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(54) **AIR CONDITIONER**

KLIMAANLAGE

CLIMATISEUR

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Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] Conventionally, there is known an air conditioner in which a front panel of a casing, a heat exchanger, and a bellmouth are arranged in this order from front to back of the casing, and air inlets are provided around the front panel. Such an air conditioner is provided with a once-through fan, which generates an air flow in which air is sucked in from the air inlets, passes through the heat exchanger and an opening of the bellmouth, and is blown out from air outlets (see patent document 1).

[0003] The second patent document discloses an air conditioner mountable to a ceiling with a suction opening in a central part of a front panel and with air outlets disposed to all four sides of the suction opening and additional air outlet disposed at side walls located adjacent and above of the front panel.

[0004] <Patent document 1> JP-A Publication No. 64-58965 (Figures 1 and 2)

[0005] <Patent document 2> JP-A Publication No. 2002-005500 Patent document EP-A-1512919 discloses an air conditioner according to the preamble of claim 1.

DISCLOSURE OF THE INVENTION

<TECHNICAL PROBLEM>

[0006] In the above described type of air conditioner, the air inlets are provided around the front panel, and thus it is possible to improve the design of the front panel. However, the air suction resistance is increased compared to the case where the air inlets are provided in the center of the front panel. This causes the output of the once-through fan to be insufficient, making it difficult to secure the necessary static pressure.

[0007] An object of the present invention is to provide an air conditioner capable of securing the necessary static pressure even when the arrangement of air inlets is such that the suction resistance tends to increase.

<SOLUTION TO THE PROBLEM>

[0008] An air conditioner according to claim 1 includes a heat exchanger, a bellmouth, a casing, and a turbofan. The bellmouth is disposed behind the heat exchanger such that an opening thereof through which air passes faces the heat exchanger. The casing has a front panel that covers the front side of the heat exchanger, and is provided with air inlets and air outlets. The turbofan is disposed behind the bellmouth, and generates an air flow in which air is sucked in from the air inlets, passes through the heat exchanger and the opening of the bellmouth, and is blown out from the air outlets. Additionally, the air inlets are provided in the front panel and/or around thereof, and are located substantially outside the opening of the bellmouth as seen from the front. Further, the total suction area of the air inlets is equal to or greater than 15% of the projected area of the heat exchanger as seen from the front.

[0009] In this air conditioner, an air flow is generated by the turbofan, so that it is possible to secure the necessary static pressure even when the arrangement of the air inlets is such that the suction resistance tends to increase. In addition, although the use of the turbofan when the arrangement of the air inlets is such that the suction resistance tends to increase may augment the suction noise, the present invention can reduce the suction noise because the total suction area of the air inlets is equal to or greater than 15% of the projected area of the heat exchanger as seen from the front.

[0010] According to a preferred embodiment, the distance between the heat exchanger and the bellmouth is equal to or greater than 10% of the diameter of the opening of the bellmouth.

[0011] In this air conditioner, an air flow is generated by the turbofan, so that it is possible to secure the necessary static pressure even when the arrangement of the air inlets is such that the suction resistance tends to increase. In addition, when an air flow is generated by the turbofan disposed behind the heat exchanger, air tends to unevenly flow mainly through the center of the heat exchanger, which may reduce the heat exchange efficiency; however, the present invention can improve the air conditioning efficiency because the distance between the heat exchanger and the bellmouth is equal to or greater than 10% of the diameter of the opening of the bellmouth, allowing air to easily flow over a larger area of the heat exchanger.

<EFFECTS OF THE INVENTION>

[0012] In the air conditioner according to an embodiment of the present invention, an air flow is generated by the turbofan, so that it is possible to secure the necessary static pressure even when the arrangement of the air inlets is such that the suction resistance tends to increase. In addition, it is possible to reduce the suction noise because the total suction area of the air inlets is equal to or greater than 15% of the projected area of the heat exchanger as seen from the front.

[0013] Furthermore, it is possible to improve the air conditioning efficiency, by choosing the distance between the heat exchanger and the bellmouth to be equal to or greater than 10% of the diameter of the opening of the bellmouth, which allows air to easily flow over a larger area of the heat exchanger.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Figure 1 is a front view of an air conditioner.
Figure 2 is a side view of the air conditioner.
Figure 3 is a side cross sectional view of the air conditioner.
Figure 4 is a schematic view showing the projected area of an indoor heat exchanger as seen from the front.
Figure 5 is a schematic view showing the distance between the indoor heat exchanger and a bellmouth, and the diameter of an opening of the bellmouth.
Figure 6 is a graph showing the relationship between the ratio of the total suction area to the heat exchange area and the suction noise.
Figure 7 is a graph showing the relationship between the air conditioning efficiency and the distance between the indoor heat exchanger and the bellmouth with respect to the diameter of the opening of the bellmouth.

EXPLANATION OF THE REFERENCE SYMBOLS

[0015]

1	Air conditioner
2	Casing
4	Indoor heat exchanger (heat exchanger)
5	Air blowing device (turbofan)
6	First air outlet (air outlet)
7	Second air outlet (air outlet)
8	First air inlet (air inlet)
9	Second air inlet (air inlet)
10	Third air inlet (air inlet)
11	Fourth air inlet (air inlet)
13	Bellmouth
14	Opening
22	Front panel

BEST MODE FOR CARRYING OUT THE INVENTION

<STRUCTURE>

[0016] An air conditioner 1 according to an embodiment of the present invention is shown in Figure 1 through Figure 3. Figure 1 is a front view of the air conditioner 1, and Figure 2 is a side view of the air conditioner 1. In addition, Figure 3 is a side cross sectional view of the air conditioner 1. The air conditioner 1 is a floor standing indoor unit, and is provided with a casing 2, an indoor heat exchanger 4, a bellmouth 13, and an air blowing device 5. Note that the terms "up", "down", "left", and "right" used in the description below refer to the up, down, left, and right sides of the air conditioner 1 as seen from the front.

<CASING 2>

[0017] The casing 2 comprises a hollow body made of synthetic resin, and houses the indoor heat exchanger 4, the bellmouth 13, and the air blowing device 5 therein. The casing 2 includes a casing main body 21 and a front panel 22 attached to a front surface of the casing main body 21.

[0018] The front surface of the casing main body 21 has a large opening formed therein. The casing main body 21 has the indoor heat exchanger 4, the bellmouth 13, and the air blowing device 5 arranged in this order from front to back inside thereof.

[0019] The front surface of the casing 2 has a first air outlet 6 and a second air outlet 7 provided thereto. The first air outlet 6 is an opening having a horizontally long shape that is disposed along the upper end of the front surface of the casing 2, and air that is blown out into the room passes therethrough. The second air outlet 7 is an opening having a horizontally long shape that is disposed along the lower end of the front surface of the casing 2, and air that is blown out into the room passes therethrough. Note that the first air outlet 6 is provided with a first flap 61 that guides air blown out from the first air outlet 6 such that the first flap 61 can freely pivot, and the first air outlet 6 can be opened and closed by the first flap 61. In addition, the second air outlet 7 is provided with a second flap 62 that guides air blown out from the second air outlet 7 such that the second flap 62 can freely pivot.

[0020] The front panel 22 is mounted to the front surface of the casing main body 21, and has an outer shape that is smaller than the front surface of the casing main body 21. The front panel 22 covers the front side of the indoor heat exchanger 4, and is disposed below the first air outlet 6 as seen from the front. In addition, a front surface of the front panel 22 is disposed at a slight distance forward from the front surface of the casing main body 21. Side surfaces 23 and 24 of the front panel 22 which connect the side end portions of the front surface of the front panel 22 to the front surface of the casing main body 21 are provided with a first air inlet 8 and a second air inlet 9, respectively. The first air inlet 8 is an opening having a longitudinally long shape that is disposed in the right side surface 23 of the front panel 22, and air sucked into the casing 2 from the room passes therethrough. The second air inlet 9 is an opening having a longitudinally long shape that is disposed in the left side surface 24 of the front panel 22, and air sucked into the casing 2 from the room passes therethrough.

[0021] In addition, a top surface 25 of the front panel 22 which connects the upper end portion of the front surface of the front panel 22 to the front surface of the casing main body 21 is provided with a third air inlet 10. The third air inlet 10 is an opening having a horizontally long shape that is disposed below the first air outlet 6, and air sucked into the casing 2 from the room passes therethrough. In addition, a bottom portion of the front surface

of the front panel 22 is provided with a fourth air inlet 11. The fourth air inlet 11 is an opening having a horizontally long shape that is disposed above the second air outlet 7, and air sucked into the casing 2 from the room passes therethrough. Note that a bottom surface of the front panel 22 which connects the front lower end of the front panel 22 to the front surface of the casing main body 21 is closed. In addition, a portion between the third air inlet 10 and the fourth air inlet 11 of the front surface of the casing 2 is a flat panel portion 20 in which an opening is not provided.

[0022] As described above, the casing 2 has the four air inlets from the first air inlet 8 through the fourth air inlet 11 provided in the front panel 22, one at each of the four sides (up, down, left, and right) around the flat panel portion 20, and air is sucked in from the four sides (up, down, left, and right) of the flat panel portion 20. In addition, as shown in Figure 1, these air inlets 8 through 11 are located outside the opening 14 of the bellmouth 13 as seen from the front.

<INDOOR HEAT EXCHANGER 4>

[0023] The indoor heat exchanger 4 shown in Figure 3 constitutes a refrigerant circuit together with an outdoor heat exchanger disposed in the outdoor unit (not shown) and performs heat exchange with air that passes through the indoor heat exchanger 4. The indoor heat exchanger 4 is disposed behind the front panel 22. The indoor heat exchanger 4 has a thin plate-like outer shape and is disposed parallel to the flat panel portion 20. In addition, the indoor heat exchanger 4 has the same size as the front panel 22 as seen from the front, and the following expression is obtained: $S/B \geq 0.15$, where B is the projected area of the indoor heat exchanger 4 as seen from the front, and S (not shown) is the total suction area of the above described air inlets 8 through 11, as shown in Figure 4. In other words, the total suction area S of the air inlets 8 through 11 is equal to or greater than 15% of the projected area B of the indoor heat exchanger 4 as seen from the front.

<BELLMOUTH 13>

[0024] The bellmouth 13 is disposed behind the indoor heat exchanger 4, and the bellmouth 13 includes a flat portion 15 and a circular tube portion 16. The flat portion 15 has an outer shape that is about the same size as that of the indoor heat exchanger 4 as seen from the front, and is disposed parallel to the indoor heat exchanger 4 so as to face the rear surface of the indoor heat exchanger 4. The flat portion 15 is connected to the edge on the entrance side of an opening 14 of the circular tube portion 16. Note that the circular tube portion 16 curves such that the diameter of its front end side expands, and the circular tube portion 16 is loosely connected to the peripheral edge of the opening 14. Here, the following expression is obtained: $a/d \geq 0.1$, where "a" is the distance between the indoor heat exchanger 4 and the bellmouth 13, i.e., the distance between the indoor heat exchanger 4 and the entrance of the opening 14 of the bellmouth 13, and "d" is the diameter of the opening 14 of the bellmouth 13. In other words, the distance "a" between the indoor heat exchanger 4 and the bellmouth 13 is equal to or greater than the diameter "d" of the opening 14 of the bellmouth 13. Note that the rear end of the circular tube portion 16 enters inside a fan cover 53 (described later) through an opening on a front surface of the fan cover 53. In addition, the opening 14 of the bellmouth 13 has an outer shape that is smaller than that of the indoor heat exchanger 4 as seen from the front.

<AIR BLOWING DEVICE 5>

[0025] The air blowing device 5 is disposed behind the bellmouth 13, and generates an air flow in which air is sucked in from each of the air inlets 8 through 11, passes through the indoor heat exchanger 4 and the opening 14 of the bellmouth 13, and is blown out from each of the air outlets 6 and 7. The air blowing device 5 is a turbofan that sucks in air from the front and causes the wind to blow out in a centrifugal direction. The air blowing device 5 includes a fan rotor 51, a fan motor 52, and the fan cover 53.

[0026] The fan rotor 51 is disposed such that a rotation axis AX thereof is horizontal. The fan rotor 51 includes a plurality of blades disposed so as to spiral away from the rotation axis AX.

[0027] The fan motor 52 is a driving source for rotatingly driving the fan rotor 51, and is disposed behind the fan rotor 51.

[0028] The fan cover 53 is a member that is disposed in front of the fan rotor 51. An opening through which air that is taken into the fan cover 53 passes is disposed in the front surface of the fan cover 53. Air that passes through the opening in the front surface of the fan cover 53 branches up and down as a result of being blown out in a centrifugal direction by the fan rotor 51 and is blown out into the room from the first air outlet 6 and the second air outlet 7.

<CHARACTERISTICS>

[0029]

(1) In the air conditioner 1, the front panel 22 is provided with the air inlets 8 through 11 in the top surface 25, the right side surface 23, the left side surface 24, and the bottom portion of the front surface, respectively, and has the flat panel portion 20 in a smooth shape at the center. Accordingly, it is possible to refine the external appearance of the air conditioner 1 as seen from the front, thus allowing enhancement of the aesthetic appearance.

In addition, the air inlets 8 through 11 are disposed outside the opening 14 of the bellmouth 13 as seen

from the front. Accordingly, it is possible to allow air that is sucked in from the air inlets 8 through 11 to pass over a larger area of the indoor heat exchanger 4, thus allowing improvement of the air conditioning efficiency.

In addition, because the fourth air inlet 11 is provided in the bottom portion of the front surface of the front panel 22, it is possible to increase the suction area while suppressing an increase in the size of other air inlets 8 through 10. Accordingly, it is possible to suppress an increase in the thickness of the front panel 22 caused by an increase in the size of other air inlets 8 through 10, thus allowing the external shape of the air conditioner 1 to be thinner.

(2) Although the arrangement of the air inlets 8 through 11 as described above increases the suction resistance, it is possible in this air conditioner 1 to sufficiently secure the necessary static pressure because an air flow is generated by the air blowing device 5 that is a turbofan.

In addition, in the air conditioner 1 according to the present invention, a necessary air flow can be generated by one turbofan, unlike the case where a once-through fan is provided to each of the upper and lower air outlets as in the conventional air conditioner. Accordingly, it is possible to reduce the manufacturing cost.

(3) Although the use of the turbofan when the arrangement of the air inlets 8 through 11 is as described above may augment the suction noise, the air conditioner 1 can reduce the suction noise because the total suction area S of the air inlets 8 through 11 is equal to or greater than 15% of the projected area B of the indoor heat exchanger 4 as seen from the front. In other words, as shown in Figure 6, a sufficient effect of the suction noise reduction can be obtained in the range where $S/B \geq 15\%$. Note that, because an increase in the value of S/B entails an increase in the total suction area, it is better if the value of S/B is smaller in terms of the size reduction of the air conditioner 1. Considering this, it is more preferable that $0.15 \leq SB \leq 0.35$, for example, S/B = 0.2.

In addition, when an air flow is generated by one turbofan disposed behind the indoor heat exchanger 4, air tends to unevenly flow mainly through the center of the indoor heat exchanger 4, which may reduce the heat exchange efficiency; however, the air conditioner 1 can further improve the air conditioning efficiency because the distance "a" between the indoor heat exchanger 4 and the bellmouth 13 is equal to or greater than 10% of the diameter "d" of the opening 14 of the bellmouth 13, allowing air to easily flow over a larger area of the indoor heat exchanger 4. In other words, as shown in Figure 7, a sufficient effect of an increase in the air conditioning efficiency can be obtained in the range where $a/d \geq 10\%$. In addition, because an increase in the value of a/d entails an increase in the distance between the indoor heat exchanger 4 and the bellmouth 13, it is better if the value of a/d is smaller in terms of the thickness reduction of the air conditioner 1. Considering this, it is more preferable that $0.1 \leq a/d \leq 0.25$, for example, a/d = 0.15.

<OTHER EMBODIMENT>

[0030]

(1) In the above described embodiment, all of the air inlets 8 through 11 are disposed in the front panel 22. However, one, some, or all of the air inlets 8 through 11 may be disposed in the casing main body 21, specifically at a portion or portions located around the front panel 22.

(2) In the above described embodiment, the air conditioner 1 is the floor-standing air conditioner. However, the present invention is applicable to a wall-mounted air conditioner and a ceiling-embedded air conditioner.

(3) In the above described embodiment, the air inlets 8 through 11 are located outside the opening 14 of the bellmouth 13 as seen from the front. However, they may be located somewhat inside the opening 14 of the bellmouth 13. For example, the air inlets 8 through 11 may be located inside the opening 14 of the bellmouth 13 as long as the air inlets 8 through 11 are not located within a peripheral boundary that is concentric with and 80% of the inside diameter of the opening 14 of the bellmouth 13. In other words, any such modification may be made as long as the air inlets 8 through 11 are located outside a peripheral boundary that is concentric with and 80% of the inside diameter of the opening 14 of the bellmouth 13 as seen from the front.

INDUSTRIAL APPLICABILITY

[0031] The present invention has an effect of securing the necessary static pressure even when the arrangement of air inlets is such that the suction resistance tends to increase, and the present invention is useful as an air conditioner.

Claims

1. An air conditioner (1), comprising:

a heat exchanger (4);
a bellmouth (13) disposed behind the heat exchanger (4) such that an opening (14) thereof through which air passes faces the heat exchanger (4);
a casing (2) having a front panel (22) that covers the front side of the heat exchanger (4) and pro-

vided with air inlets (8 -11) and air outlets (6, 7); and
a turbofan (5) disposed behind the bellmouth (13) and configured to generate an air flow in which air is sucked in from the air inlets (8 -11), passes through the heat exchanger (4) and the opening (14) of the bellmouth (13), and is blown out from the air outlets (6, 7), wherein
the total suction area of the air inlets (8 -11) is equal to or greater than 15% of the projected area of the heat exchanger (4) as seen from the front, **characterized in that**
the air inlets(8 -11) are provided in the front panel (22) and/or around thereof, and are located substantially outside the opening (14) of the bellmouth (13) as seen from the front.

2. An air conditioner (1), according to claim 1, **characterized in that**
the distance between the heat exchanger (4) and the bellmouth (13) is equal to or greater than 10% of the diameter of the opening (14) of the bellmouth (13).

3. An air conditioner (1), according to claim 1 or 2, **characterized in that**:

the central portion of the front panel (22) has a flat panel portion (20), in which no opening is provided, and the air inlets (8-11) are provided around the flat panel portion (20).

4. An air conditioner (1), according to any one of claims 1-3, **characterized in that**:

the flat panel portion (20) is disposed so as to overlap with the opening (14) of the bellmouth (13) as seen from the front and is located in front of the heat exchanger (4).

Patentansprüche

1. Klimaanlage (1) mit:

einem Wärmetauscher (4);
einer Düse (13), die hinter dem Wärmetauscher (4) angeordnet ist, sodass eine Öffnung (14) derselben, durch welche Luft gelangt, dem Wärmetauscher (4) zugewandt ist;
einem Gehäuse (2) mit einem Vorderpaneel (22), welche die Vorderseite des Wärmetauschers (4) überdeckt und mit Lufteinlässen (8-11) und Luftauslässen (6, 7) versehen ist; und
einem Turbogebläse (5), das hinter der Düse (13) angeordnet ist und dazu geeignet ist, eine Luftströmung zu erzeugen, bei der Luft von den Lufteinlässen (8-11) eingesaugt wird, durch den Wärmetauscher (4) und die Öffnung (14) der Düse (13) gelangt, und von den Luftauslässen (6, 7) nach außen geblasen wird, wobei
der Gesamtansaugbereich der Lufteinlässe (8-11) identisch ist mit oder größer ist als 15 % der projizierten Fläche des Wärmetauschers (4), wenn von vorne betrachtet, **dadurch gekennzeichnet, dass**
die Lufteinlässe (8-11) in dem Vorderpaneel (22) und/oder um dieses vorgesehen sind und im Wesentlichen außerhalb der Öffnung (14) der Düse (13) angeordnet ist, wenn von vorne betrachtet.

2. Klimaanlage (1) nach Anspruch 1, **dadurch gekennzeichnet, dass**
der Abstand zwischen dem Wärmetauscher (4) und der Düse (13) identisch ist mit oder größer ist als 10 % des Durchmessers der Öffnung (14) der Düse (13).

3. Klimaanlage (1) nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass**:

der zentrale Abschnitt des Vorderpaneels (22) einen flachen Paneelabschnitt (20) aufweist, in welchem keine Öffnung vorgesehen ist, und die Lufteinlässe (8-11) um den flachen Paneelabschnitt (20) vorgesehen sind.

4. Klimaanlage (1) nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass**:

der flache Paneelabschnitt (20) so angeordnet ist, dass er mit der Öffnung (14) der Düse (13) überlappt, wenn von vorne betrachtet, und vor dem Wärmetauscher (4) angeordnet ist.

Revendications

1. Climatiseur (1), comprenant :

un échangeur de chaleur (4) ;
un pavillon (13) disposé derrière l'échangeur de chaleur (4) de sorte qu'une ouverture (14) de celui-ci par laquelle l'air passe soit en face de l'échangeur de chaleur (4) ;
un carter (2) ayant un panneau avant (22) qui couvre le côté avant de l'échangeur de chaleur (4) et pourvu d'entrées d'air (8 à 11) et de sorties d'air (6, 7) ; et
un turboventilateur (5) disposé derrière le pavillon (13) et configuré pour générer un écoulement d'air dans lequel l'air est aspiré à partir des entrées d'air (8 à 11), passe par l'échangeur de chaleur (4) et l'ouverture (14) du pavillon (13), et est soufflé à partir des sorties d'air (6, 7), dans

lequel
la surface d'aspiration totale des entrées d'air (8 à 11) est supérieure ou égale à 15% de la surface projetée de l'échangeur de chaleur (4), telle que vue de l'avant, **caractérisé en ce que** les entrées d'air (8 à 11) sont prévues dans le panneau avant (22) et/ou autour de celui-ci, et sont situées substantiellement à l'extérieur de l'ouverture (14) du pavillon (13) telles que vues de l'avant.

2. Climatiseur (1), selon la revendication 1, **caractérisé en ce que**
la distance entre l'échangeur de chaleur (4) et le pavillon (13) est supérieure ou égale à 10% du diamètre de l'ouverture (14) du pavillon (13).

3. Climatiseur (1), selon la revendication 1 ou 2, **caractérisé en ce que** :

la partie centrale du panneau avant (22) a une partie de panneau plate (20), dans laquelle aucune ouverture n'est prévue, et les entrées d'air (8 à 11) sont prévues autour de la partie de panneau plate (20).

4. Climatiseur (1), selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** : la partie de panneau plate (20) est disposée de manière à se chevaucher avec l'ouverture (14) du pavillon (13) telle que vue de l'avant et est située devant l'échangeur de chaleur (4).

FIG. 1

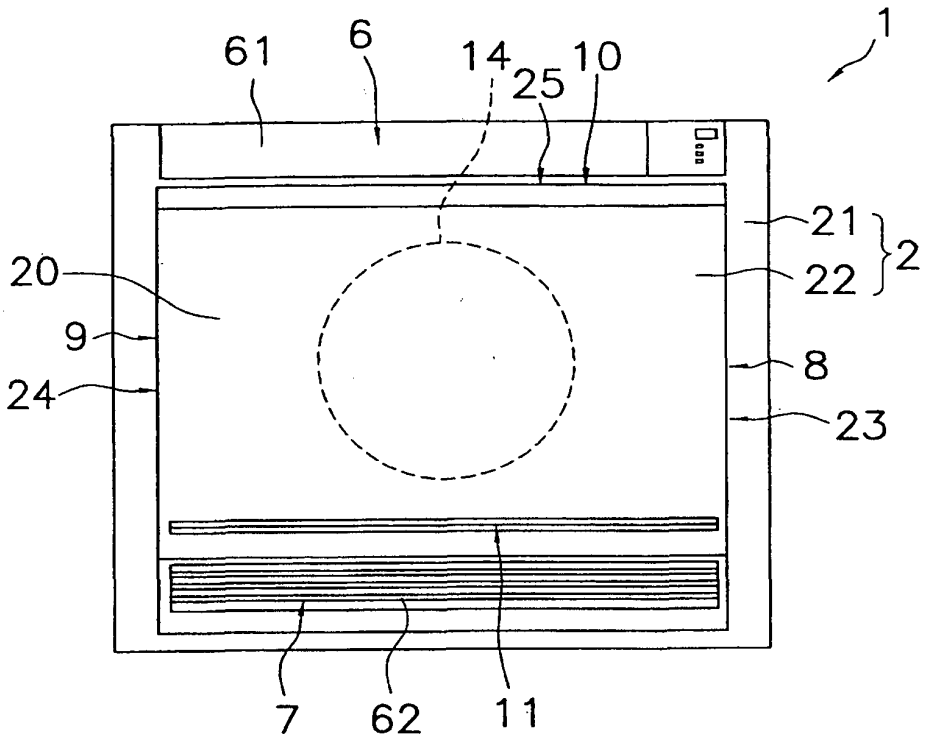
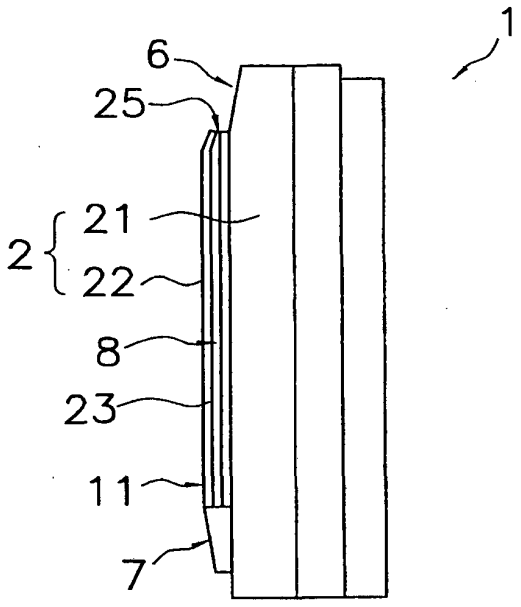


FIG. 2



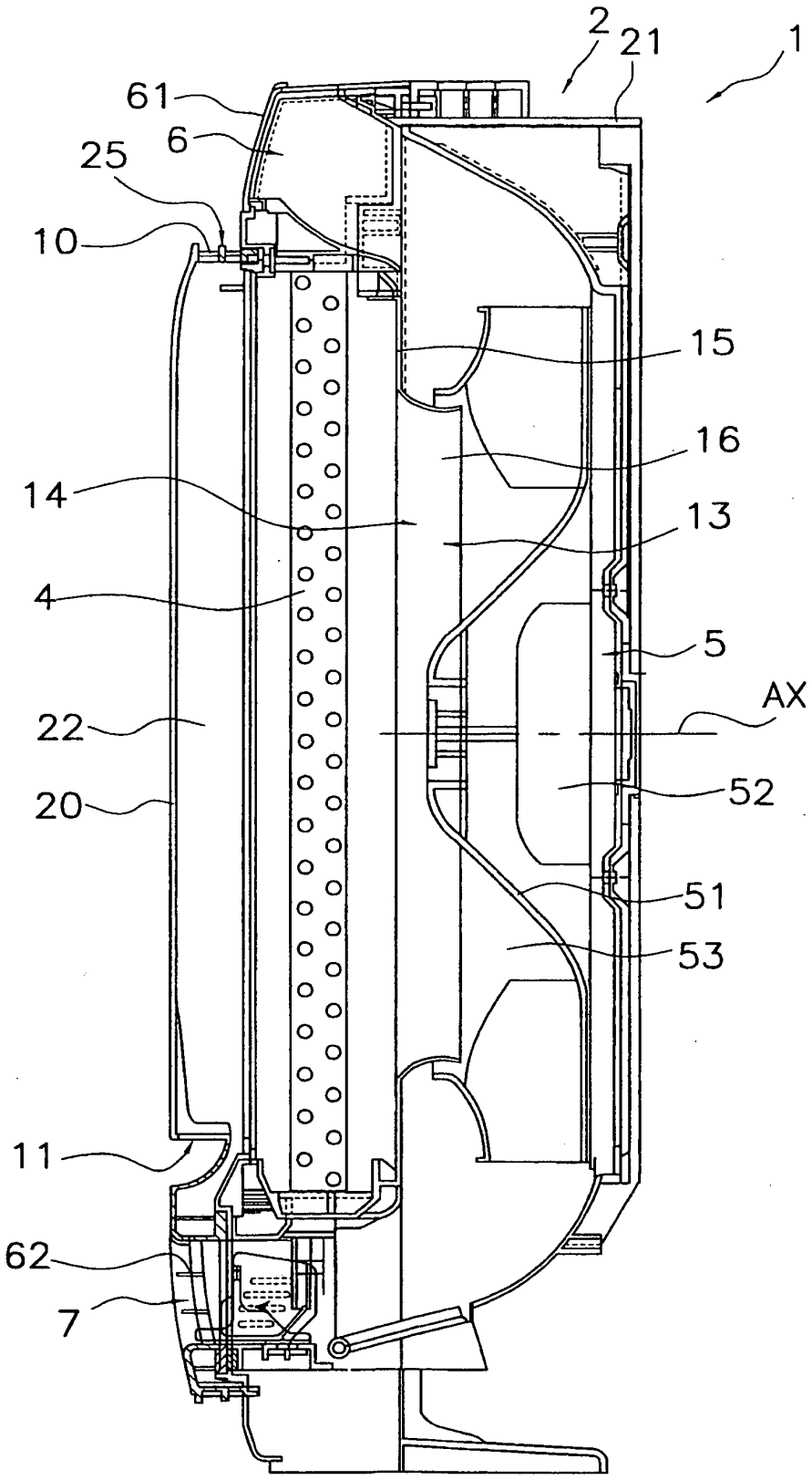


FIG. 3

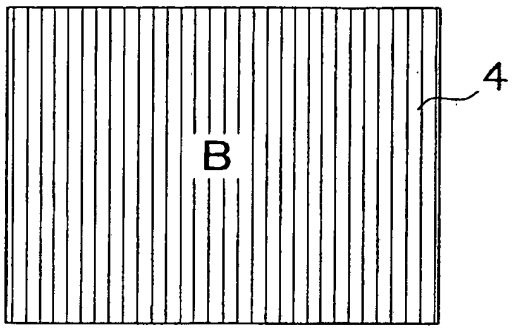


FIG. 4

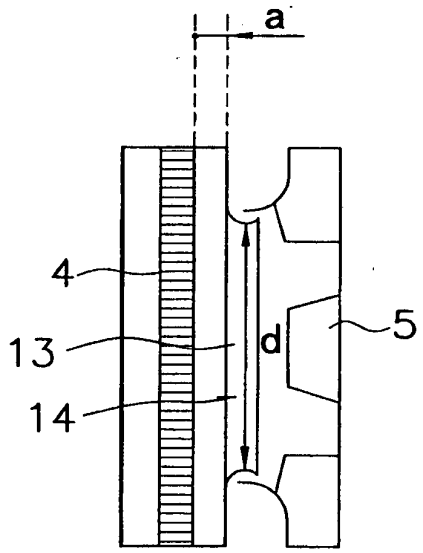


FIG. 5

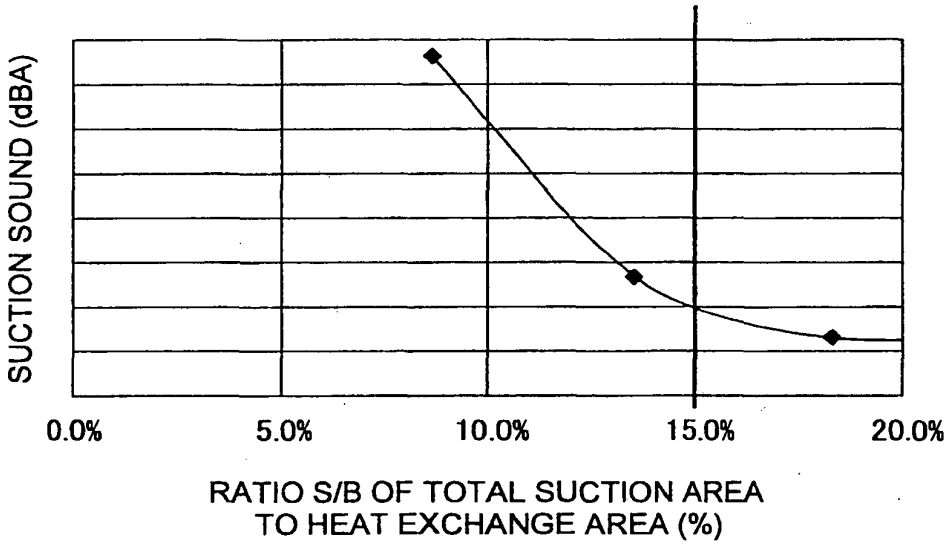

SUCTION SOUND (dBA)
0.0%
5.0%
10.0%
15.0%
20.0%
RATIO S/B OF TOTAL SUCTION AREA
TO HEAT EXCHANGE AREA (%)

FIG. 6

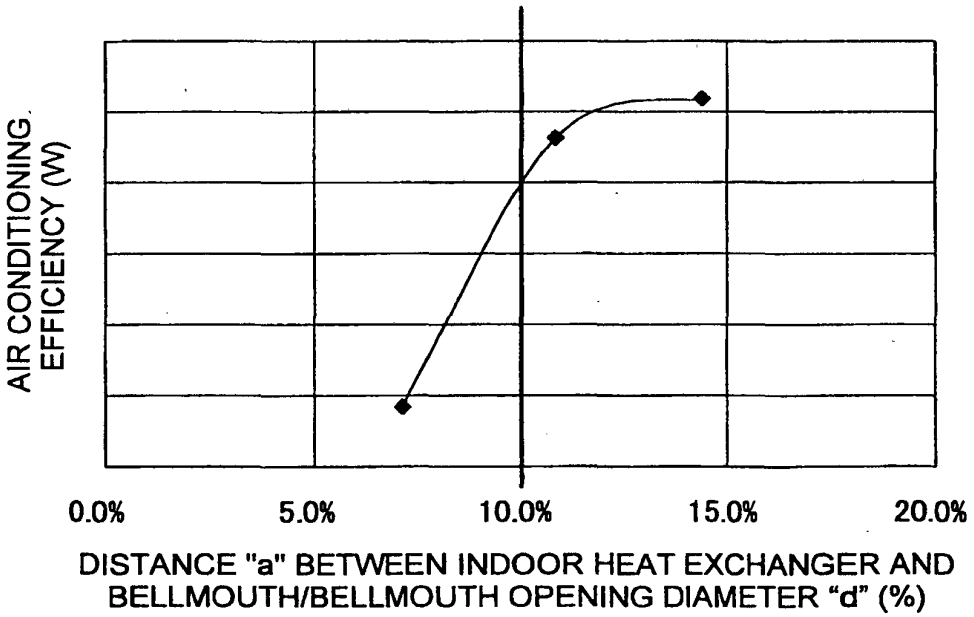

AIR CONDITIONING
EFFICIENCY (W)
0.0%
5.0%
10.0%
15.0%
20.0%
DISTANCE "a" BETWEEN INDOOR HEAT EXCHANGER AND
BELLMOUTH/BELLMOUTH OPENING DIAMETER "d" (%)

FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 6458965 A **[0004]**
- JP 2002005500 A **[0005]**
- EP 1512919 A **[0005]**