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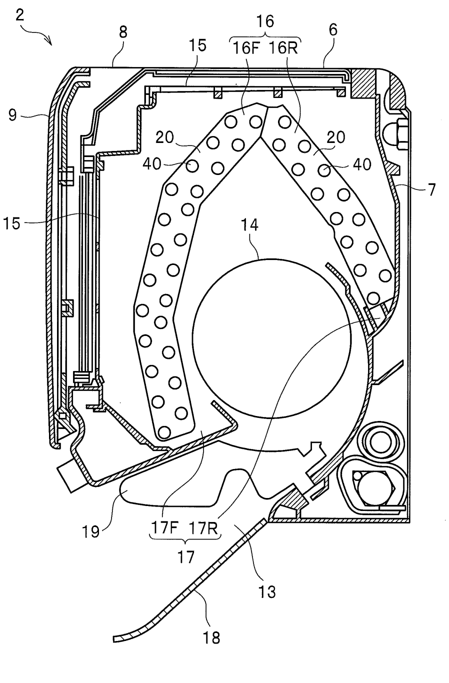
(54) **AIR CONDITIONER INDOOR UNIT**

(57) An indoor unit 2 for an air conditioner includes a heat exchanger 16 for exchanging heat between air and refrigerant; a drain pan 17 for receiving drain water which drops from the heat exchanger; and a controller for controlling a freezing operation of making frost or ice adhere to a surface of the heat exchanger. A volume of the drain pan is equal to or greater than a total adhesion amount of frost or ice to adhere to the heat exchanger during the freezing operation. Preferably, in consideration that the drain water is discharged out side of the indoor unit 2 through the drain pipe, a volume of the drain pan is equal to or greater than (the total adhesion amount of frost or ice - an amount of drainage through the drain pipe per unit time × a smaller one of an amount of time required for all the frost or ice to melt and an amount of time required for all the frost or ice to drop into the drain pan).

FIG.2



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Description

TECHNICAL FIELD

[0001] The present invention relates to an indoor unit for an air conditioner.

BACKGROUND ART

[0002] An indoor unit for an air conditioner conditions indoor air by: suctioning the indoor air into the indoor unit; applying a selected one of heating, cooling and dehumidifying processes to the suctioned indoor air by passing the suctioned indoor air through a heat exchanger to obtain the conditioned air; and blowing out the obtained conditioned air into the building.

[0003] In the indoor unit for the air conditioner, a filter is arranged closing a clearance between an air suction port for suctioning the indoor air and the heat exchanger in order to prevent dust included in the indoor air from entering the inside of the indoor unit, and the filter collects most of the dust. Fine dust smaller than the mesh size of the filter still passes through the mesh of the filter, and enters the inside of the indoor unit.

[0004] Inside the indoor unit, static electricity is produced around the heat exchanger by friction which occurs when the suctioned indoor air hits the heat exchanger. In addition, the fine dust having entered the inside of the indoor unit contains oil in many cases. The fine dust having entered the inside of the indoor unit adheres to the heat exchanger due to the static electricity and the oil.

[0005] The dust adhering to the heat exchanger contains components which are nutrients for bacteria (including molds) . Meanwhile, for example, each time the air conditioner performs a cooling or dehumidifying operation in the summer, moisture in the air condenses on fins of the heat exchanger, and the ambient atmosphere around the heat exchanger becomes highly humid. Continuous adhering of the dust to the heat exchanger, therefore, grows the bacteria, and is likely to generate foul smell. In view of this, it is desirable that the air conditioner remove the dust adhering to the heat exchanger to keep the heat exchanger clean throughout the year.

[0006] With this taken into consideration, for example, Patent Literature 1 has proposed an air conditioner which performs a heating operation and thereafter a cooling or dehumidifying operation to make water adhere to the surfaces of the fins of the heat exchanger, and washes down the dust including the oil, which adheres to the surfaces of the fins, using the adhering water. The air conditioner described in Patent Literature 1, however, requires an anti-dirt treatment to be applied to the surfaces of the fins in order to wash down the dust using the water adhering to the surfaces of the fins.

[0007] Against this background, a scheme has been considered, for example, in which: frost or ice is made to adhere to the surfaces of the fins by an operation of decreasing the temperature of the heat exchanger; thereafter, the frost or ice is melted by an operation of raising the temperature of the heat exchanger; and the dust adhering to the heat exchanger is washed down using momentum with which the melted water flows down. The process of washing the heat exchanger in this way will be hereinafter referred to as "freeze washing." This freeze washing can make a large amount of frost (including ice) adhere to the surfaces of the fins per unit time, which is larger than an amount of water a normal cooling or dehumidifying operation makes adhere to the surfaces of the fins per unit time. This freeze washing, therefore, can wash down the dust adhering to the heat exchanger without applying the anti-dirt treatment to the surfaces of the fins.

CITATION LIST

Patent Literature

[0008] Patent Literature 1: Japanese Patent Application Publication No. 2008-138913

SUMMARY OF INVENTION

Technical Problem

[0009] The freeze washing, however, produces a large amount of water (drain water) per unit time, which is larger than an amount of water the normal cooling or dehumidifying operation does. It is desired that the air condition not leak the large amount of water (drain water) to the outside of the indoor unit.

[0010] The present invention has been made to solve the above problem. A main object of the present invention is to provide an indoor unit for an air conditioner which leaks no water to the outside of the indoor unit during the freeze washing.

Solution to Problem

[0011] To achieve the above object, the present invention is an indoor unit for an air conditioner which is characterized in that the indoor unit includes: a heat exchanger for exchanging heat between air and refrigerant; a drain pan for receiving drain water which drops from the heat exchanger; and a controller for controlling a freezing operation of making frost or ice adhere to a surface of the heat exchanger. The indoor unit is further characterized in that a volume of the drain pan is equal to or greater than a total adhesion amount of frost or ice to adhere to the heat exchanger during the freezing operation.

[0012] Other means will be described later.

Advantageous Effects of Invention

[0013] According to the present invention, it is possible to prevent water from leaking to the outside during the freeze washing.

BRIEF DESCRIPTION OF DRAWINGS

[0014]

FIG. 1 is a configuration diagram of an air conditioner according to a first embodiment.
FIG. 2 is a cross-sectional diagram of an indoor unit for the air conditioner according to the first embodiment.
FIG. 3 is a perspective diagram of a drain pan section in a housing used for the indoor unit according to the first embodiment.
FIG. 4 is a partially magnified diagram of a front drain pan in the drain pan section.
FIG. 5 is a graphic diagram illustrating a relationship between a surface area of a heat exchanger and an amount of drain water produced by freeze washing.
FIG. 6 is a schematic diagram illustrating an arrangement structure of a drain pipe in the drain pan section.
FIG. 7 is a schematic diagram illustrating another arrangement structure of the drain pipe in the drain pan section.
FIG. 8 is a schematic diagram illustrating a structure of an inlet of the drain pipe in the drain pan section.
FIG. 9 is a schematic diagram illustrating another structure of the inlet of the drain pipe in the drain pan section.
FIG. 10A is a schematic diagram (1) of a drain pan section of a housing according to a modification.
FIG. 10B is a schematic diagram (2) of a drain pan section of a housing according to a modification.
FIG. 10C is a schematic diagram (3) of a drain pan section of a housing according to a modification.
FIG. 11 is a perspective diagram of a drain pan section in a housing used in an indoor unit according to the second embodiment.
FIG. 12 is a partially magnified diagram of a front drain pan in the drain pan section.
FIG. 13 is a perspective diagram of a heat insulating material used in the second embodiment.
FIG. 14 is a partially magnified diagram (1) of a drainage part in a front drain pan.
FIG. 15 is a partially magnified diagram (2) of the drainage part in the front drain pan.
FIG. 16 is a schematic diagram illustrating an arrangement relationship between the heat exchanger and the front drain pan.
FIG. 17 is a schematic diagram (1) of a heat insulating material according to a modification.
FIG. 18 is a schematic diagram (2) of a heat insulating material according to a modification.
FIG. 19 is a schematic diagram of a drainage part in a front drain pan according a modification.

DESCRIPTION OF EMBODIMENTS

[0015] Hereinafter, modes for carrying out the present invention (hereinafter referred to as "embodiments") will be described in detail with reference to the accompanying drawings. It should be noted that the drawings only schematically show the present invention to an extent that the present invention can be sufficiently understood. The present invention is not limited to illustrated examples. The same reference signs are used throughout the drawings to refer to common components and similar components, and duplicated descriptions are omitted.

[First Embodiment]

<Configuration of Air Conditioner>

[0016] Referring to FIGS. 1 and 2, descriptions will be hereinbelow provided for a configuration of an air conditioner

1 according to the first embodiment. FIG. 1 is a configuration diagram of the air conditioner 1 according to the first embodiment. FIG. 2 is a cross-sectional diagram of an indoor unit 2 of the air conditioner 1.

[0017] As illustrated in FIG. 1, the air conditioner 1 includes the indoor unit 2 placed inside a building, an outdoor unit 3 placed outside the building, and a remote controller 12 placed near a user inside the building.

[0018] The indoor unit 2 conditions indoor air by: suctioning the indoor air into the indoor unit 2; applying a selected one of heating, cooling and dehumidifying processes to the suctioned indoor air by passing the suctioned indoor air through a heat exchanger 16 (see FIG. 2) ; obtaining the conditioned air; and blowing out the obtained conditioned air into the building. The indoor unit 2 is connected to the outdoor unit 3 through a connecting pipe 5, and circulates a refrigerant between the indoor unit 2 and the outdoor unit 3. The outdoor unit 3 exchanges heat between the air and the circulating refrigerant.

[0019] The indoor unit 2 includes structural bodies such as an air blowing fan 14 (see FIG. 2) and the heat exchanger 16 (see FIG. 2) inside a housing 7 and a decorative frame 8. The air blowing fan 14 is a through-flow fan which sends air from an air inlet port 6 to an air outlet port 13. The heat exchanger 16 is a unit which exchanges heat between the air and the refrigerant.

[0020] In an example illustrated in FIG. 1, a front surface of the decorative frame 8 has a shape which: includes an upper portion extending in an up-down direction; and a lower portion whose low side extends slantingly toward a rear. A front panel 9 is attached to the upper portion of the front surface of the decorative frame 8. The front panel 9 is a member covering the front surface of the indoor unit 2. Furthermore, a receiver 10, a display 11, and an up-down wind direction board 18 are mounted in the lower portion of the front surface of the decorative frame 8.

[0021] The receiver 10 is a device which receives operation signals sent from the remote controller 12. The receiver 10 is electrically connected to a controller CL built in the indoor unit 2. The controller CL controls operations and actions of the air conditioner 1 based on the operation signals received from the remote controller 12 via the receiver 10.

[0022] The display 11 is a device which displays how the air conditioner 1 is operating.

[0023] The up-down wind direction board 18 is a member for defining an up-down direction of the conditioned air which is blown out from the air outlet port 13. The up-down wind direction board 18 has a configuration in which: the up-down wind direction board 18 is pivotally supported near its lower end by the decorative frame 8 (or the housing 7) such that an upper portion of the up-down wind direction board 18 opens and closes in the up-down direction; and the up-down wind direction board 18 is turned by a driving section (not illustrated) . The indoor unit 2 forms the air outlet port 13 by opening the up-down wind direction board 18.

[0024] As illustrated in FIG. 2, the indoor unit 2 includes, in its inside, a filter 15, a drain pan 17 and a left-right wind direction board 19 in addition to the air flowing fan 14, the heat exchanger 16 and the up-down wind direction board 18.

[0025] The filter 15 is a member for preventing dust from entering the inside of the housing 7.

[0026] The drain pan 17 is a member for receiving drops of water (drain water) which condenses on the surfaces of fins 20 of the heat exchanger 16.

[0027] The left-right wind direction board 19 is a member for defining a left-right direction of the conditioned air which is blown out from the air outlet port 13.

[0028] The filter 15 is arranged in a way that closes a gap between the air inlet port 6 and the heat exchanger 16. The air conditioner 1 has a configuration in which: the filter 15 prevents dust larger than the mesh size of the filter 15 from entering the inside of the housing 7; and by freeze washing (described later), the air conditioner 1 washes away dust which passes through the mesh of the filter 15 because of being smaller than the mesh size of the filter 15. The air conditioner 1 preferably has a configuration including a filter cleaning mechanism (not illustrated), and may be capable of automatically cleaning the filter 15 using the filter cleaning mechanism (more preferably, on a regular basis).

[0029] The air blowing fan 14 is arranged near a substantially central portion of the inside of the indoor unit 2 such that the air blowing fan 14 is capable of: suctioning the air from the air inlet port 6; and blowing out the air from the air outlet port 13. The heat exchanger 16 is arranged upstream of the air blowing fan 14 (on a side closer to the air inlet port 6), and is formed substantially in the shape of the letter V turned upside down to cover an upstream side of the air blowing fan 14.

[0030] The heat exchanger 16 includes a front heat exchanger 16F and a rear heat exchanger 16R. The front heat exchanger 16F and the rear heat exchanger 16R each include multiple fins (heat exchange plates) 20, and multiple pipes 40 penetrating through the multiple fins 20. Each fin 20 is a long thin plate-shaped member for exchanging heat between the refrigerant and the air. The fin 20 is made from, for example, an aluminum alloy. Each pipe 40 is a member in which the refrigerant flows.

[0031] With the above configuration, using the filter 15, the indoor unit 2 collects most of the dust from the indoor air suctioned into the indoor unit 2. Some of the dust, however, cannot be collected by the filter 15. Such dust passes through the mesh of the filter 15, and enters the inside of the indoor unit 2 to adhere to the heat exchanger 16. If such dust continues to adhere to the heat exchanger 16, there is likelihood that bacteria (including molds) grow and start to smell foul. With this taken into consideration, it is desirable that the air conditioner 1 be configured to remove dust which adheres to the heat exchanger 16. In this embodiment, therefore, the air conditioner 1 performs the following washing process on the heat exchanger 16 by controlling operations.

[0032] To put it specifically, to begin with, the air conditioner 1 performs an action of making frost or ice adhere to the surfaces of the fins 20 of the heat exchanger 16 (hereinafter referred to as a "freezing action") by performing an operation of decreasing the temperature of the heat exchanger 16 to cool the heat exchanger 16 quickly. In this embodiment, an operation for the freezing action is referred to as a "freezing operation."

[0033] One may consider that the freezing operation sublimes moisture in the air to make frost (including ice) directly adhere to the surfaces of the fins 20 of the heat exchanger 16 without passing the moisture through a water droplet phase. There is, however, likelihood that moisture in the air condenses on the surfaces of the fins 20 of the heat exchanger 16, and the condensed moisture freezes thereon to make frost (ice) adhere to the surfaces of the fins 20 of the heat exchanger 16 after passing through a water droplet phase.

[0034] It should be noted that during the freezing operation, the air conditioner 1 does not operate the air blowing fan 14 unlike during the normal cooling operation. This makes it possible for the air conditioner 1 to inhibit the dropping (falling) of water (condensed water) condensed on the surfaces of the fins 20 of the heat exchanger 16, and thereby to make the water (condensed water) stay on the surfaces of the fins 20 for a longer time. The air conditioner 1 can thus secure a stable amount of frozen water.

[0035] After the freezing operation, the air conditioner 1 performs an action of defrosting (melting) the frost (ice) (hereinafter referred to as a "melting action") by performing an operation of raising the temperature of the heat exchanger 16 to heat the heat exchanger 16 quickly. In this embodiment, an operation for the melting action is referred to as a "melting operation." By the melting operation, the air conditioner 1 turns the frost (ice) back into water. While turning the frost (ice) back into water, the air conditioner 1 washes down fine dust adhering to the heat exchanger 16, using momentum with which the melted (defrosted) water drops down. This makes it possible for the air conditioner 1 to enhance the maintainability of the heat exchanger 16, and accordingly to wash the heat exchanger 16 efficiently. This washing process (the washing process performed by the freezing operation and the melting operation in combination) will be hereinafter referred to as a "freeze washing."

[0036] It should be noted that using the drain pan 17, the air conditioner 1 receives water (drain water) which flows out during the melting operation. A flow passage in which the water (drain water) flows is formed in the drain pan 17. Mirror surface processing is applied to an inner wall surface of the flow passage in order to facilitate the flow of the water (drain water). A drain pipe is connected to the flow passage. The air conditioner 1 discharges the water (drain water) flowing out via the drain pipe, to the outside of the housing 7.

<Configuration of Drain Pan>

[0037] Referring to FIGS. 3 to 6, descriptions will be provided for a configuration of the drain pan 17. The embodiment will discuss the configuration in which the drain pan 17 is integrally formed in the housing 7. FIG. 3 is a perspective diagram of a drain pan section in the housing 7. FIG. 4 is a partially magnified diagram of a front drain pan 17F in the drain pan section. FIG. 5 is a graphic diagram showing a relationship between a surface area of the heat exchanger 16 and an amount of drain water produced by the freeze washing. FIG. 6 is a schematic diagram illustrating an arrangement structure of a drain pipe 22 in the drain pan section.

[0038] As illustrated in FIG. 3, the drain pan 17 includes: a rear drain pan 17R arranged under the rear heat exchanger 16R (see FIG. 2); and a front drain pan 17F arranged under the front heat exchanger 16F (see FIG. 2). In this embodiment, communicating passages 21a, 21b are provided in two sides of the rear drain pan 17R. Furthermore, drain pipes 22a, 22b are provided in two sides of the front drain pan 17F. The communicating passages 21a, 21b will be hereinafter generically referred to as a "communicating passage 21." In addition, the drain pipes 22a, 22b will be hereinafter generically referred to as a "drain pipe 22."

[0039] The rear drain pan 17R receives water which drops from the rear heat exchanger 16R (see FIG. 2). A bottom surface of the rear drain pan 17R inclines downward from its part farthest from the communicating passage 21 toward its part nearest to the communicating passage 21. In this embodiment, the bottom surface of the rear drain pan 17R has a shape in which: the bottom surface is highest around its substantially central portion in the left-right direction, and is lower in its left and right end portions than its substantially central portion. Thus, water dropping from the rear heat exchanger 16R (see FIG. 2) flows out from the rear drain pan 17R to the communicating passage 21.

[0040] A bottom surface of the communicating passage 21 inclines downward from the rear drain pan 17R toward the front drain pan 17F. Thus, water dropping from the rear heat exchanger 16R (see FIG. 2) flows out from the communicating passage 21 to the front drain pan 17F.

[0041] As illustrated in FIG. 4, the front drain pan 17F communicates with the drain pipe 22. In this embodiment, the drain pipe 22 is formed as a circular pipe which is an integral part of the housing 7. The drain pipe 22 has a structure in which its inlet 23 is opened toward the inside of the front drain pan 17F.

[0042] The front drain pan 17F receives water dropping from the front heat exchanger 16F (see FIG. 2). Furthermore, water dropping from the rear heat exchanger 16R (see FIG. 2) flows into the front drain pan 17F from the rear drain pan

17R. Water dropping from the front heat exchanger 16F (see FIG. 2) and water dropping from the rear heat exchanger 16R (see FIG. 2) are discharged to the outside of the indoor unit 2 via the drain pipe 22. The water dropping from the front heat exchanger 16F (see FIG. 2) and the water dropping from the rear heat exchanger 16R (see FIG. 2) will be hereinafter generically referred to as "drain water."

<Volume of Drain Pan>

[0043] In the indoor unit 2, the freezing operation makes a large amount of frost (or ice) adhere to the rear heat exchanger 16R and the front heat exchanger 16F per unit time, which is larger than an amount of water the normal cooling or dehumidifying operation makes adhere to the rear heat exchanger 16R and the front heat exchanger 16F per unit time. The frost (ice) having adhered to the rear heat exchanger 16R and the front heat exchanger 16F melts all at once during the melting operation. Thus, the large amount of drain water, which is larger than the amount of water produced per unit time during the normal cooling or dehumidifying operation, is produced per unit time during the freezing operation. Such a large amount of drain water drops into the rear drain pan 17R and the front drain pan 17F all at once.

[0044] If the rear drain pan 17R or the front drain pan 17F had not had a volume large enough to contain the large amount of drain water produced during the melting operation, the drain water would spill out of the front drain pan 17F or the rear drain pan 17R before the drain water is discharged to the outside of the indoor unit 2 via the drain pipes 22a, 22b. The drain water would thus leak to the outside of the indoor unit 2. With this taken into consideration, it is desirable that the air conditioner 1 be designed not to allow the large amount of drain water produced during the melting operation to leak to the outside of the indoor unit 2. It is accordingly desirable that the drain pan 17 have a volume large enough not to allow the large amount of drain water produced during the melting operation to spill out of the drain pan 17.

[0045] In view of this, in this embodiment, the indoor unit 2 is configured such that the volume of the whole drain pan 17 including the rear drain pan 17R and the front drain pan 17F is equal to or greater than a total adhesion amount of frost or ice to adhere to the heat exchanger 16 during the freezing operation. Incidentally, given that drain water is discharged to the outside of the indoor unit 2 via the drain pipe 22, the indoor unit 2 may be configured such that based on the total adhesion amount of frost or ice to adhere to the heat exchanger 16 during the freezing operation, the volume of the drain pan 17 is equal to or greater than (the total adhesion amount of frost or ice - an amount of drainage through the drain pipe 22 per unit time × a smaller one of the amount of time required for all the frost or ice to melt and the amount of time required for all the frost or ice to drop into the drain pan 17). This point will be discussed in detail later.

[0046] In this respect, FIG. 5 illustrates a relationship between the surface area of the whole heat exchanger 16 including the rear heat exchanger 16R and the front heat exchanger 16F, and the amount of drain water produced during the freeze washing (a total adhesion amount of frost or ice) . FIG. 5 shows experimental results which were measured when the air conditioner 1 performed the freeze washing under conditions: an indoor temperature of 27 °C and an indoor humidity of 35%. As illustrated in FIG. 5, in the experiment, for example, 34.2 ml of drain water was produced in a case that the surface area of the whole heat exchanger 16 including the rear heat exchanger 16R and the front hear exchanger 16F was 15 m^2. In other words, the amount w of drain water produced during the melting operation (the total adhesion amount of frost or ice) and the surface area x of the heat exchanger 16 has a relationship expressed with

$$w = 2.28x.$$

[0047] Meanwhile, in a case where the freeze washing is performed in an environment where the indoor humidity is lower than that in the experiment of FIG. 5, the amount of drain water produced after the melting of frost (ice) is smaller than that in the experiment of FIG. 5 even if the surface area x of the heat exchanger 16 and a freezing time are equal to those in the experiment of FIG. 5. In addition, in a case where the freeze washing is performed in an environment where the indoor humidity is higher than that in the experiment of FIG. 5, the amount of drain water produced after the melting of frost (ice) can be controlled by controlling the freezing time. The indoor unit 2, therefore, can prevent the drain water produced during the freeze washing from leaking to the outside of the indoor unit 2 in a case where the volume y_0 of the whole drain pan 17 including the rear drain pan 17R and the front drain pan 17F is equal to or greater than w, that is to say, (y_0=2.28x). The volume y_0 of the drain pan 17, therefore, may be equal to or greater than 2.28x.

[0048] It should be noted that the value y_0 represents the volume of the drain pan 17 which is applied in a case where the process of discharging the drain water from the front drain pan 17F to the outside of the indoor unit 2 via the drain pipe 22 is not taken into consideration. In parallel with the process of melting frost (ice), however, the indoor unit 2 actually performs the process of discharging the drain water from the front drain pan 17F to the outside of the indoor unit 2 via the drain pipe 22.

[0049] In a case where, therefore, the drain water discharging process is taken into consideration, the indoor unit 2 allows the volume of the drain pan 17 to be set at a value y_1 obtained by subtracting a drainage amount (for example,

x) of drain water to be discharged through the drainage process from the above value y_0. In other words, in the case where the drain water discharging process is taken into consideration, the indoor unit 2 can prevent the drain water produced through the freeze washing from leaking to the outside of the indoor unit 2 when the volume y_1 of the whole drain pan 17 including the rear drain pan 17R and the front drain pan 17F is equal to or greater than (w-x), that is to say, (y_1=(2.28-1)x). In the case where, therefore, the drain water discharging process is taken into consideration, the volume y_1 of the drain pan 17 may be equal to or greater than (2.28-1)x.

[0050] In the value (2.28-1)x, the value 2.28x corresponds to the "total adhesion amount (m^3) of frost or ice," while the value x corresponds to the "amount (m^3/s) of drainage through the drain pipe 22 per unit time × the smaller one (s) of the amount of time required for all the frost or ice to melt and the amount of time required for all the frost or ice to drop into the drain pan 17. " In other words, the indoor unit 2 can prevent the drain water produced during the freeze washing from leaking to the outside of the indoor unit 2 in the case where the volume y_1 of the drain pan 17 to be calculated with the drain water discharging process taken into consideration is equal to or greater than (the total adhesion amount (m^3) of frost or ice - the amount (m^3/s) of drainage through the drain pipe 22 per unit time × the smaller one (s) of the amount of time required for all the frost or ice to melt and the amount of time required for all the frost or ice to drop into the drain pan 17).

[0051] It should be noted that whether to use the value y_0 or the value y_1 as the volume of the drain pan 17 may be chosen depending on the operation. In a case where the value y_0 is used as the volume of the drain pan 17, the volume of the drain pan 17 is larger than otherwise, and the size of the indoor unit 2 is accordingly larger than otherwise. In exchange for this, however, a larger margin can be set for the spill of the drain water out of the drain pan 17. On the other hand, in a case where the value y_1 is used as the volume of the drain pan 17, the volume of the drain pan 17 can be made smaller, and the size of the indoor unit 2 can be accordingly reduced.

[0052] It is desirable that the indoor unit 2 not only include the drain pan 17 which is provided with a volume large enough not to allow the large amount of drain water produced during the melting operation to spill out of the drain pan 17, but also have a structure which facilitates the discharging of all the drain water to the outside of the indoor unit 2 through the drain pipe 22 without spilling the drain water out of the front drain pan 17F. In this respect, "all the drain water" means a total of the drain water dropping from the rear heat exchanger 16R and the drain water dropping from the front heat exchanger 16F.

[0053] To this end, in this embodiment, the indoor unit 2 is configured such that an inner diameter R (see FIG. 6) of the drain pipe 22 and a depth h (see FIG. 6) of the front drain pan 17F satisfy a relationship expressed with Equation (9) given below. This point will be discussed in detain later.

[0054] In this respect, a flow rate of the drain water flowing in the drain pipe 22 per unit time is a product of a cross-sectional area of the inside of the drain pipe 22 made of a circular pipe and an outflow speed of the drain water. The flow rate "Q" (m^3/s) of the drain water flowing in the drain pipe 22 per unit time, therefore, has a relationship expressed with

$$Q = r^2 \pi v \qquad \text{... Equation (1)}$$

Where r is a radius (m) of the drain pipe 22 with the inner diameter R (m) (that is to say, R=2r), and v is the outflow speed (m^3/s) of the drain water flowing in the drain pipe 22.

[0055] Furthermore, based on Torricelli's law, the outflow speed "v" (m^3/s) of the drain water flowing in the drain pipe 22 has a relationship expressed with

$$v = \sqrt{2gh} \qquad \text{... Equation (2)}$$

where h is the depth (m) of the front drain pan 17F, and g is a gravitational acceleration (m/s^2). Incidentally, Torricelli's law is a law on an outflow speed of a liquid which flows out of a container through a relatively small hole made in a side surface of the container. Furthermore, the depth "h" of the front drain pan 17F is a value representing the distance from the upper limit surface of the front drain pan 17F which does not allow the drain water to spill out of the front drain pan 17F to a bottom surface BS1 of the front drain pan 17F.

[0056] By substituting Equation (2) for v in Equation (1),

$$Q = r^2 \pi \sqrt{2gh} \qquad \text{... Equation (3)}$$

is obtained.

[0057] In this respect, the flow rate "Q" of the drain water flowing in the drain pipe 22 per unit time is a flow rate at which the amount "w" (m^3) of drain water (the total adhesion amount "w" (m^3) of frost or ice) produced during the melting operation per hour (3600 seconds), that is to say, "w×10^6" (mm^3), flows in the drain pipe 22. In addition, the amount "w" of drain water (the total adhesion amount "w" of frost or ice) corresponds to the volume y_0 required for the drain pan 17. The flow rate "Q" of the drain water flowing in the drain pipe 22 per unit time, therefore, has a relationship expressed with

$$Q = \frac{w \times 10^6}{3600} = \frac{y_0 \times 10^6}{3600}$$

... Equation (4).

[0058] By substituting Equation (4) for Q in Equation (3),

$$r^2 \pi \sqrt{2gh} = \frac{y_0 \times 10^6}{3600}$$

... Equation (5)

is obtained.

[0059] From Equation (5),

$$r^2 \sqrt{h} = \frac{y_0 \times 10^6}{3600 \pi \sqrt{2g}}$$

... Equation (6)

is obtained.

[0060] Furthermore, from Equation (6),

$$r \sqrt[4]{h} = \sqrt{\frac{y_0 \times 10^6}{3600 \pi \sqrt{2g}}} = 14 \sqrt{\frac{y_0}{\pi \sqrt{g}}}$$

... Equation (7)

is obtained.

[0061] Since the inner diameter "R" of the drain pipe 22 is equal to 2r, from Equation (7),

$$2r \sqrt[4]{h} = 28 \sqrt{\frac{y_0}{\pi \sqrt{g}}}$$

... Equation (8)

is obtained.

[0062] When the inner diameter "R" of the drain pipe 22 is set larger than a value which satisfies the relationship expressed with Equation (8), the drain pipe 22 can easily discharge all the drain water to the outside of the indoor unit 2 through the drain pipe 22 without spilling the drain water out of the front drain pan 17F. When, therefore, the inner diameter R (FIG. 6) of the drain pipe 22 and the depth h (FIG. 6) of the front drain pan 17F are set in a way that satisfies a relationship expressed with

$$R \sqrt[4]{h} > 28 \sqrt{\frac{y_0}{\pi \sqrt{g}}}$$

... Equation (9),

the drain pipe 22 can easily discharge all the drain water to the outside of the indoor unit 2 through the drain pipe 22 without spilling the drain water out of the front drain pan 17F.

[0063] It should be noted that: y_0 represents the volume of the whole drain pan 17 including the rear drain pan 17R and the front drain pan 17F; and the volume y_0 of the whole drain pan 17 and the surface area x of the whole heat exchanger 16 including the rear heat exchanger 16R and the front heat exchanger 16F has a relationship expressed with

$$y_0 = 2.28x.$$

Incidentally, the inner diameter R of the drain pipe 22 preferably may be equal to or greater than 11 mm, for example.

[0064] The indoor unit 2 is configured such that the inner diameter R of the drain pipe 22 and the depth h of the front drain pan 17F satisfy the relationship expressed with Equation (9) . The indoor unit 2 like this can discharge the drain water to the outside of the indoor unit 2 before the drain water spills out of the front drain pan 17F. Furthermore, the indoor unit 2 can excellently discharge the large amount of drain water produced during the freeze washing without uselessly increasing the size of the housing 7.

[0065] It should be noted that as illustrated in FIG. 6, the drain pipe 22 may be arranged such that a center axis C22 of the drain pipe 22 inclines downward from the inlet 23 to an outlet 24 of the drain pipe 22. Thus, the indoor unit 2 can smoothly discharge the drain water, which collects in the front drain pan 17F, to the outside of the indoor unit 2.

[0066] Furthermore, during the freeze washing, dust having adhered to the front heat exchanger 16F and the rear heat exchanger 16R flows down together with the drain water. In the vicinity of the inlet 23 of the drain pipe 22, therefore, the drain water and the dust mix together into sludge and easily accumulate. Accordingly, the drain water and the dust in the form of sludge are highly likely to enter the inside of the drain pipe 22.

[0067] Because of the slanting arrangement of the drain pipe 22, however, the indoor unit 2 makes it easy for the drain water and the dust, which enters the inside of the drain pipe 22, to drop due to their own weights. Even if, therefore, the drain water and the dust in the form of sludge flow into the drain pipe 22, the indoor unit 2 can excellently send out the drain water and the dust to the outside of the indoor unit 2. The indoor unit 2 like this can keep the inside of the drain pipe 22 in a condition suitable to discharge the drain water. The indoor unit 2 further can inhibit the drain water and the dust from accumulating around the inlet 23 of the drain pipe 22. The indoor unit 2 accordingly can improve the efficiency of discharging the drain water which collects in the front drain pan 17F.

[0068] Meanwhile, the shape of the bottom surface BS1 of the front drain pan 17F may be changed, for example, as illustrated in FIG. 7. FIG. 7 is a schematic diagram illustrating another arrangement structure of the drain pipe 22. As illustrated in FIG. 7, the front drain pan 17F has a structure in which in the vicinity of the inlet 23 of the drain pipe 22, a bottom surface BS2 of the front drain pan 17F inclines downward from a side farthest from the inlet 23 of the drain pipe 22 toward a side nearest to the inlet 23 of the drain pipe 22. In other words, the front drain pan 17F has a shape in which in the vicinity of the outlet of the flow passage, a recessed part is formed in the bottom surface of the front drain pan 17F. Furthermore, an inclination angle $\alpha 22$ of the center axis C22 of the drain pipe 22 is equal to or greater than an inclination angle $\alpha 17$ of the bottom surface BS1 of the front drain pan 17F in the vicinity of the inlet 23 of the drain pipe 22. The indoor unit 2 like this facilitates the flow of the drain water including the dust, which collects in the front drain pan 17F, toward the drain pipe 22 due to the drain water's own weight. The indoor unit 2, therefore, can discharge the drain water, which collects in the front drain pan 17F, more smoothly that in the case where the indoor unit 2 has the configuration illustrated in FIG. 6. The indoor unit 2 accordingly can improve the efficiency of discharging the drain water which collects in the front drain pan 17F.

[0069] The shape of the inlet 23 of the drain pipe 22 may be changed, for example, as illustrated in FIGS. 8 or 9. FIG. 8 is a schematic diagram illustrating an inlet structure of the drain pipe 22. FIG. 9 is a schematic diagram illustrating another inlet structure of the drain pipe 22.

[0070] In a case illustrated in FIG. 8, the inlet 23 of the drain pipe 22 has a shape in which a lower half circumference of the inlet 23 of the drain pipe 22 extend toward the front of the inlet 23 of the drain pipe 22. Thereby, the indoor unit 2 is configured such that an opening area S23 of the inlet 23 of the drain pipe 22 is larger than a cross-sectional area S22M of the drain pipe 22 in the vicinity of the center of the drain pipe 22.

[0071] Meanwhile, in a case illustrated in FIG. 9, an inlet 123 of the drain pipe 22 is formed in the shape of an ellipse facing upward. Thereby, the indoor unit 2 is configured such that an opening area S123 of the inlet 123 of the drain pipe 22 is larger than the cross-sectional area S22M of the drain pipe 22 in the vicinity of the center of the drain pipe 22.

[0072] With the configuration illustrated in FIG. 8 or FIG. 9, the drain pipe 22 can efficiently take the drain water, which collects in the front drain pipe 17F, into the drain pipe 22, and discharge it to the outside. Thereby, the indoor unit 2 can efficiently take the drain water including the dust into the drain pipe 22. Even if, therefore, in the vicinity of the inlet 23 of the drain pipe 22, the drain water and the dust mix into sludge and become hard to discharge, the indoor unit 2 can excellently take the drain and the dust into the drain pipe 22, and make them go out to the outside of the indoor unit 2. Thus, the indoor unit 2 can inhibit the drain water and the dust from accumulating around the inlet 23 of the drain pipe 22. The indoor unit 2 accordingly can improve the efficiency of discharging the drain water which collects in the front drain pan 17F.

<Modifications to Drain Pan Section in Housing>

[0073] The drain pan section of the housing 7 may be changed, for example, to those of housings 7A, 7B, 7C illustrated in FIGS. 10A to 10C. FIGS. 10A to 10C are schematic diagrams illustrating modifications of the drain pan section of the housing 7.

[0074] The housing 7A in an example illustrated FIG. 10A is different from the housing 7 illustrated in FIG. 3 in that: the rear drain pan 17R has a shape extended in the left-right direction; and the communicating passages 21a, 21b are arranged in places on a front side of the rear drain pan 17R. In the housing 7A, specifically, the communicating passages 21a, 21b are arranged in locations near both left and right sides of the rear drain pan 17R. Furthermore, the bottom surfaces of the communicating passages 21a, 21b are formed inclining downward from the rear drain pan 17R toward the front drain pan 17F.

[0075] The housing 7B in an example illustrated FIG. 10B is different from the housing 7 illustrated in FIG. 3 in that: the communicating passage 21 is arranged only in a location on either of the left and right sides of the rear drain pan 17R. Furthermore, the bottom surface of the rear drain pan 17R is formed inclining downward from a side farthest from the communicating passage 21 toward a side nearest to the communicating passage 21.

[0076] The housing 7C in an example illustrated FIG. 10C is different from the housing 7B illustrated in FIG. 10B in that: the rear drain pan 17R has a shape extended in the left-right direction; and the communicating part 21 is arranged in a location on a front side of the rear drain pan 17R.

[0077] Like in the housings 7A, 7B, 7C illustrated in FIGS. 10A to 10C, the communicating passage 21 may be arranged in locations near both the left and right sides of the rear drain pan 17R, in a location of either the left or right side of the rear drain pan 17R, or in a location near either the left or right side of the rear drain pan 17R, instead of being arranged on the two sides of the front drain pan 17F and the rear drain pan 17R. The communicating passage 21 thus can make the front drain pan 17F and the rear drain pan 17R communicate with each other. Furthermore, the bottom surface of the rear drain pan 17R is formed such that the bottom surface thereof is slightly lower on the sides nearest to the communicating passages 21a, 21b than on the sides farthest from the communicating passages 21a, 21b. The housings 7A, 7B, 7C like this illustrated in FIGS. 10A to 10C can increase freedom in the arrangement structure of the communicating passage 21, and can improve the efficiency of discharging the drain water which drops from the rear heat exchanger 16R into the rear drain pan 17R.

[0078] It should be noted that combinations of the structures illustrated in FIGS. 6 to 10C depending on the necessity makes it possible for the inner unit 2 to inhibit the drain water and the dust from accumulating near the inlet 23 of the drain pipe 22. The indoor unit 2 thus can improve the efficiency of discharging the drain water which collects in the front drain pan 17F.

<Main Features of Indoor Unit>

[0079]

(1) In the indoor unit 2 according to this embodiment, the volume of the drain pan 17 is equal to or greater than the total adhesion amount w of frost or ice to adhere to the heat exchanger 16 during the freezing operation. Incidentally, given that the drain water is discharged to the outside of the indoor unit 2 via the drain pipe 22, the indoor unit 2 preferably may be configured such that the volume of the drain pan 17 is equal to or greater than (the total adhesion amount of frost or ice - the amount of drainage through the drain pipe 22 per unit time × a smaller one of the amount of time required for all the frost or ice to melt and the amount of time required for all the frost or ice to drop into the drain pan 17). In this case, the configuration may be such that the volume of the whole drain pan 17 including the rear drain pan 17R and the front drain pan 17F is equal to or greater than (2.28-1)x, where x is the surface area of the whole heat exchanger 16 including the rear heat exchanger 16R and the front heat exchanger 16F.
In the indoor unit 2 like this, the drain pan 17 has the volume large enough not to allow the large amount of drain water produced during the melting operation to spill out of the drain pan 17. The indoor unit 2, therefore, can prevent the drain water from leaking to the outside of the indoor unit 2 during the freeze washing.

(2) The communicating passage 21 may be configured such that: the communicating passage 21 is arranged in the locations of both the left and right sides of the rear drain pan 17R, or in the locations near both the left and right sides of the rear drain pan 17R; and the bottom surface of the communicating passage 21 inclines downward from the rear drain pan 17R toward the front drain pan 17F (see FIG. 3 or FIG. 10A).
Otherwise, the communicating passage 21 may be configured such that: the communicating passage 21 is arranged in the location of either the left or right side of the rear drain pan 17R, or in the location near either the left or right side of the rear drain pan 17R: and the bottom surface of the communicating passage 21 inclines downward from

the rear drain pan 17R toward the front drain pan 17F (see FIG. 10B or FIG. 10C). In the case of this configuration, the bottom surface of the rear drain pan 17R may be configured to incline downward from the side farthest from the communicating passage 21 toward the side nearest to the communicating passage 21.

The indoor unit 2 like this can increase the freedom in the arrangement structure of the communicating passage 21, and can improve the efficiency of discharging the drain water which drops from the rear heat exchanger 16R into the rear drain pan 17R.

(3) The inner diameter R of the drain pipe 22 and the depth h of the front drain pan 17F may satisfy a relationship expressed with

$$R\sqrt[4]{h} > 28\sqrt{\frac{y_0}{\pi\sqrt{g}}} \quad \text{… Equation (10)}$$

where g is the gravitational acceleration, and y_0 is the volume of the whole drain pan 17 including the rear drain pan 17R and the front drain pan 17F.

The indoor unit 2 like this can discharge the drain water to the outside of the indoor unit 2 before the drain water spills out of the front drain pan 17F. Furthermore, the indoor unit 2 can excellently discharge the large amount of drain water produced during the freeze washing without uselessly increasing the size of the housing 7.

(4) At least in the vicinity of the inlet 23 of the drain pipe 22, the bottom surface of the front drain pan 17F inclines downward from the side farthest from the inlet 23 of the drain pipe 22 toward the side nearest to the inlet 23 of the drain pipe 22 (see FIG. 7).

The indoor unit 2 like this can excellently send out the drain water and the dust to the outside of the indoor unit, even if in the vicinity of the inlet 23 of the drain pipe 22, the drain water and the dust mix into sludge, as well as the drain water and the dust in the form of sludge flow into the drain pipe 22 in the form of sludge. The indoor unit 2 like this can keep the inside of the drain pipe 22 in the condition suitable to discharge the drain water. The indoor unit 2 further can inhibit the drain water and the dust from accumulating around the inlet 23 of the drain pipe 22. The indoor unit 2 accordingly can improve the efficiency of discharging the drain water which collects in the front drain pan 17F.

(5) The drain pipe 22 is arranged such that the center axis C22 inclines downward from the inlet 23 toward the outlet 24. Furthermore, the inclination angle α22 of the center axis C22 of the drain pipe 22 is equal to or greater than the inclination angle α17 of the bottom surface BS2 of the front drain pan 17F in the vicinity of the inlet 23 of the drain pipe 22 (see FIG. 7) .

The indoor unit 2 makes it easy for the drain water including the dust, which collects in the front drain pan 17F, to flow toward the drain pipe 22 due to the weight of the drain water's own. The indoor unit 2, therefore, can smoothly discharge the drain water which collects in the front drain pan 17F. The indoor unit 2 accordingly can improve the efficiency of discharging the drain water which collects in the front drain pan 17F.

(6) The indoor unit 2 may be configured such that the opening surface S23 of the inlet 23 (the opening surface S123 of the inlet 123) of the drain pipe 22 is greater than the cross-sectional area S23M of the drain pipe 22 in the vicinity of the center of the drain pipe 22 (see FIGS. 8 and 9).

[0080] The indoor unit 2 like this can efficiently take the drain water including the dust, which collects in the front drain pan 17F, into the drain pipe 22, and can discharge the drain water including the dust to the outside of the indoor unit 2 through the drain pipe 22. Thus, the indoor unit 2 can efficiently take the drain water including the dust into the drain pipe 22. Even if, therefore, in the vicinity of the inlet 23 of the drain pipe 22, the drain water and the dust mix into sludge and become hard to discharge, the indoor unit 2 can excellently take the drain and the dust into the drain pipe 22, and send the drain water and the dust out to the outside of the indoor unit 2 through the drain pipe 22. Thus, the indoor unit 2 can inhibit the drain water and the dust from accumulating around the inlet 23 of the drain pipe 22. The indoor unit 2 accordingly can improve the efficiency of discharging the drain water which collects in the front drain pan 17F.

[0081] As discussed above, the indoor unit 2 for the air conditioner 1 according to the first embodiment is capable of preventing the water from leaking to the outside of the indoor unit 2 during the freeze washing.

[Second Embodiment]

[0082] The second embodiment provides an indoor unit 2A with the following points taken into consideration.

(1) If drain water and dust remain inside the drain pan 17, there is concern that the water may leak next time the freeze washing is performed, or bacteria (including molds) may grow in the drain water and dust. With this concern

taken into consideration, in the indoor unit 2A, an uneven part 130 (see FIGS. 11 and 12), although discussed later, is provided inside the drain pan 17 to decrease surface tension (bonding force) of the drain water, and to thus facilitate the flow of the drain water. Thereby, the indoor unit 2A facilities the flow of the dust together with the drain water, and reduces an amount of dust which remains inside the drain pan 17. Incidentally, the uneven part 130 (see FIG. 12), although discussed later, is not provided in a place immediately before the inlet 23 (see FIG. 12) of the drain pipe 22. This inhibits accumulation of the dust around the inlet 23 of the drain pipe 22.

(2) There is likelihood that during the freeze washing, cold drain water flows into the drain pan 17, and makes moisture in the air condenses into condensation water to adhere to various portions of the drain pan 17 (for example, a lower surface of the front drain pan 17F). In the case where, for example, the condensation water adheres to the lower surface of the front drain pan 17F, there is likelihood that the condensation water drops into the air outlet port 13 (see FIG. 2), and is thus spread into the room. Thereby, the condensation water leaks to the outside of the indoor unit 2A. With this taken into consideration, in the indoor unit 2A, a heat insulating material (foamed resin material) 111 (see FIGS. 11 and 12) and the like, although discussed later, are arranged in various portions of the drain pan 17 to inhibit the condensation. Incidentally, the indoor unit 2A has a configuration which is designed with arrangement positions and shapes of the later-discussed heat insulating material (foamed resin material) 111 taken into consideration in order not to decrease the drainage efficiency by decreasing the outflow speed of the drain water during the drainage.

(3) It is difficult to process the housing 7 which includes the drain pan 17. For this reason, in the indoor unit 2A, the later-discussed uneven part 130 (see FIGS. 11 and 12) is provided inside the drain pan 17 by use of a member separate from the housing 7 including the drain pan 17. To put it specifically, the later-discussed uneven part 130 is formed on the later-discussed heat insulating member (foamed resin material) 111 (see FIGS. 11 and 12) or the like in advance, and the resultant heat insulating member (foamed resin material) 111 or the like is arranged on an upper surface of the inside of the drain pan 17. Thereby, the later-discussed uneven part 130 is provided inside the drain pan 17.

(4) If a gap is formed between the heat exchanger 16 and the drain pan 17, the gap forms an air passage through which air passes instead of passing through the heat exchanger 16. This decreases the heat exchanging efficiency of the indoor unit 2A. Furthermore, there is likelihood that the gap may allow water to drop through the gap (water to leak to the outside of the indoor unit 2A). With these taken into consideration, the indoor unit 2A has a configuration in which the heat exchanger 16 and the drain pan 17 are arranged in close contact with each other, that is to say, a configuration in which no gap is formed between the heat exchanger 16 and the drain pan 17 (see FIG. 16) .

[0083] Referring to FIGS. 11 to 16, descriptions will be hereinbelow provided for a configuration of the indoor unit 2A according to the second embodiment. FIG. 11 is a perspective diagram of a drain pan section in a housing 107 to be used for the indoor unit 2A. FIG. 12 is a partially-magnified diagram of the front drain pan 17F in the drain pan section. FIG. 12 is a magnified diagram illustrating the configuration of an A section and its vicinity in FIG. 11. FIG. 13 is a perspective diagram of the heat insulating material (foamed resin material) 111 to be used in the second embodiment. FIGS. 14 and 15 are partially-magnified diagrams of a drainage part 120 in the front drain pan 17F. FIG. 14 illustrates a configuration of the drainage part 120 taken along the B-B line in the FIG. 12. FIG. 15 illustrates a configuration of the drainage part 120 taken along the C-C line in the FIG. 12, but near the inlet 23 of the drain pipe 22. FIG. 16 is a schematic diagram illustrating an arrangement relationship between the front heat exchanger 16F and the front drain pan 17F.

[0084] The following points make the indoor unit 2A according to the second embodiment different from the indoor unit 2 (see FIG. 2) according to the first embodiment.

(1) The heat insulating material 111 with a projecting part 112 formed thereon is attached to the front side of a pan part 110 in the front drain pan 17F (FIGS. 11 and 12). The pan part 110 is a flow passage section in the front drain pan 17F which extends in the left-right direction of the front drain pan 17F.

(2) Projecting parts 122 are formed on the drainage part 120 in the front drain pan 17F (see FIGS. 11 and 12). The drainage part 120 is a flow passage section in the front drain pan 17F which extends in the front-rear direction of the front drain pan 17F.

(3) A heat insulating material 161 with a projecting part 162 formed thereon is attached to a pan part 160 in the rear drain pan 17R (see FIG. 11). The pan part 160 is a flow passage section in the rear drain pan 17R which extends in the left-right direction of the rear drain pan 17R.

(4) Projecting parts 172 are formed in the communicating passage 21 (see FIG. 11).

(5) A heat insulating material 211 is attached to the back side of the drainage part 120 in the front drain pan 17F in the vicinity of the inlet 23 of the drain pipe 22.

[0085] The heat insulating material 111 (see FIGS. 11 and 12), the heat insulating material 161 (see FIG. 11) and the heat insulating material 211 (see FIG. 15) are members which are attached to the housing 107 of the indoor unit 2A to inhibit moisture in the air from condensing on various portions of the drain pan 17 due to cold drain water which flows into the drain pan 17 during the freeze washing. The indoor unit 2A can inhibit moisture in the air from condensing into condensation water to adhere to the drain pan 17, using the heat insulating materials 111, 161, 211 which are arranged on the respective portions of the drain pan 17.

[0086] These heat insulating materials 111, 161, 211 are made of foamed resin material with low hygroscopicity, such as foamed styrol or foamed urethane. Particularly, the heat insulating materials 111, 161 in which their respective flow passages in which drain water flows are formed are made of material with low hygroscopicity, and the surfaces of the heat insulating materials 111, 161 are water-repellent. Since the heat insulating materials 111, 161 like this absorb no water, they can inhibit the growth of molds. Furthermore, the heat insulating materials 111, 161 can make it easy to evaporate drain water flowing into the respective flow passage sections. The heat insulating materials 111, 161 can accordingly contribute to decreasing the size of the drain pan 17. Incidentally, mirror surface processing preferably may be applied to the flow passage sections in the heat insulating materials 111, 161 in order to facilitate the flow of the drain water.

[0087] FIG. 13 illustrates an example of the heat insulating material 111. The heat insulating material 111 has a structure which enables the heat insulating material 111 to be attached to the drainage part 120 in the inside of the front drain pan 17F which extends in the front-rear direction of the front drain pan 17F. As illustrated in FIG. 13, the projecting part 112 is formed on an upper surface of the heat insulating material 111. The projecting part 112 is formed extending in a direction in which the drain water flows (a direction in which the flow passage extends). The projecting part 112 functions as the uneven part 130 for decreasing the surface tension (boding force) of the drain water. The indoor unit 2A decreases the surface tension (boding force) of the drain water by use of the projecting part 112 on the heat insulating material 111, and can facilitate the flow of the drain water by allowing droplets of the drain water to flow as they are without having to wait until the droplets grow into drops through bonding. Thereby, the indoor unit 2A facilitates the flow of dust together with the drain water, and decreases an amount of dust which remains inside the drain pan 17.

[0088] The heat insulating material 161 (see FIG. 11) has the same shape as the heat insulating material 111. The heat insulating material 161 has a structure which enables the heat insulating material 161 to be attached to the inside of the rear drain pan 17R. A projecting part 162, which is similar to the projecting part 112, is formed on an upper surface of the heat insulating material 161. The projecting part 162 is formed extending in the direction in which the drain water flows (the direction in which the flow passage extends).

[0089] The heat insulating material 211 (see FIG. 15) has a structure which enables the heat insulating material 211 to be attached to a space located near the inlet 23 of the drain pipe 22, and formed under the drainage part 120 in the front drain pan 17F.

[0090] The projecting parts 122 are formed on the drainage part 120 in the front drain pan 17F (see FIGS. 11 and 12). Each projecting part 122 is formed extending in the direction in which the drain water flows (the direction in which the flow passage extends) . In this embodiment, the upper surface of the projecting part 122 is formed in the shape of a substantially flat surface (see FIG. 14) . Like the projecting part 112, the projecting parts 122 function as the uneven part 130 for decreasing the surface tension (boding force) of the drain water.

[0091] The projecting parts 122 are formed on the drainage part 120 except for in a place immediately before the inlet 23 of the drain pipe 22 (see FIG. 12). Thereby, the indoor unit 2A inhibits accumulation of dust around the inlet 23 of the drain pipe 22.

[0092] In this embodiment, the projecting parts 122 have a configuration in which the projecting parts 122 are formed directly on the housing 107 which includes the front drain pan 17F. Instead, however, the indoor unit 2A may be designed such that: the projecting parts 122 are beforehand formed on a member (not illustrated) separate from the housing 107; and the projecting parts 122 are arranged on the drainage part 120 by attaching the separate member to the drainage part 120.

[0093] It should be noted that a bottom surface of the drainage part 120 in the front drain pan 17F has a shape in which the bottom surface inclines downward toward the inlet 23 of the drain pipe 22 (FIG. 12). In other words, the drainage part 120 in the front drain pan 17F has a shape in which a recessed portion is formed in the bottom surface near the outlet of the flow passage. Thereby, the indoor unit 2A facilitates the flow of the drain water toward the inlet 23 of the drain pipe 22.

[0094] The communicating passage 21 is provided with the projecting parts 172 (see FIG. 11). The projecting parts 172 are formed extending in the direction in which the drain water flows (the direction in which the flow passage extends). In this embodiment, the projecting parts 172 have a configuration in which the projecting parts 172 are formed directly on the housing 107 which includes the front drain pan 17F.

[0095] As illustrated in FIG. 16, in this embodiment, the heat exchanger 16 (in the illustrated example, the front heat exchange 16F) and the drain pan 17 (in the illustrated example, the front drain pan 17F) are arranged in contact with each other to close a gap between the space where the air blowing fan 14 (see FIG. 2) is arranged and a space outside the space. Thereby, the indoor unit 2A has a configuration in which the heat exchanger 16 (in the illustrated example, the front heat exchange 16F) and the drain pan 17 (in the illustrated example, the front drain pan 17F) are arranged in close contact with each other, that is to say, a configuration in which no gap is formed between the heat exchanger 16 and the drain pan 17. The indoor unit 2A like this can inhibit a decrease in the heat exchanging efficiency, and the occurrence of water droppings (leakage of water to the outside of the indoor unit 2A) which would occur if a gap were formed between the heat exchanger 16 and the drain pan 17.

[0096] It should be noted that because of the arrangement of the heat exchanger 16 and the drain pan 17 in close contact with each other, the indoor unit 2A can facilitate the movement of condensation water adhering to the fins 20 of the heat exchanger 16 from the fins 20 of the heat exchanger 16 to the drain pan 17. Thereby, the indoor unit 2A can improve the efficiency of washing down the dust which adheres to the heat exchanger 16.

<Modifications>

[0097] The heat insulation material (foamed resin material) 111 used in the pan part 110 in the front drain pan 17F may be changed to those illustrated in FIGS. 17 and 18, for example. FIG. 17 is a schematic diagram of a heat insulating material (foamed resin material) 111A according to a modification. FIG. 17A illustrates a shape of the heat insulating material 111A which is viewed from above. FIG. 17B illustrates a cross-sectional shape of the heat insulating material 111A. FIG. 18 is a schematic diagram of a heat insulating material (foamed resin material) 111B according to another modification, and illustrates a shape of the heat insulating material 111B which is viewed from above.

[0098] In an example illustrated in FIG. 17A, the heat insulating material 111A has a configuration in which: multiple substantially rectangular projecting parts 212 are arranged at equal intervals in the vertical and horizontal directions; and recessed parts 213 are formed between the projecting parts 212. As illustrated in FIG. 17B, each recessed part 213 is substantially shaped like a triangle which becomes wider upward. The recessed parts 213 are formed with a depth h213, with a width t213, and at equal intervals.

[0099] The heat insulating material 111A like this decreases the surface tension (boding force) of the drain water by use of the projecting parts 212, and can facilitate the flow of the drain water by allowing droplets of the drain water to flow as they are without having to wait until the droplets grow into drops through bonding. Thereby, using the heat insulating material 111A, the indoor unit 2A facilitates the flow of the dust together with the drain water, and can decrease an amount of dust which remains inside the drain pan 17. Furthermore, since the projecting parts 212 are formed in the flow passage section, the heat insulating material 111A has a larger surface area than the heat insulating material 111 (see FIG. 13). Thus, the heat insulating material 111A makes it easier for drain water flowing into the flow passage section to evaporate than the heat insulating material 111 (see FIG. 13).

[0100] The heat insulating material 111B in an example illustrated in FIG. 18 is different from the heat insulating material 111A (see FIG. 18) in that the heat insulating material 111B has a configuration in which the projecting parts 212 are staggered one after another. Like the heat insulating material 111A, the heat insulating material 111B decreases the surface tension (boding force) of the drain water by use of the projecting parts 212, and can facilitate the flow of the drain water. Furthermore, like the heat insulating material 111A, the heat insulating material 111B has a larger surface area than the heat insulating material 111 (see FIG. 13), since the projecting parts 212 are formed in the flow passage section. Thus, like the heat insulating material 111A, the heat insulating material 111B makes it easier for drain water flowing into the flow passage section to evaporate than the heat insulating material 111 (see FIG. 13).

[0101] Moreover, the shape of the drainage part 120 in the front drain pan 17F may be changed to that illustrated in FIG. 19, for example. FIG. 19 is a schematic diagram of the drainage part 120 in the front drain pan 17F according to another modification.

[0102] In an example illustrated in FIG. 19, multiple (in the illustrated example, two) projecting parts 122A are formed on the bottom surface of the drainage part 120. Each projecting part 122A is substantially shaped like a triangle which becomes narrower upward. Each projecting part 122A is formed extending in the direction in which the drain water flows (the direction in which the flow passage extends) . Each projecting part 122A is formed with a depth h122A, and with a width t122A. The drainage part 120 like this decreases the surface tension (bonding force) of the drain water by use of the projecting parts 122A, and can facilitate the flow of the drain water.

[0103] As discussed above, the indoor unit 2A according to the second embodiment is capable of preventing the water from leaking to the outside of the indoor unit 2A during the freeze washing, like the indoor unit 2 according to the first embodiment.

[0104] Furthermore, the indoor unit 2A can improve the drainage efficiency since the indoor unit 2A can facilitate the flow of the drain water. Moreover, the indoor unit 2A can inhibit moisture in the air from condensing to adhere to the drain pan 17.

Reference Signs List

[0105]

1 air conditioner
2, 2A indoor unit
3 outdoor unit
5 connecting pipe
6 air inlet port
7, 7A, 7B, 7C, 107 housing
8 decorative frame
9 front panel
10 receiver
11 display
12 remote controller
13 air outlet port
14 air blowing fan
15 filter
16 heat exchanger
16F front heat exchanger
16R rear heat exchanger
17 drain pan
17F front drain pan
17R rear drain pan
18 up-down wind direction board
19 left-right wind direction board
20 fin
21 (21a, 21b) communicating passage
22 (22a, 22b) drain pipe
23 inlet of drain pipe
24 outlet of drain pipe
40 pipe
110, 160 pan part
111, 111A, 111B, 161, 211 heat insulating material (foamed resin material)
112, 122, 122A, 162, 172, 212 projecting part
120 drainage part
130 uneven part
213 recessed part
BS1 bottom surface of front drain pan
BS2 bottom surface of front drain pan near inlet of drain pipe
CL controller
C22 center axis of drain pipe
H122A height of projecting part
H213 depth of recessed part
S22M cross-sectional area of drain pipe near center of drain pipe
S23, S123 opening area of inlet of drain pipe
t122A distance between each two adjacent projecting parts
t213 width of recessed part
α22 inclination angle of drain pipe

Claims

1. An indoor unit for an air conditioner, comprising:

a heat exchanger for exchanging heat between air and refrigerant;
a drain pan for receiving drain water which drops from the heat exchanger; and
a controller for controlling a freezing operation of making frost or ice adhere to a surface of the heat exchanger, wherein
a volume of the drain pan is equal to or greater than a total adhesion amount of frost or ice to adhere to the heat exchanger during the freezing operation.

2. A indoor unit for an air conditioner, comprising:

a heat exchanger for exchanging heat between air and refrigerant;
a drain pan for receiving drain water which drops from the heat exchanger;
a controller for controlling a freezing operation of making frost or ice adhere to a surface of the heat exchanger; and
a drain pipe for discharging the drain water, which collects in the drain pan, from the drain pan to an outside of the indoor unit, wherein
based on a total adhesion amount of frost or ice to adhere to the heat exchanger during the freezing operation, a volume of the drain pan is equal to or greater than (the total adhesion amount of frost or ice - an amount of drainage through the drain pipe per unit time × a smaller one of an amount of time required for all the frost or ice to melt and an amount of time required for all the frost or ice to drop into the drain pan).

3. A indoor unit for an air conditioner, comprising:

a rear heat exchanger, arranged in a rear portion of the indoor unit, for exchanging heat between air and refrigerant;
a front heat exchanger, arrange in a front portion of the indoor unit, for exchanging heat between air and refrigerant;
a rear drain pan for receiving drain water which drops from the rear heat exchanger;
a front drain pan for receiving drain water which drops from the front heat exchanger and incoming drain water which flows from the rear drain pan;
a communicating passage for connecting the rear drain pan and the front drain pan; and
a drain pipe for discharging drain water, which collects in the front drain pan, from the front drain pan to an outside of the indoor unit, wherein
a volume of a whole drain pan including the rear drain pan and the front drain pan is equal to or greater than (2.28-1)x, where x is a surface area of a whole heat exchanger including the rear heat exchanger and the front heat exchanger.

4. The indoor unit for an air conditioner according to claim 3, wherein
the communicating passage is arranged in locations of both left and right sides of the rear drain pan, or in locations near both the left and right sides of the rear drain pan, and
a bottom surface of the communicating passage inclines downward from the rear drain pan toward the front drain pan.

5. The indoor unit for an air conditioner according to claim 3, wherein
the communicating passage is arranged in a location of either a left or right side of the rear drain pan, or in a location near either the left or right side of the rear drain pan,
a bottom surface of the communicating passage inclines downward from the rear drain pan toward the front drain pan, and
a bottom surface of the rear drain pan inclines downward from a side farthest from the communicating passage toward a side nearest to the communicating passage.

6. The indoor unit for an air conditioner according to claim 3, wherein an inner diameter R of the drain pipe and a depth h of the front drain pan satisfy a relationship expressed with

$$R\sqrt[4]{h} > 28\sqrt{\frac{y_0}{\pi\sqrt{g}}}$$

where g is a gravitational acceleration, and y_o is the volume of the whole drain pan including the rear drain pan and the front drain pan.

7. The indoor unit for an air conditioner according to claim 3, wherein at least near an inlet of the drain pipe, a bottom surface of the front drain pan inclines downward from a side farthest from the inlet of the drain pipe toward a side nearest to the inlet of the drain pipe.

8. The indoor unit for an air conditioner according to claim 7, wherein
the drain pipe is arranged such that a center axis of the drain pipe inclines downward from the inlet toward an outlet

of the drain pipe, and
an inclination angle of the center axis of the drain pipe is equal to or greater than an inclination angle of the bottom surface of the front drain pan.

9. The indoor unit for an air conditioner according to claim 3, wherein an opening area of an inlet of the drain pipe is greater than a cross-sectional area of the drain pipe near a center of the drain pipe.

10. A indoor unit for an air conditioner, comprising:

a rear heat exchanger, arranged in a rear portion of the indoor unit, for exchanging heat between air and refrigerant;
a front heat exchanger, arrange in a front portion of the indoor unit, for exchanging heat between air and refrigerant;
a rear drain pan for receiving drain water which drops from the rear heat exchanger;
a front drain pan for receiving drain water which drops from the front heat exchanger and incoming drain water which flows from the rear drain pan;
a communicating passage for connecting the rear drain pan and the front drain pan; and
a drain pipe for discharging drain water, which collects in the front drain pan, from the front drain pan to an outside of the indoor unit, wherein
the rear drain pan, the front drain pan and the communicating passage form a flow passage of the drain water, and an uneven part is formed in an arbitrary portion of a bottom surface of the flow passage.

11. The indoor unit for an air conditioner according to claim 10, wherein the uneven part is formed extending in an extension direction of the flow passage.

12. The indoor unit for an air conditioner according to claim 10, wherein a part of a bottom surface of the front drain pan inclines downward from a side farthest from the drain pipe toward a side nearest to the drain pipe.

13. The indoor unit for an air conditioner according to claim 10, wherein
the drain pipe is arranged such that a center axis of the drain pipe inclines downward from an inlet toward an outlet of the drain pipe, and
an inclination angle of the center axis of the drain pipe is equal to or greater than an inclination angle of a bottom surface of the front drain pan near the inlet of the drain pipe.

14. The indoor unit for an air conditioner according to claim 10, wherein a recessed part is formed in the bottom surface of the flow passage near an outlet of the flow passage.

15. The indoor unit for an air conditioner according to claim 10, wherein a first heat insulating member is arranged on a back side of a flow passage section in the front drain pan which extends in a front-rear direction.

16. The indoor unit for an air conditioner according to claim 10, wherein a second heat insulating member is arranged on a front side of a flow passage section in the front drain pan which extends in a left-right direction.

17. The indoor unit for an air conditioner according to claim 10,
further comprising an air blowing fan arranged between the rear heat exchanger and the front heat exchanger,
wherein the front heat exchanger and the front drain pan are arranged in contact with each other to close a gap between a space where the air blowing fan is arrange and a space outside the space.

Amended claims under Art. 19.1 PCT

1. A indoor unit for an air conditioner, comprising:

a rear heat exchanger, arranged in a rear portion of the indoor unit, for exchanging heat between air and refrigerant;
a front heat exchanger, arrange in a front portion of the indoor unit, for exchanging heat between air and refrigerant;
a controller for controlling a freezing operation of making frost or ice adhere to surfaces of the rear heat exchanger

and the front heat exchanger;
a rear drain pan for receiving drain water which drops from the rear heat exchanger;
a front drain pan for receiving drain water which drops from the front heat exchanger and incoming drain water which flows from the rear drain pan;
a communicating passage for connecting the rear drain pan and the front drain pan; and
a drain pipe for discharging drain water, which collects in the front drain pan, from the front drain pan to an outside of the indoor unit, wherein
a volume (m^3) of a whole drain pan including the rear drain pan and the front drain pan is equal to or greater than

$$(2.28\times10^{-6}(m)\times x(m^2)-z\times10^{-6}(m^3))$$

where x is a surface area (m^2) of a whole heat exchanger including the rear heat exchanger and the front heat exchanger, and $z\times10^{-6}$ is a value (m^3) obtained by multiplying an amount (m^3/s) of drainage through the drain pipe per unit time by a smaller one (s) of an amount of time required for all the frost or ice to melt and an amount of time required for all the frost of ice to drop into the front drain pan or the rear drain pan.

2. The indoor unit for an air conditioner according to claim 1, wherein
the communicating passage is arranged in locations of both left and right sides of the rear drain pan, or in locations near both the left and right sides of the rear drain pan, and
a bottom surface of the communicating passage inclines downward from the rear drain pan toward the front drain pan.

3. The indoor unit for an air conditioner according to claim 1, wherein
the communicating passage is arranged in a location of either a left or right side of the rear drain pan, or in a location near either the left or right side of the rear drain pan,
a bottom surface of the communicating passage inclines downward from the rear drain pan toward the front drain pan, and
a bottom surface of the rear drain pan inclines downward from a side farthest from the communicating passage toward a side nearest to the communicating passage.

4. The indoor unit for an air conditioner according to claim 1, wherein an inner diameter R of the drain pipe and a depth h (m) of the front drain pan satisfy a relationship expressed with

$$R\sqrt[4]{h} > 28\sqrt{\frac{y_0}{\pi\sqrt{g}}}$$

where g is a gravitational acceleration (m/s^2), and y_o is the volume (m^3) of the whole drain pan including the rear drain pan and the front drain pan.

5. The indoor unit for an air conditioner according to claim 1, wherein at least near an inlet of the drain pipe, a bottom surface of the front drain pan inclines downward from a side farthest from the inlet of the drain pipe toward a side nearest to the inlet of the drain pipe

6. The indoor unit for an air conditioner according to claim 5, wherein
the drain pipe is arranged such that a center axis of the drain pipe inclines downward from the inlet toward an outlet of the drain pipe, and
an inclination angle of the center axis of the drain pipe is equal to or greater than an inclination angle of the bottom surface of the front drain pan.

7. The indoor unit for an air conditioner according to claim 1, wherein an opening area of an inlet of the drain pipe is greater than a cross-sectional area of the drain pipe near a center of the drain pipe.

8. The indoor unit for an air conditioner according to any one of claims 1 to 7, wherein the volume of the drain pan is equal to or greater than a total adhesion amount of frost or ice to adhere to the heat exchanger during the freezing operation.

9. The indoor unit for an air conditioner according to any one of claims 1 to 8, wherein
the rear drain pan, the front drain pan and the communicating passage form a flow passage of the drain water, and an uneven part is formed in an arbitrary portion of a bottom surface of the flow passage.

10. The indoor unit for an air conditioner according to claim 9, wherein the uneven part is formed extending in an extension direction of the flow passage.

11. The indoor unit for an air conditioner according to claim 9 or 10, wherein a part of the bottom surface of the front drain pan inclines downward from a side farthest from the drain pipe toward a side nearest to the drain pipe.

12. The indoor unit for an air conditioner according to any one of claims 9 to 11, wherein
the drain pipe is arranged such that a center axis of the drain pipe inclines downward from an inlet toward an outlet of the drain pipe, and
an inclination angle of the center axis of the drain pipe is equal to or greater than an inclination angle of a bottom surface of the front drain pan near the inlet of the drain pipe.

13. The indoor unit for an air conditioner according to any one of claims 9 to 12, wherein a recessed part is formed in the bottom surface of the flow passage near an outlet of the flow passage.

14. The indoor unit for an air conditioner according to any one of claims 9 to 13, wherein a first heat insulating member is arranged on a back side of a flow passage section in the front drain pan which extends in a front-rear direction.

15. The indoor unit for an air conditioner according to any one of claims 9 to 14, wherein a second heat insulating member is arranged on a front side of the flow passage section in the front drain pan which extends in a left-right direction.

16. The indoor unit for an air conditioner according to any one of claims 9 to 15,
further comprising an air blowing fan arranged between the rear heat exchanger and the front heat exchanger, wherein the front heat exchanger and the front drain pan are arranged in contact with each other to close a gap between a space where the air blowing fan is arrange and a space outside the space.

17. (cancelled)

FIG. 1

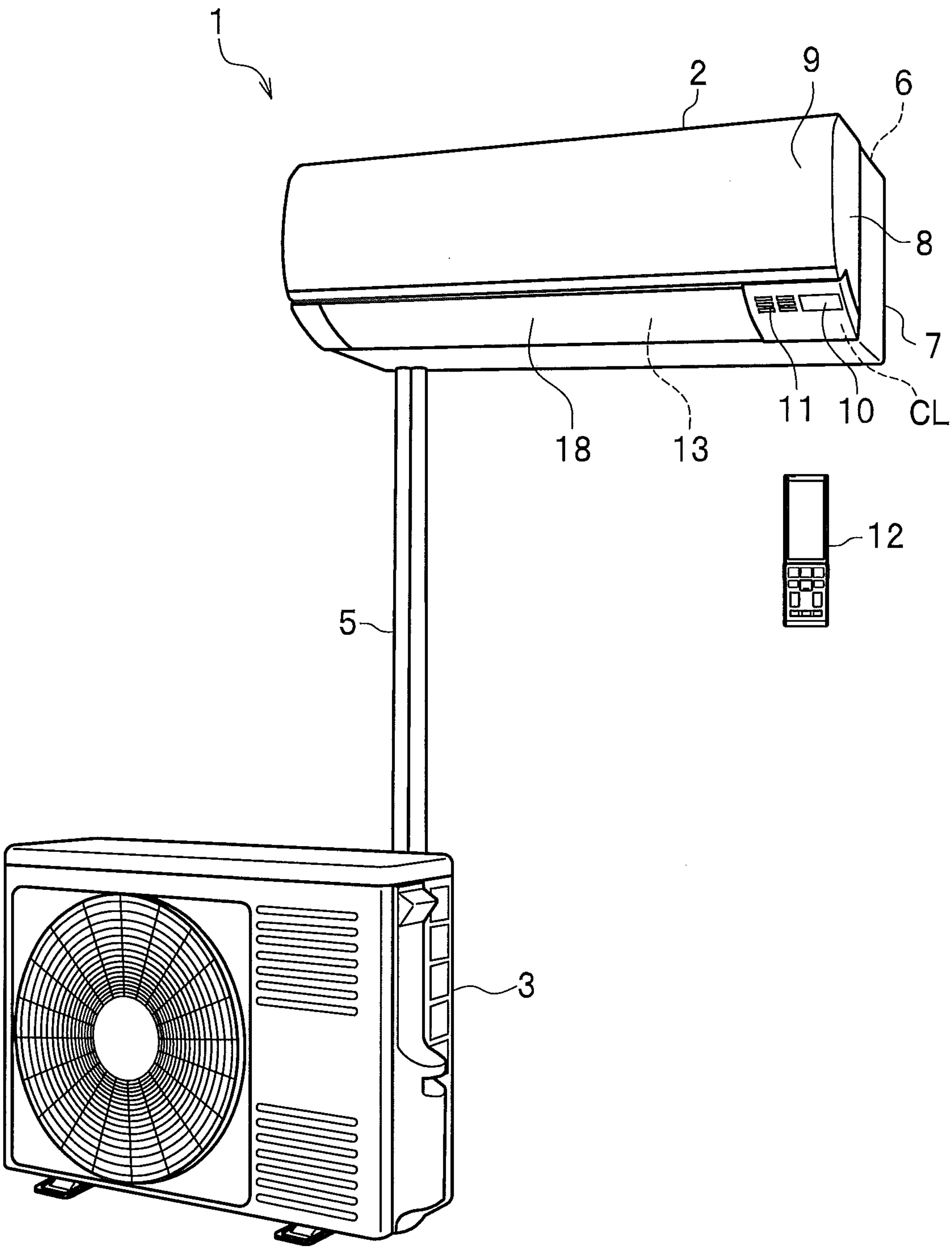


FIG.2

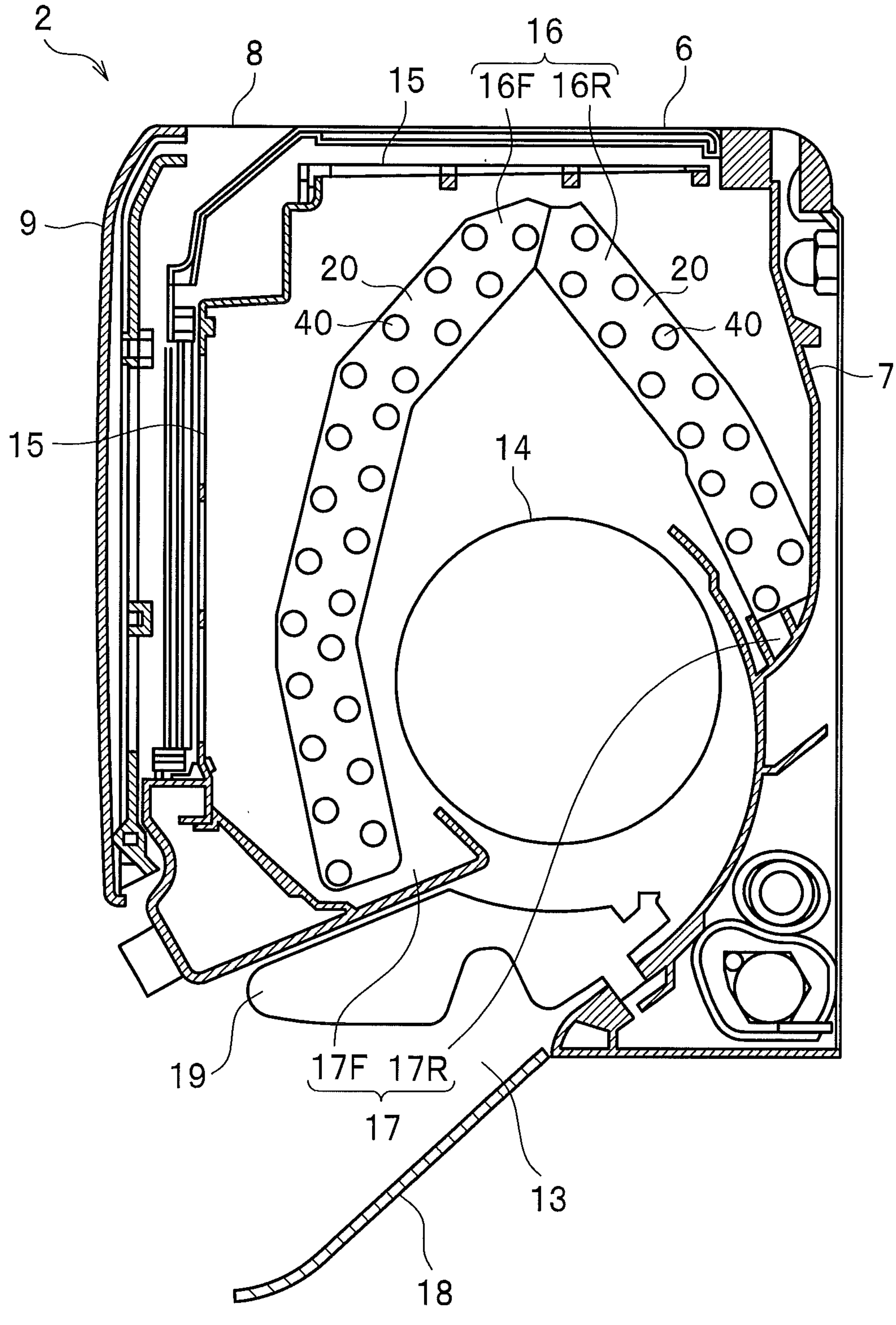


FIG.3

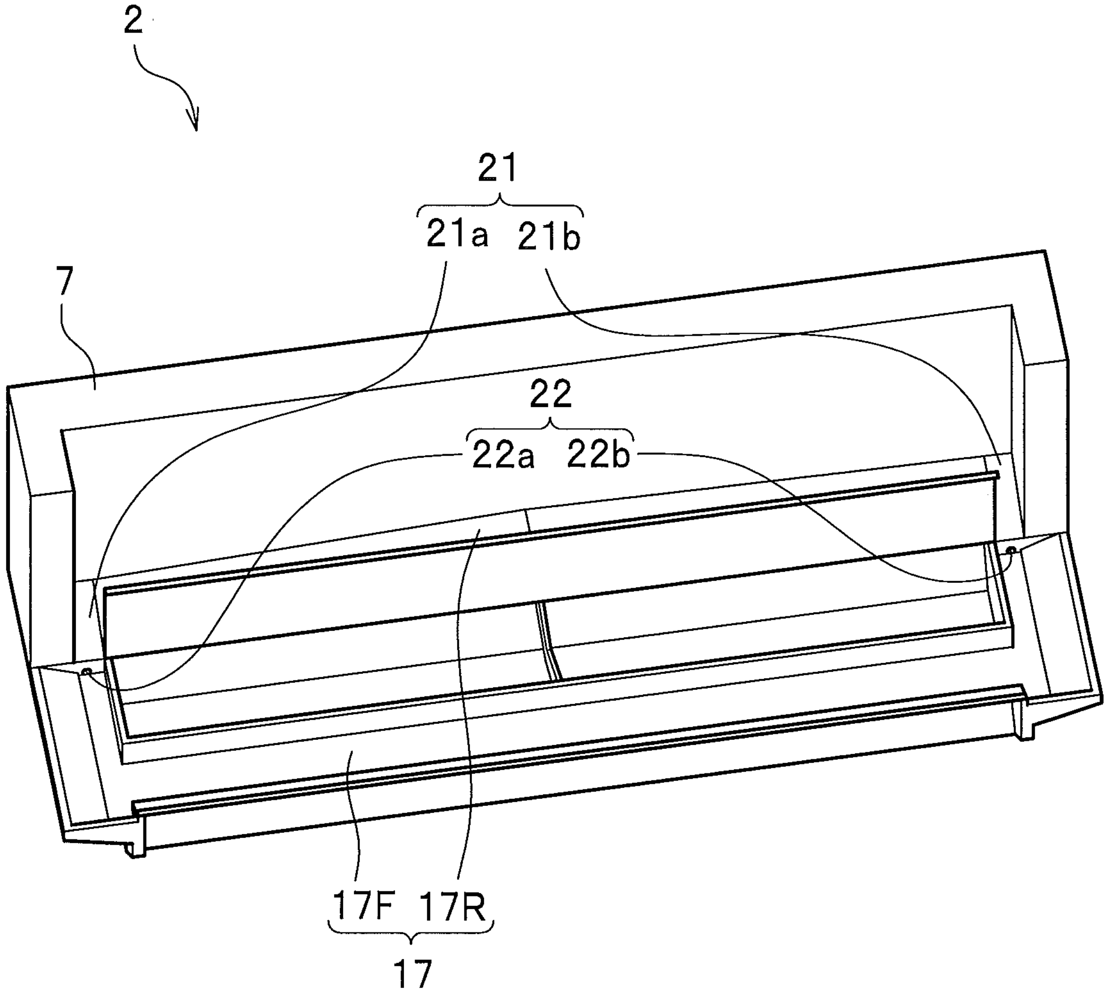


FIG.4

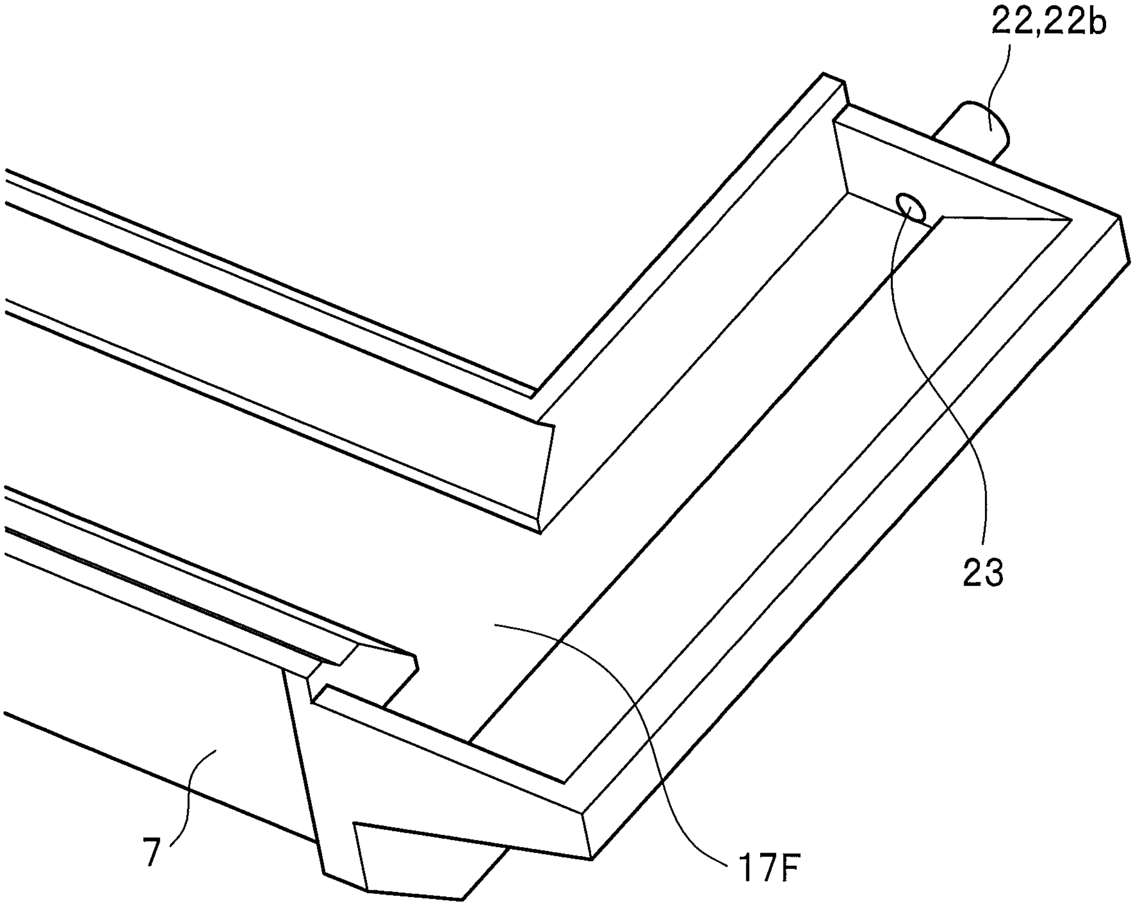


FIG.5

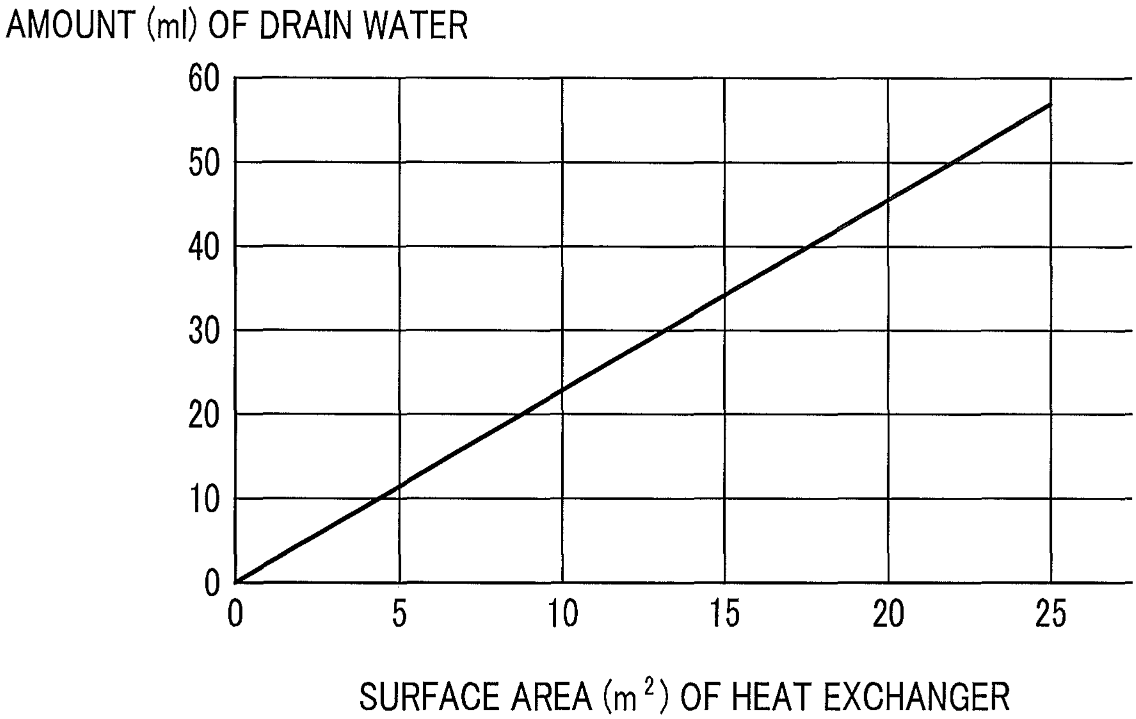

AMOUNT (ml) OF DRAIN WATER
60
50
40
30
20
10
0
0
5
10
15
20
25
SURFACE AREA (m 2) OF HEAT EXCHANGER

FIG.6

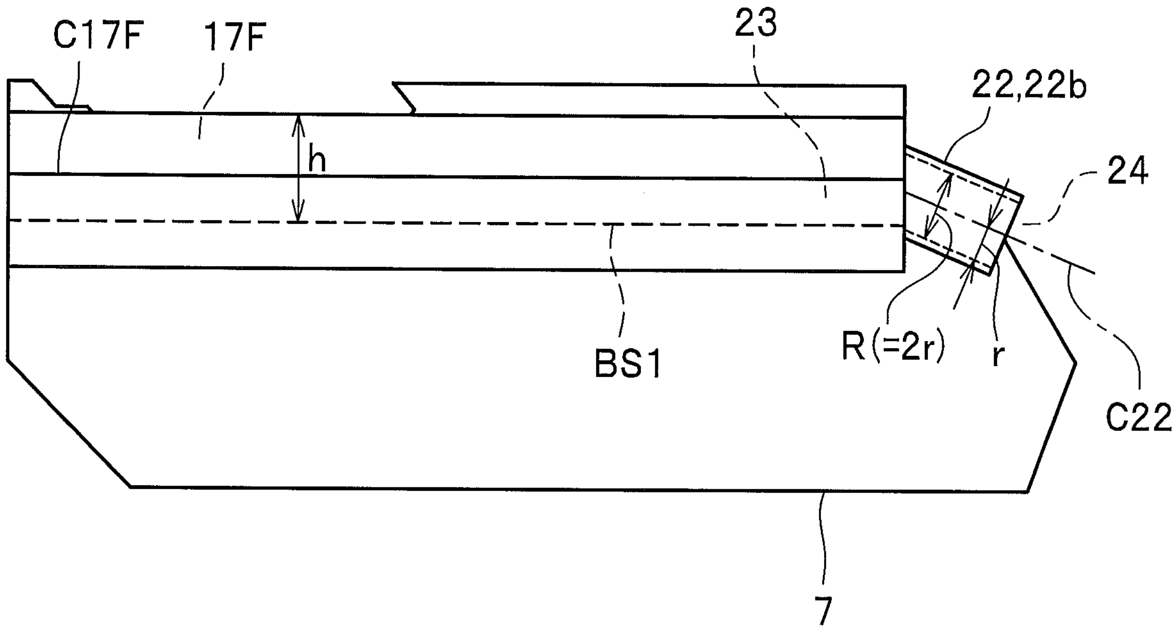

C17F
17F
23
22,22b
h
24
BS1
R(=2r)
r
C22
7

FIG.7

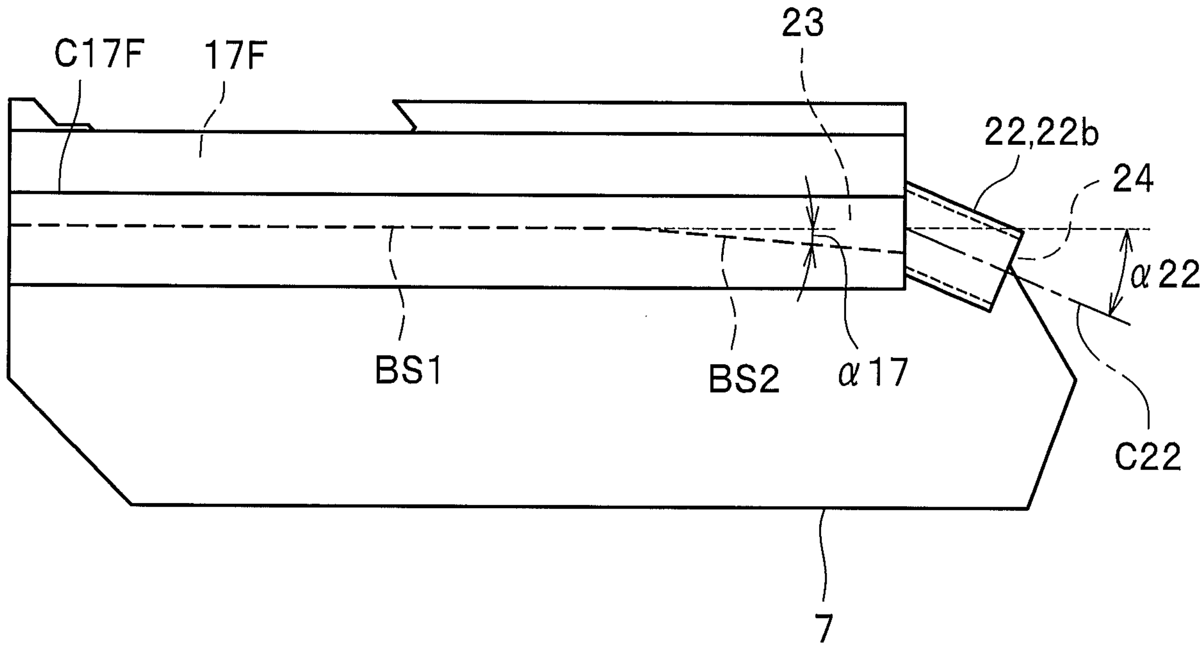

C17F
17F
23
22,22b
24
α22
BS1
BS2
α17
C22
7

FIG.8

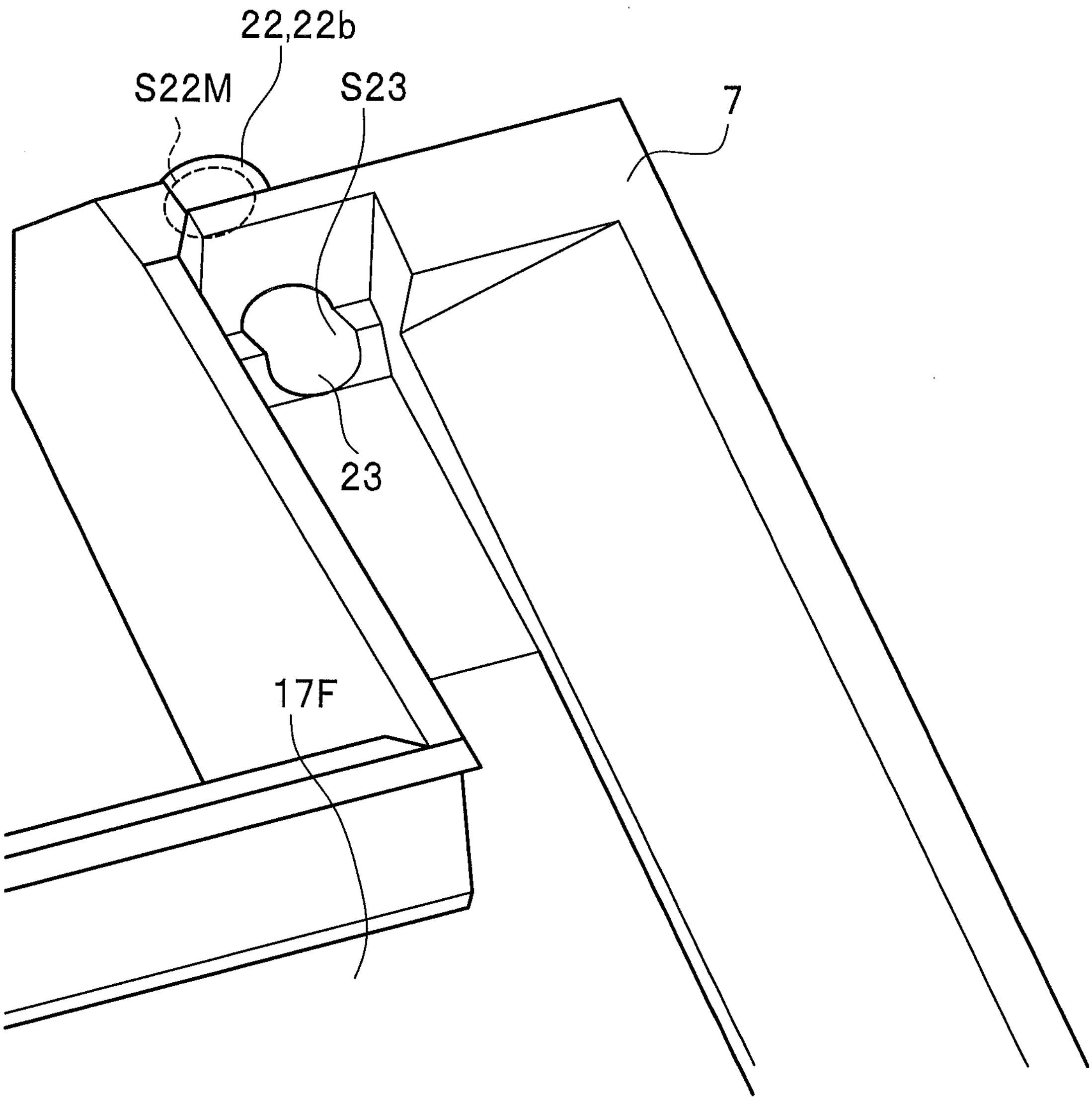


FIG.9

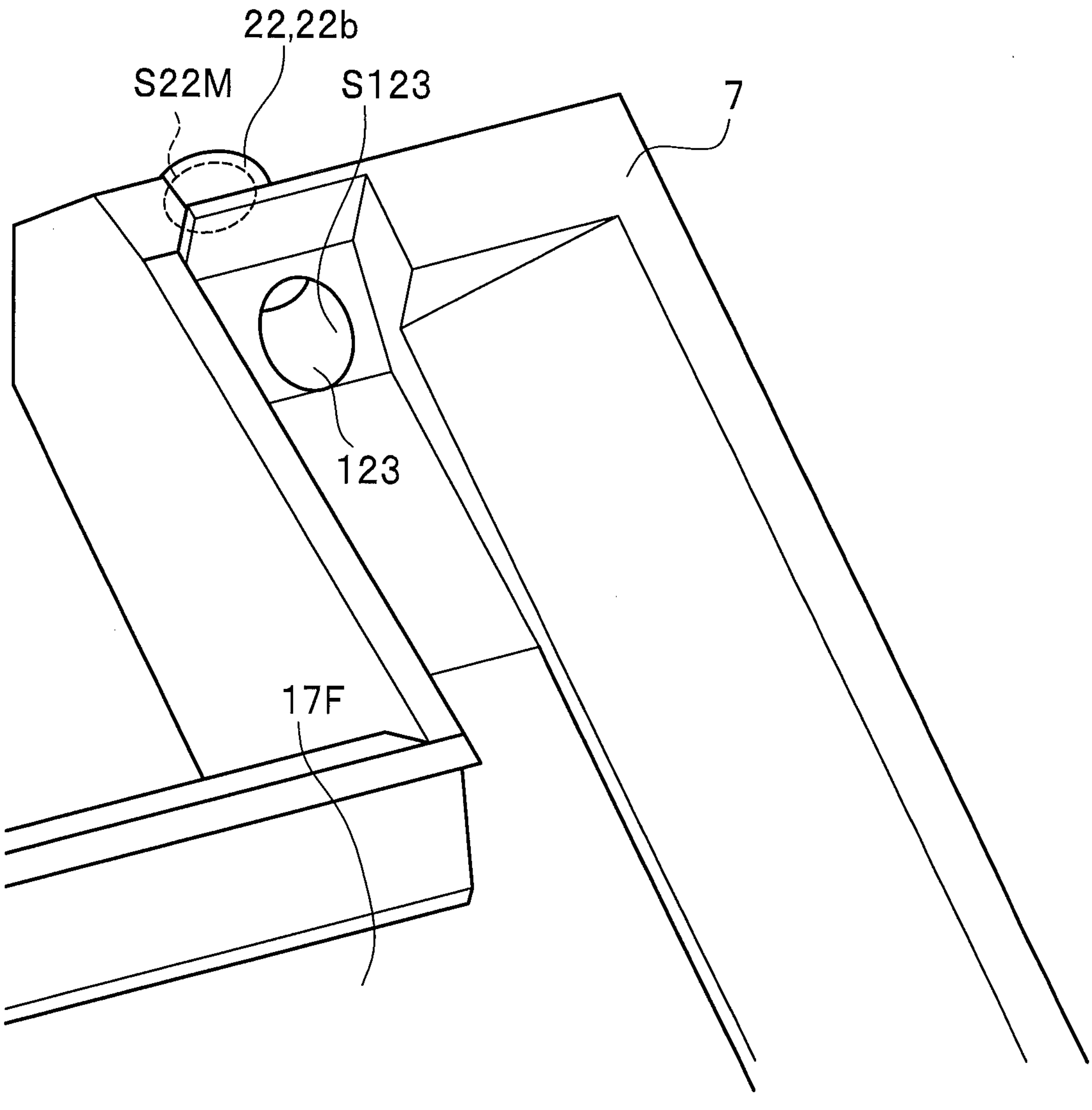


FIG.10A

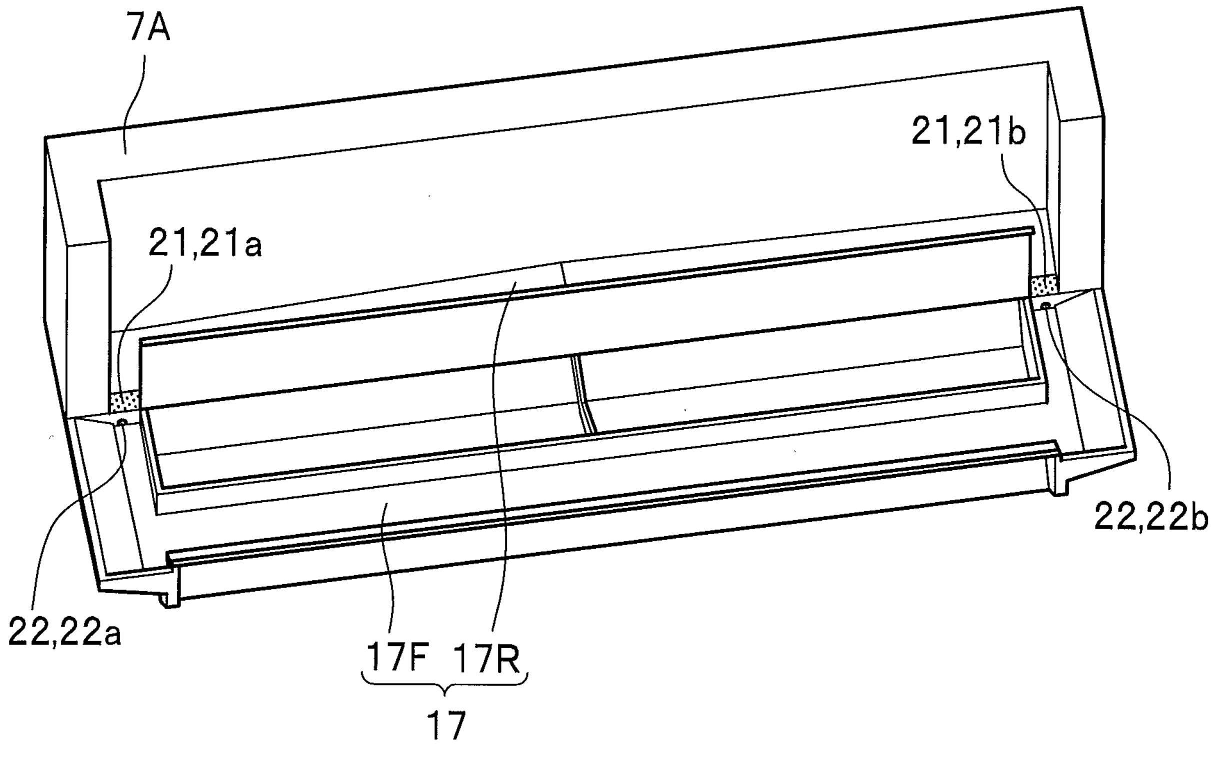


FIG.10B

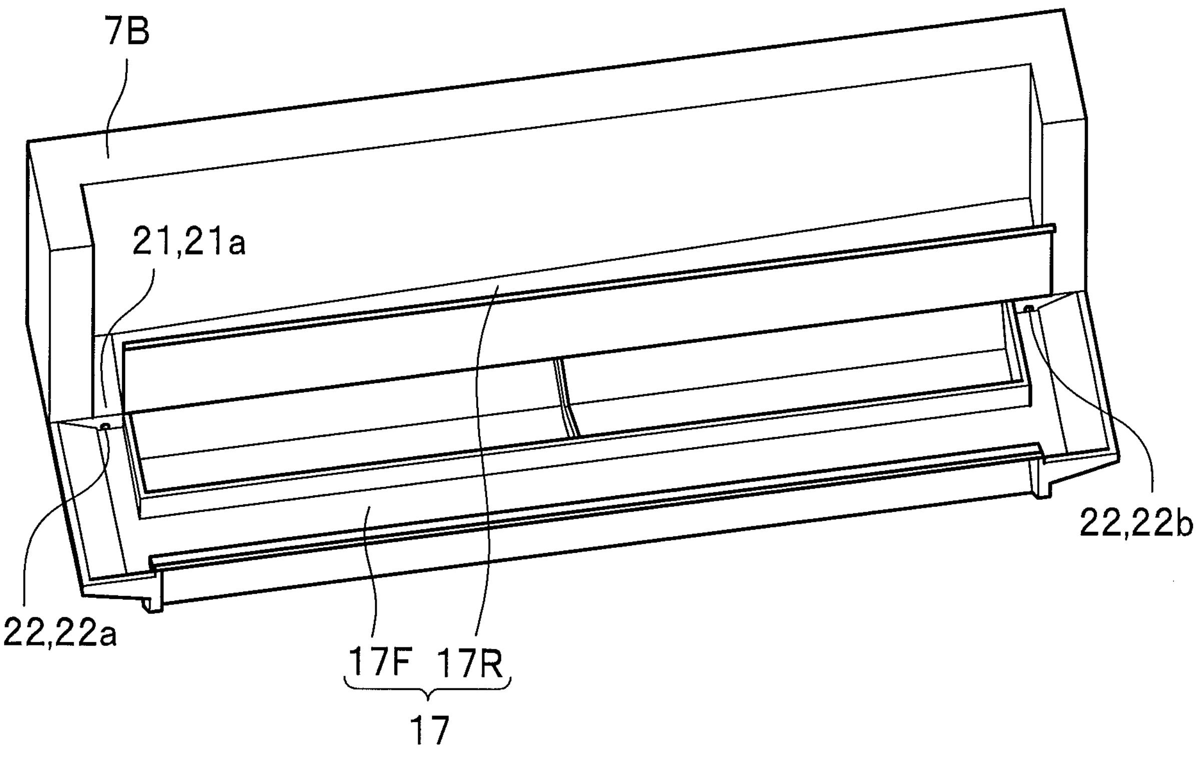


FIG.10C

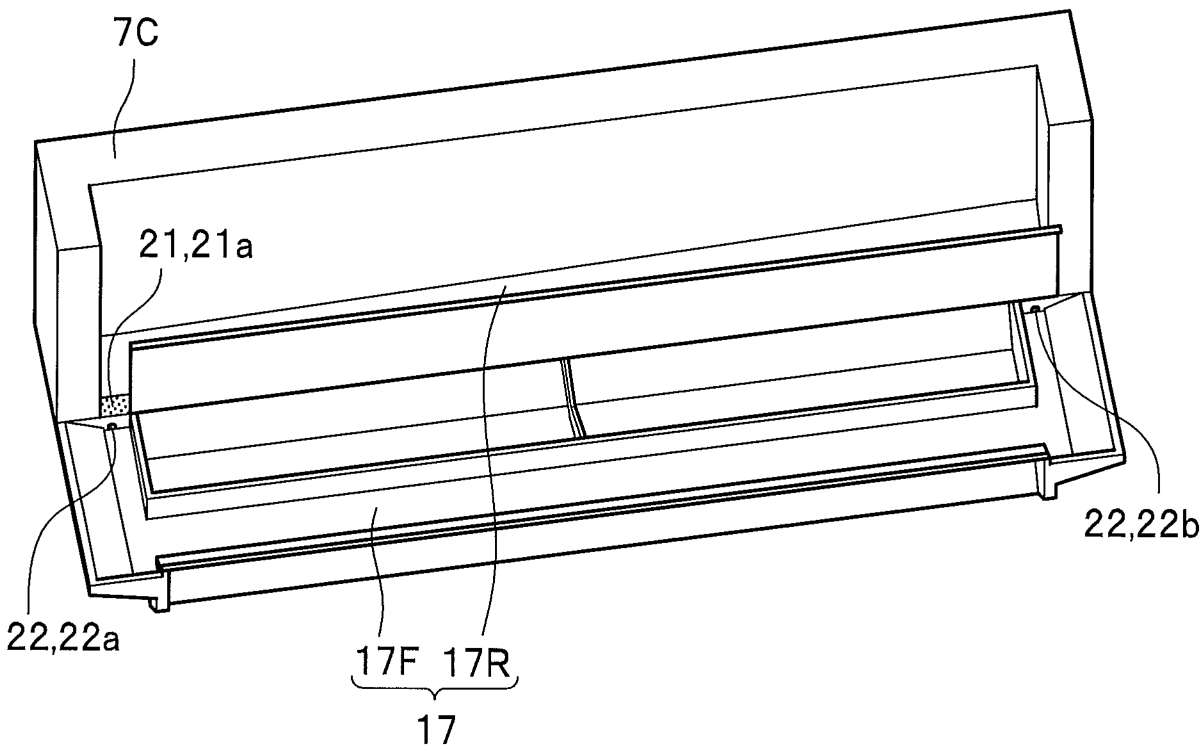


FIG.11

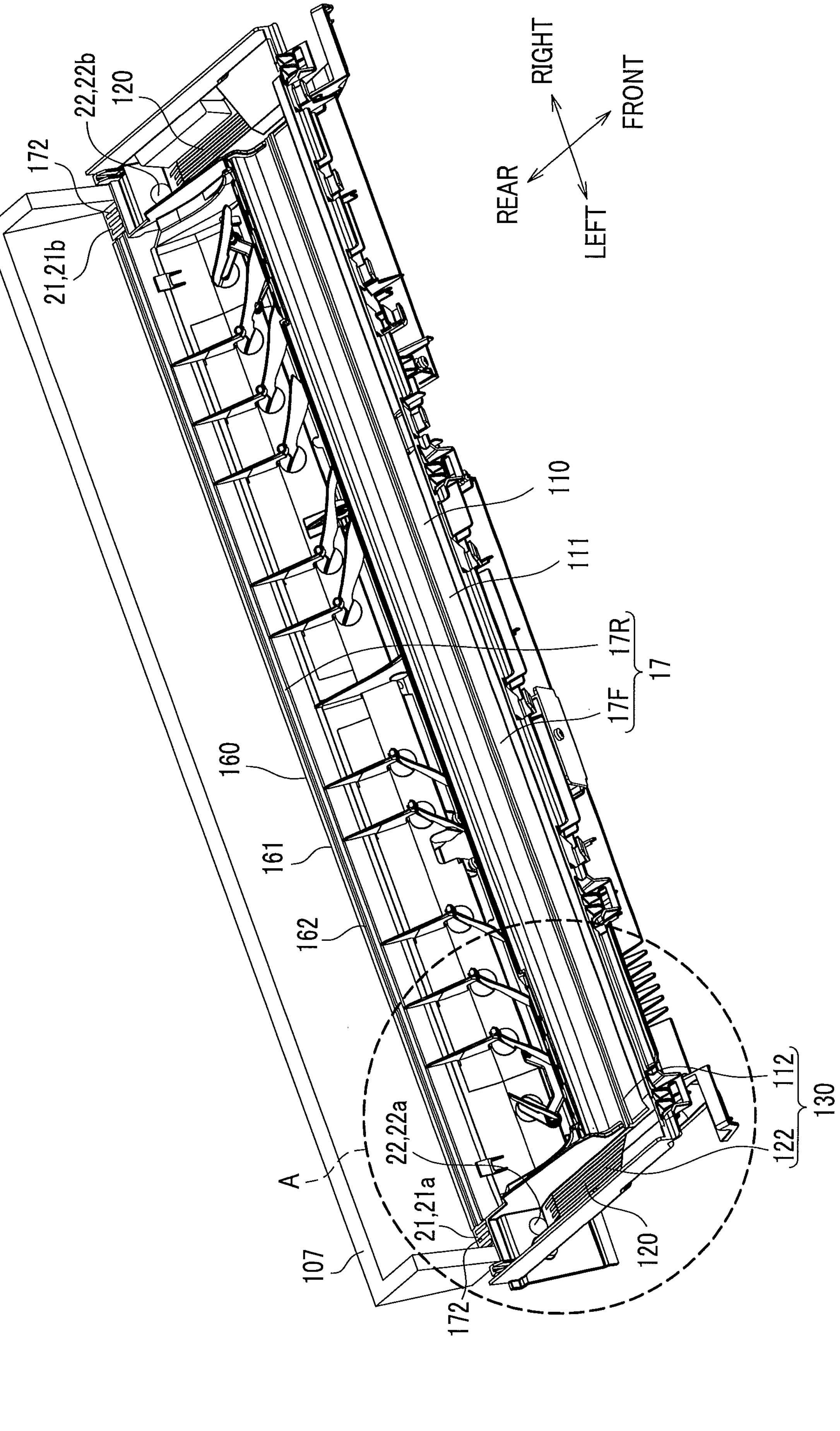

RIGHT
FRONT
REAR
LEFT
22,22b
120
172
21,21b
110
111
17R
17
17F
160
161
162
112
130
122
120
A
22,22a
21,21a
107
172

FIG.12

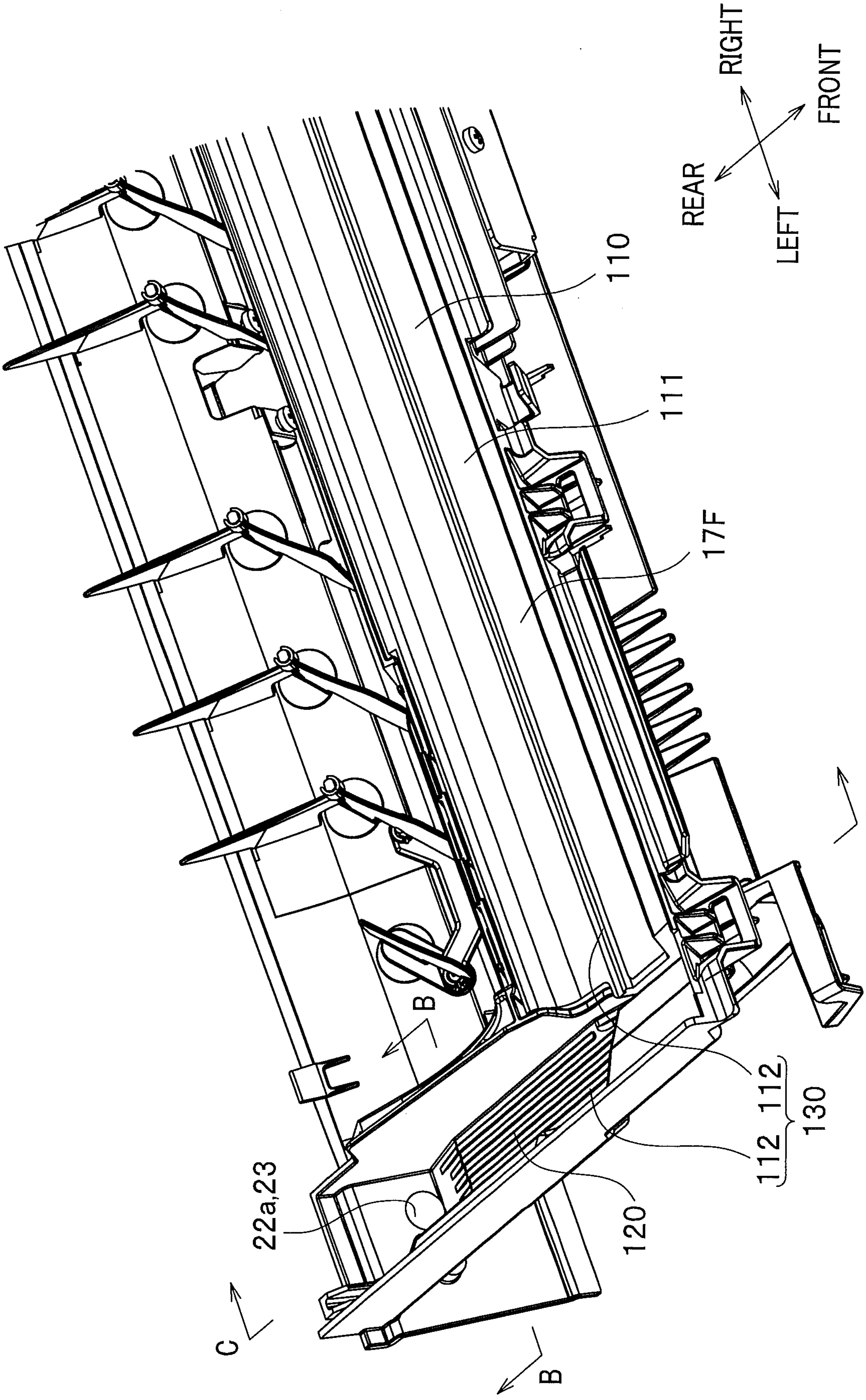

RIGHT
FRONT
REAR
LEFT
110
111
17F
C
B
112
112
112
130
120
22a,23
C
B

FIG.13

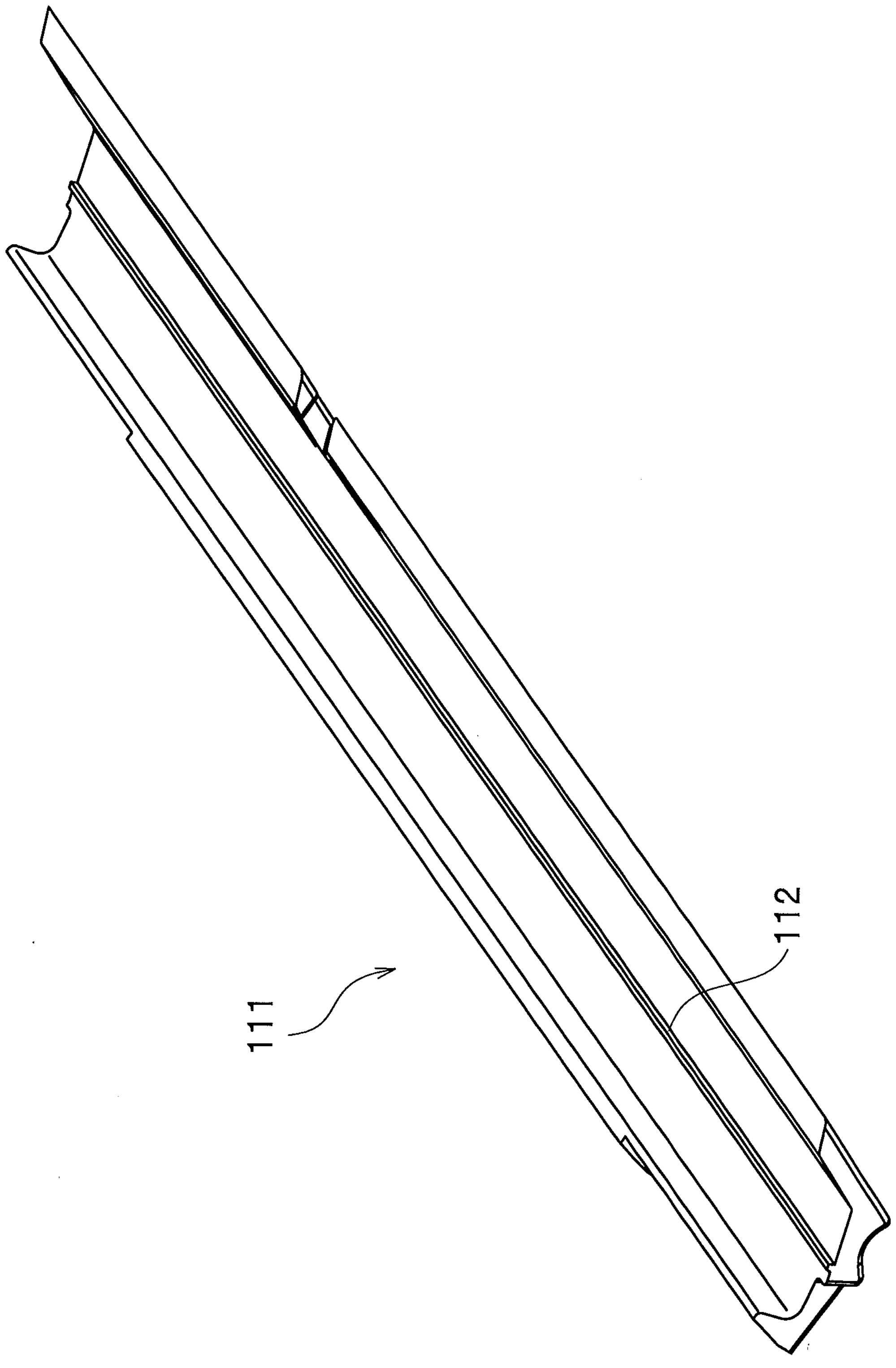


FIG.14

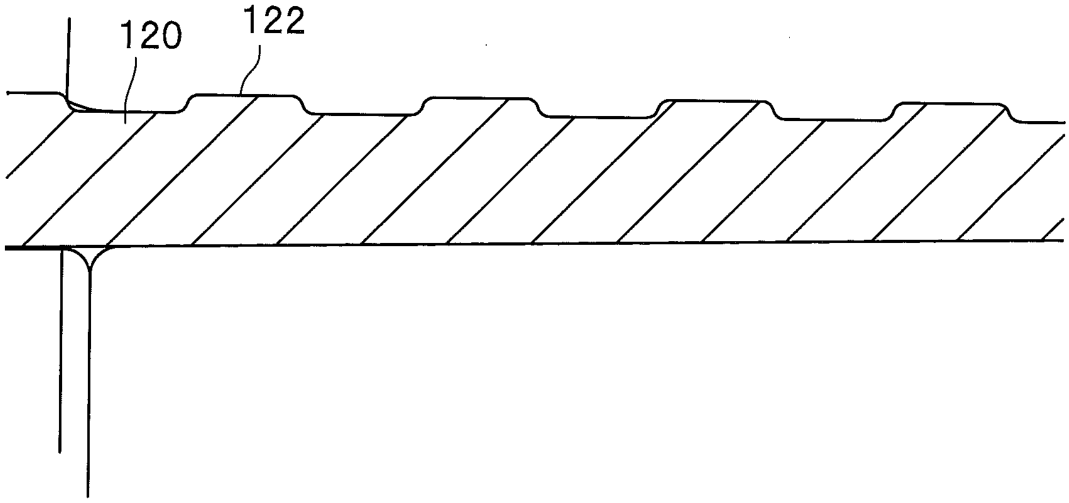


FIG.15

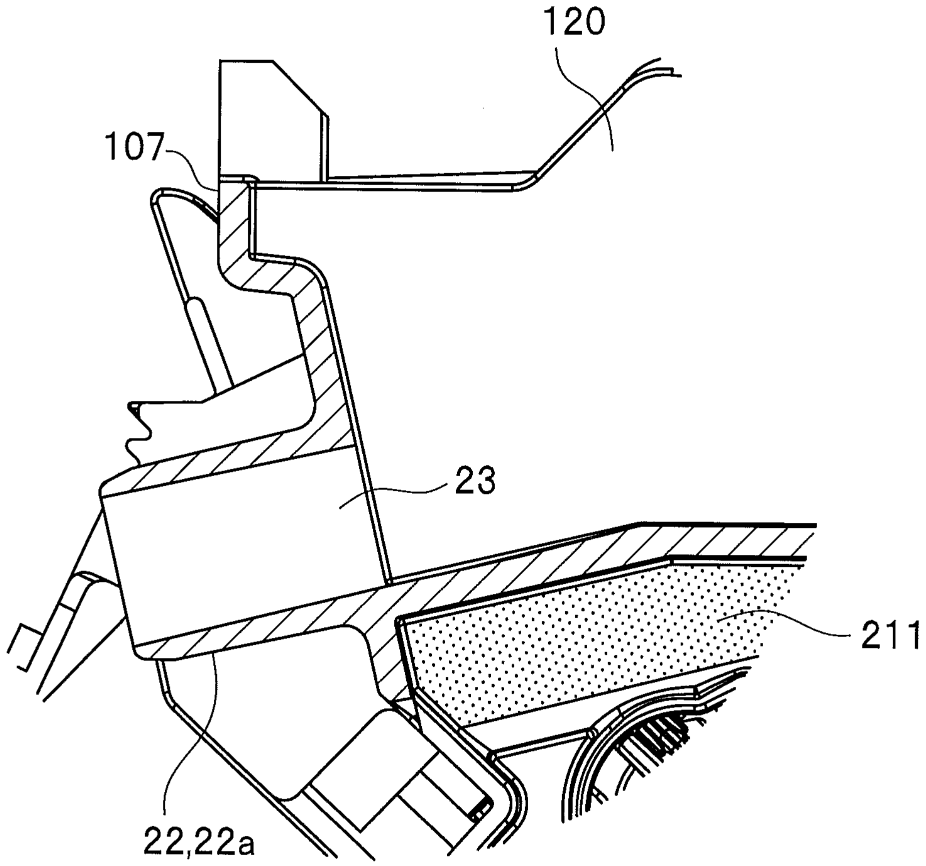


FIG.16

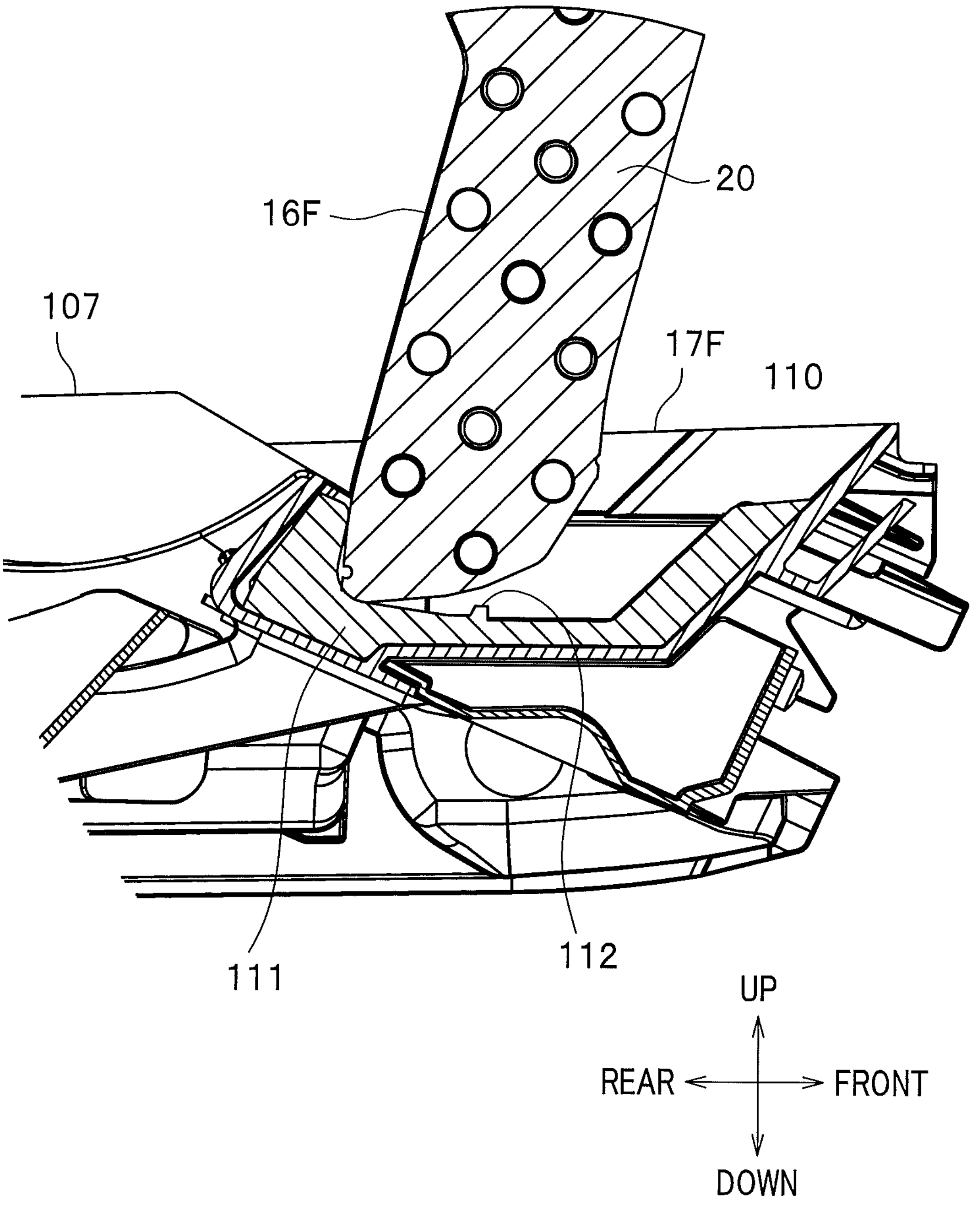


FIG.17A

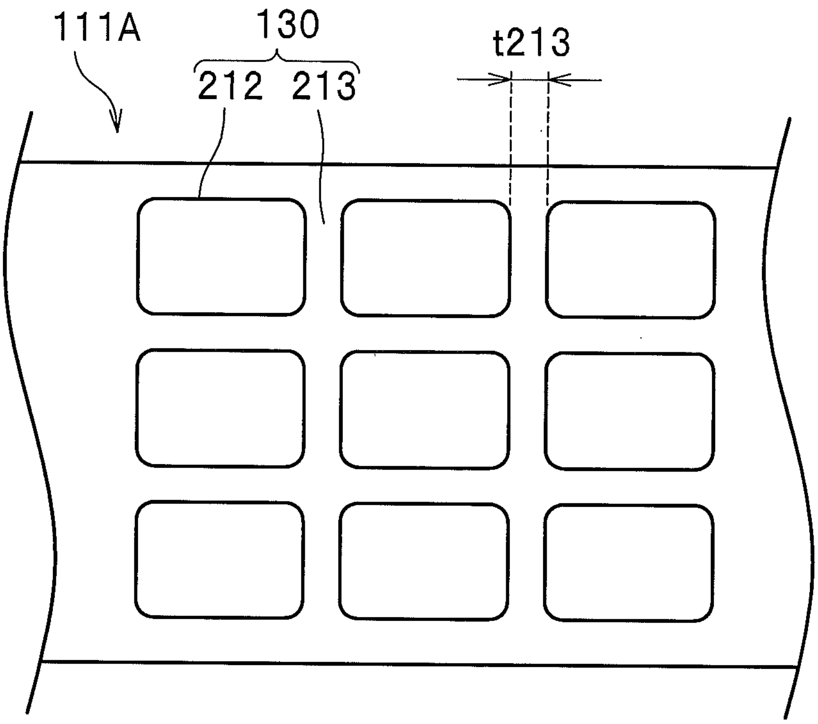


FIG.17B

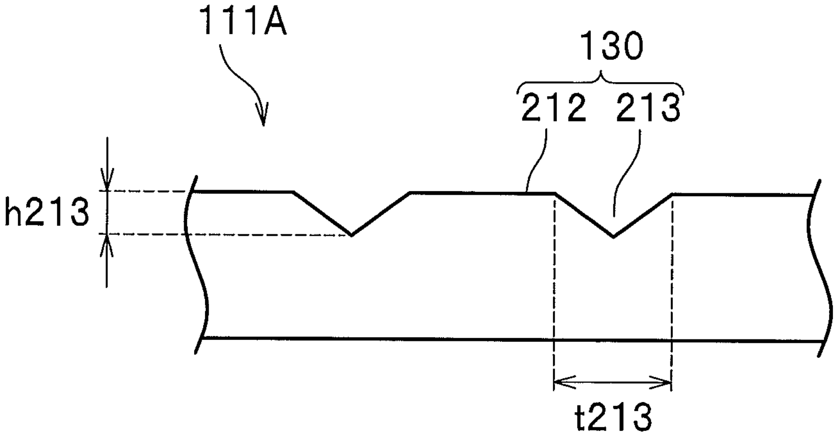


FIG. 18

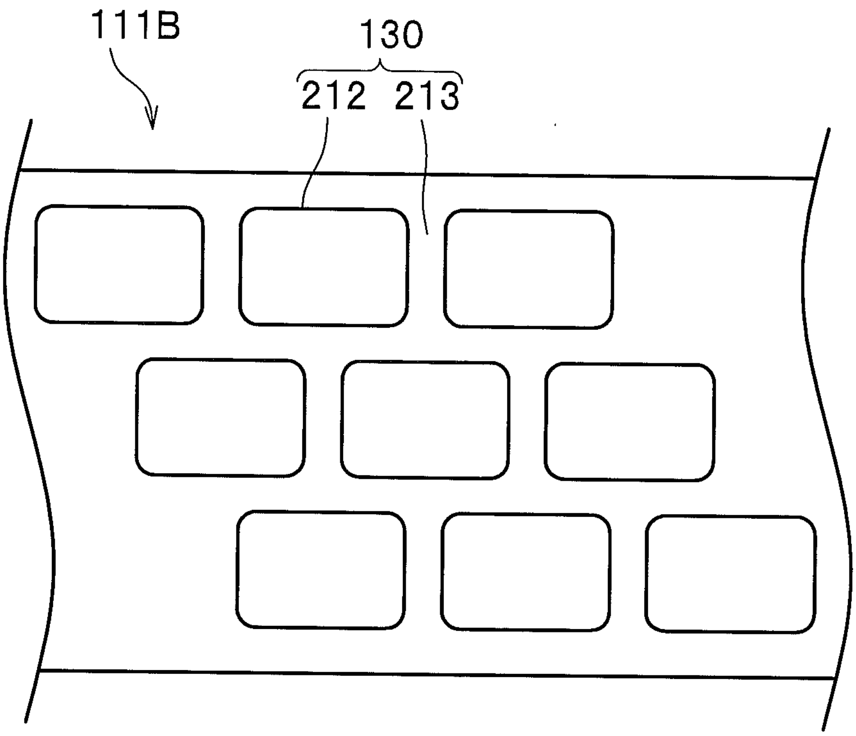


FIG.19A

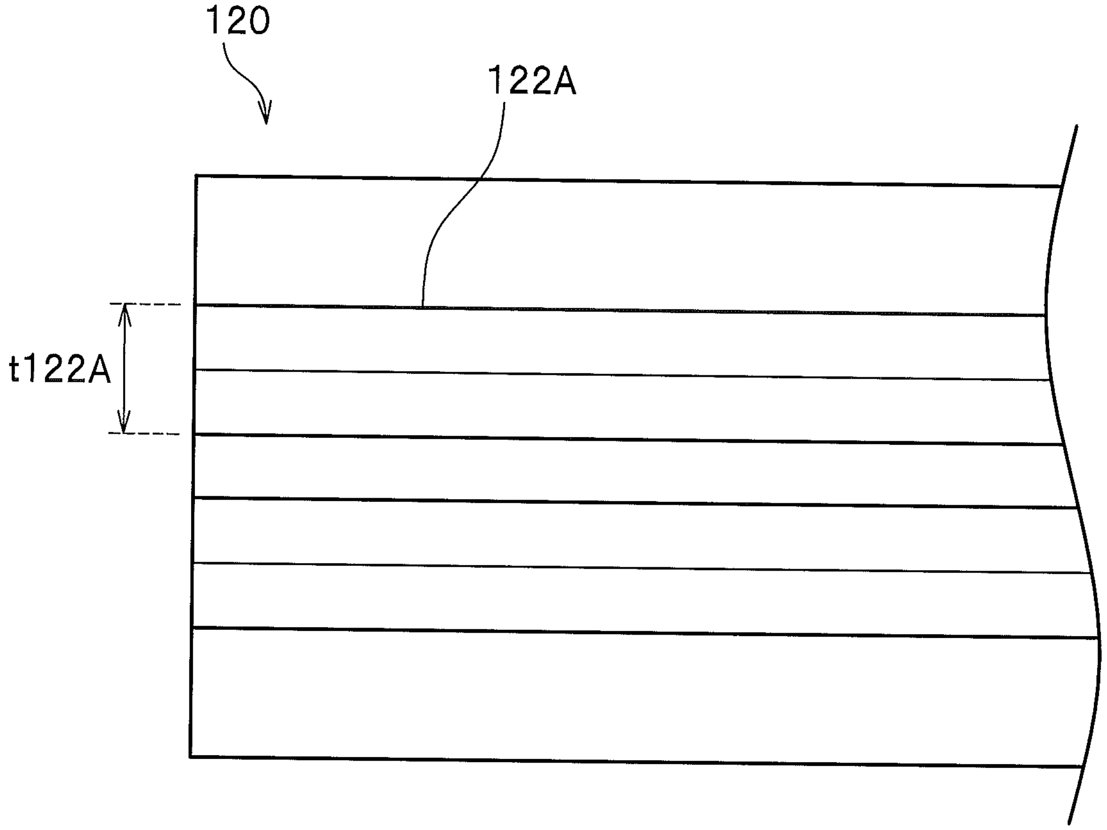
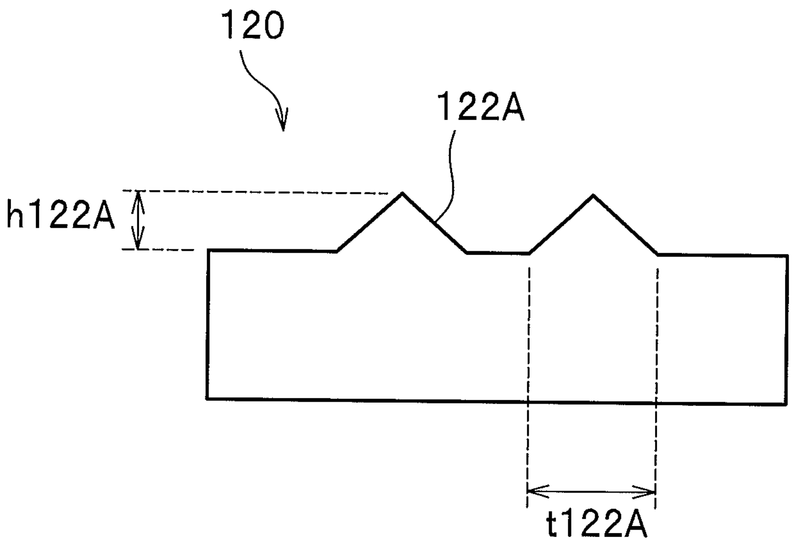


FIG.19B



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/036039

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F24F1/00(2011.01)i, F24F13/22(2006.01)i

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

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F24F1/00, F24F13/22

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	1971-2017
Registered utility model specifications of Japan	1996-2017
Published registered utility model applications of Japan	1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2010-14288 A (TOSHIBA CARRIER CORPORATION) 21 January 2010, paragraphs [0010]-[0073], fig. 1-10 (Family: none)	1-2 3
Y A	JP 2005-98559 A (TOSHIBA CORPORATION) 14 April 2005, paragraph [0031] & US 2007/0125119 A1, paragraph [0050] & WO 2005/019748 A1 & EP 1669706 A1 & KR 10-2006-0087520 A & CN 1839288 A	1-2 3
Y A	JP 2011-12820 A (SANYO ELECTRIC CO., LTD.) 20 January 2011, paragraphs [0004], [0015] (Family: none)	1-2 3

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25.12.2017	09.01.2018

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

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

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/036039

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 11-257680 A (SAMSUNG ELECTRONICS CO., LTD.) 21 September 1999, paragraphs [0007], [0011]-[0033], fig. 3, 4 & US 6062032 A, column 1, lines 31-34, column 2, line 20 to column 4, line 61, fig. 3, 4 & KR 10-0256416 B1 & ES 2167131 A2 & CN 1221098 A	2, 10-17
Y	JP 2001-317760 A (FUNAI ELECTRIC CO., LTD.) 16 November 2001, paragraphs [0021]-[0032], fig. 1-7 (Family: none)	2, 10-17
Y	JP 5-164344 A (TOSHIBA CORPORATION) 29 June 1993, paragraphs [0012]-[0029], fig. 1-3 (Family: none)	10-17
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 2002/1987 (Laid-open No. 110830/1988) (DAIKIN INDUSTRIES, LTD.) 16 July 1988, specification, page 4, line 12 to page 7, line 11, fig. 1-3 (Family: none)	10-17
Y	JP 2006-300431 A (MITSUBISHI ELECTRIC CORPORATION) 02 November 2006, paragraphs [0007]-[0043], fig. 1-10 (Family: none)	15-16
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 180583/1986 (Laid-open No. 87429/1988) (TOSHIBA CORPORATION) 07 June 1988, specification, page 4, lines 10-20, fig. 7 (Family: none)	17
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 018116/1981 (Laid-open No. 132122/1982) (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 17 August 1982, specification, page 3, line 6 to page 6, line 20, fig. 1-3 (Family: none)	17
A	JP 10-176841 A (HITACHI AIR CONDITIONING & REFRIG CO., LTD.) 30 June 1998, paragraph [0012] (Family: none)	1-3
A	JP 2002-98347 A (CHOFU SEISAKUSHO CO., LTD.) 05 April 2002, paragraphs [0012]-[0023], fig. 1-9 (Family: none)	10-17
A	JP 6-257778 A (DAIKIN INDUSTRIES, LTD.) 16 September 1994, paragraphs [0007], [0008], fig. 1, 2 (Family: none)	10-17
A	JP 2008-202829 A (SHARP CORPORATION) 04 September 2008, paragraphs [0016]-[0023], fig. 1-4 (Family: none)	10-17

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

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/036039

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 071721/1981 (Laid-open No. 184491/1982) (RYOWA SETSUBI KK) 22 November 1982, specification, page 2, line 8 to page 3, line 15, fig. 1-5 (Family: none)	10-17
A	JP 2013-181733 A (MITSUBISHI ELECTRIC CORPORATION) 12 September 2013, paragraphs [0015]-[0039], fig. 1-10 (Family: none)	14

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/036039

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17 (2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
[see extra sheet]

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/036039

(Continuation of Box No. III)

Document 1: JP 2010-14288 A (TOSHIBA CARRIER CORPORATION) 21 January 2010, paragraphs [0010]-[0073], fig. 1-10
(Family: none)

The claims are classified into the two inventions below.

(Invention 1) Claims 1-9

Claims 1-9 have the special technical feature of "an indoor unit of an air conditioner having:

a heat exchanger that exchanges heat between air and a refrigerant;

a drain pan that receives drain water dropping from the heat exchanger; and

a control unit that controls a freezing operation that makes frost or ice adhere on the surface of the heat exchanger,

characterized in that the volumetric capacity of the drain pan is greater than or equal to the total amount of frost or ice that adheres to the heat exchanger during the freezing operation"; thus these claims are classified as invention 1.

(Invention 2) Claims 10-17

Claims 10-17 have the common technical feature between these claims and claim 1 classified as invention 1 of "an indoor unit of an air conditioner characterized by having: a heat exchanger that exchanges heat between air and a refrigerant; and

a drain pan that receives drain water dropping from the heat exchanger". However, this technical feature, which does not make a contribution over the prior art in light of the disclosure of document 1 (in particular, refer to paragraphs [0010]-[0073], fig. 1-10, etc.), cannot be said to be a special technical feature. Apart from this feature, there are not the same or corresponding special technical features between claims 10-17 and claim 1.

Furthermore, claims 10-17 do not depend from claim 1. In addition, claims 10-17 are not substantially identical to or similarly closely related to any of the claims classified as invention 1.

Accordingly claims 10-17 cannot be identified as invention 1.

Meanwhile, claims 10-17 have the special technical feature of "an indoor unit of an air conditioner having:

a rear heat exchanger that is provided behind the device to exchange heat between air and a refrigerant;

a front heat exchanger that is provided forward of the device to exchange heat between air and a refrigerant;

a rear drain pan that receives drain water dropping from the rear heat exchanger;

a front drain pan that receives drain water dropping from the front heat exchanger and drain water flowing thereinto from the rear drain pan;

a communication path that connects between the rear drain pan and the front drain pan; and

a drain pipe that drains, from the front drain pan to the outside of the device, drain water stored in the front drain pan,

characterized in that the rear drain pan, the front drain pan, and the communication path form a flow path of the drain water, and

in the flow path, a protrusion-and-recess part is formed on the bottom surface at an arbitrary location"; thus these claims are classified as invention 2.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008138913 A **[0008]**