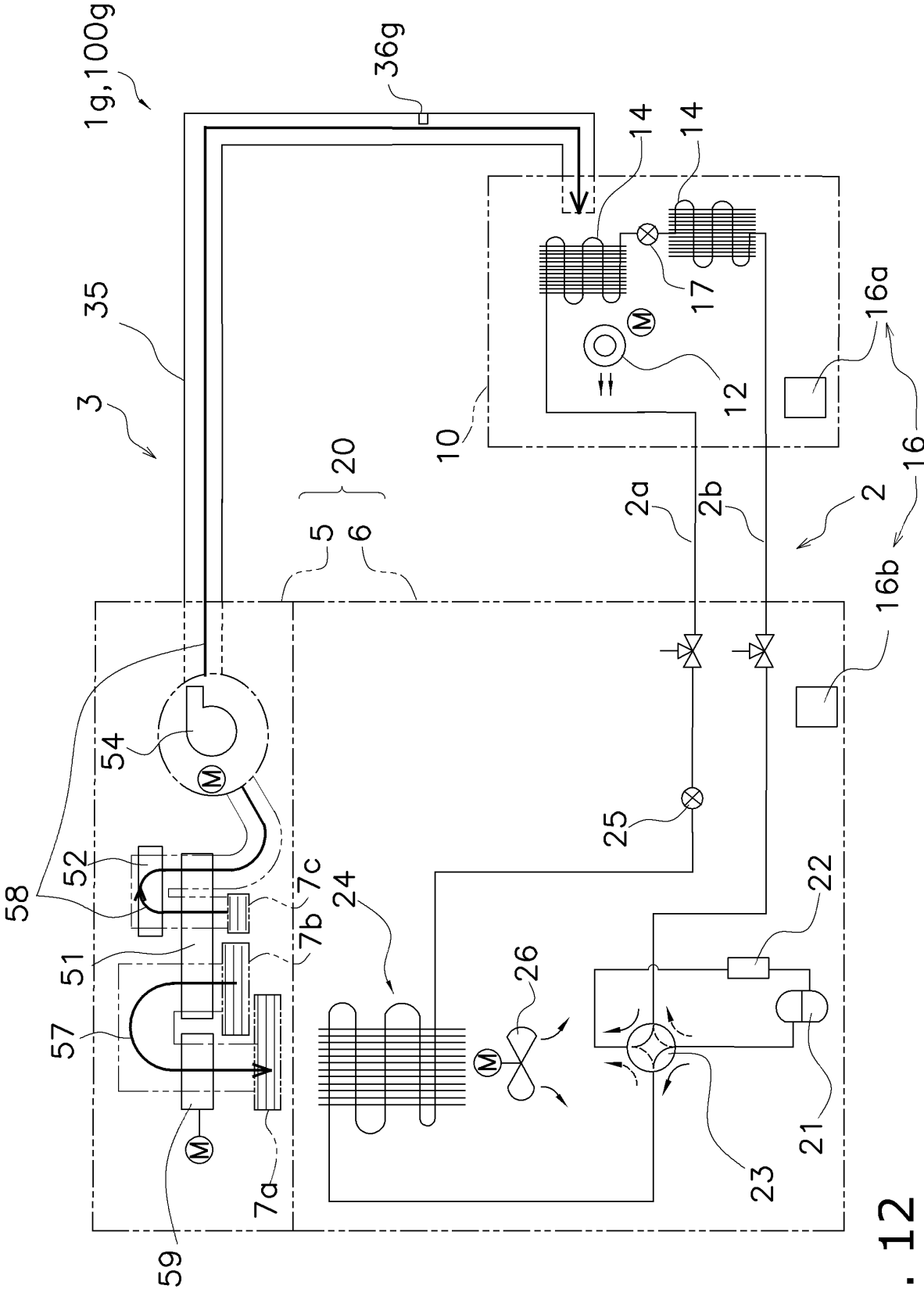


FIG. 12

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/044864

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## A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/56(2018.01)i; F24F 11/65(2018.01)i; F24F 11/74(2018.01)i; F24F 11/89(2018.01)i; F24F 3/14(2006.01)i

FI: F24F11/05; F24F11/50; F24F11/74; F24F11/89; F24F3/14

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

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## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24F3/14; F24F11/56; F24F11/65; F24F11/74; F24F11/89

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2021

Registered utility model specifications of Japan 1996-2021

Published registered utility model applications of Japan 1994-2021

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

25

| Category* | Citation of document, with indication, where appropriate, of the relevant passages               | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------|-----------------------|
| Y         | JP 2001-304645 A (DAIKIN INDUSTRIES, LTD.) 31 October 2001 (2001-10-31) paragraphs [0008]-[0022] | 1-13                  |
| Y         | JP 2013-47603 A (NISSAN MOTOR CO., LTD.) 07 March 2013 (2013-03-07) paragraphs [0009]-[0030]     | 1-13                  |
| Y         | WO 2015/076289 A1 (DAIKIN INDUSTRIES, LTD.) 28 May 2015 (2015-05-28) paragraphs [0023]-[0059]    | 7-13                  |

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

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

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

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Date of the actual completion of the international search  
06 January 2021 (06.01.2021)Date of mailing of the international search report  
26 January 2021 (26.01.2021)

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Name and mailing address of the ISA/  
Japan Patent Office  
3-4-3, Kasumigaseki, Chiyoda-ku,  
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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

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## INTERNATIONAL SEARCH REPORT

### Information on patent family members

International application No.

PCT/JP2020/044864

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| Patent Documents referred in the Report | Publication Date | Patent Family  | Publication Date |
|-----------------------------------------|------------------|----------------|------------------|
| JP 2001-304645 A                        | 31 Oct. 2001     | (Family: none) |                  |
| JP 2013-47603 A                         | 07 Mar. 2013     | (Family: none) |                  |
| WO 2015/076289 A1                       | 28 May 2015      | (Family: none) |                  |

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

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2010043848 A [0002] [0105]