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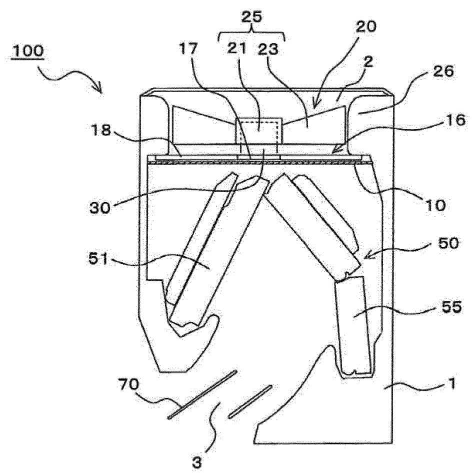
(54) INDOOR UNIT FOR AIR CONDITIONER, AND AIR CONDITIONER

(57) An indoor unit (100)is disclosed which can suppress the occurrence of noise.

An indoor unit (100) includes: a casing (1) having an air inlet (2) formed at a top portion thereof and an air outlet (3) formed at a bottom side of a front portion thereof; an axial-flow or diagonal-flow fan (20) disposed on the downstream side of the air inlet (2); a heat exchanger (50) disposed on the downstream side of the fan (20) and on the upstream side of the air outlet (3); a filter (10) that collects dust from air sucked into the casing (1); and a motor stay (16) having a fixing member (17) to which a fan motor (30) for the fan (20) is fixed and a support member (18) which secures the fixing member (17) to the casing (1). The filter (10) and the motor stay (16) are disposed on the downstream side of the fan (20). The motor stay (16) is disposed on the upstream side of the filter (10) or the downstream side of the filter (10) so that the distance between the motor stay (16) and the filter (10) will be smaller than the largest projection dimension.

F I G. 10



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Description

Technical Field

[0001] The present invention relates to an indoor unit that houses a fan and a heat exchanger in a casing and an air-conditioning apparatus including this indoor unit.

Background Art

[0002] There has been an air-conditioning apparatus that houses a fan and a heat exchanger in a casing. As an example of such an air-conditioning apparatus, "an air-conditioning apparatus including a body casing having an air inlet and an air outlet and a heat exchanger disposed within the body casing, wherein a fan unit including a plurality of small propeller fans provided side by side in the widthwise direction of the air outlet is disposed at the air outlet" has been proposed (for example, see Patent Literature 1).
In this air-conditioning apparatus, the fan unit is disposed at the air outlet so that the direction of airflow may be easily controlled, and, another fan unit having the same configuration as that of the fan unit disposed at the air outlet is also disposed at the air inlet so as to increase the amount of airflow, thereby improving the performance of the heat exchanger.

Citation List

Patent Literature

[0003]

Patent Literature 1: Japanese Unexamined Patent Application Publication JP-A-2005-003 244 (paragraphs [0012], [0013], [0018] to [0021], FIGs. 5 and 6)

Summary of the Invention

Technical Problem

[0004] In an air-conditioning apparatus, such as that disclosed in Patent Literature 1, a heat exchanger is disposed on the upstream side of a fan unit (air-sending device). A movable fan unit is disposed at the air outlet, and thus, a change of the flow channel caused by the movement of the fan or the instability of airflow due to asymmetrical suction causes a decrease in the amount of airflow or the backflow of air. Moreover, air having turbulence is input into the fan unit. Accordingly, an air-conditioning apparatus, such as that disclosed in Patent Literature 1, has a problem in that turbulence occurs in air flowing into an outer periphery of blades (propellers) at which the flow velocity is increased, thereby making the fan unit itself the source of noise (the fan unit increases noise).
An air-conditioning apparatus, such as that disclosed in Patent Literature 1, also has the following problem. Consideration is not particularly given to a support structure for a fan (more specifically, an impeller of the fan) forming a fan unit. Accordingly, the non-uniform airflow which is blown out of the fan unit increases a variation in the aerodynamic load imposed on the support structure for the fan, thereby further increasing the noise.
[0005] The present invention has been made in order to solve at least one of the above-described problems, and an object of the invention is to obtain an indoor unit that can reduce noise and an air-conditioning apparatus including this indoor unit.

Solution to Problem

[0006] An indoor unit of an air-conditioning apparatus according to the present invention includes: a casing including an air inlet formed at a top portion of the casing and an air outlet formed at a bottom side of a front portion of the casing; an axial-flow or diagonal-flow fan disposed on the downstream side of the air inlet within the casing; a heat exchanger disposed on the downstream side of the fan within the casing and on the upstream side of the air outlet, for exchanging heat between air blown out of the fan and a refrigerant; a filter that collects dust from air sucked into the casing; and a motor stay including a fixing member and a bar-like or plate-like support member, the fixing member fixing a fan motor on which an impeller of the fan is mounted or a support structure for rotatably supporting the impeller of the fan, the bar-like or plate-like support member securing the fixing member to the casing. The filter and the motor stay are disposed on the downstream side of the fan. The motor stay is disposed on the upstream side of the filter or the downstream side of the filter so that the distance between the motor stay and the filter is smaller than a projection dimension that is the largest among projection dimensions of a cross section view perpendicular to a longitudinal direction of the support member.

[0007] An indoor unit of an air-conditioning apparatus according to the present invention includes: a casing including an air inlet formed at a top portion of the casing and an air outlet formed at a bottom side of a front portion of the casing; an axial-flow or diagonal-flow fan disposed on the downstream side of the air inlet within the casing; and a heat exchanger disposed on the downstream side of the fan within the casing and on the upstream side of the air outlet, for exchanging heat between air blown out of the fan and a refrigerant. The fan includes an impeller and a housing which surrounds an outer periphery of the impeller, and the housing has a noise cancellation structure.

[0008] An air-conditioning apparatus according to the present invention includes the above-described indoor unit.

Advantageous Effects of the Invention

[0009] In the present invention, the filter and the motor stay are disposed on the downstream side of the fan. The motor stay is disposed on the upstream side of the filter or the downstream side of the filter so that the distance between the motor stay and the filter is smaller than a projection dimension that is the largest among projection dimensions in a cross section view perpendicular to a longitudinal direction of the support member. With this configuration, airflow having a smaller level of non-uniformity in the velocity distribution collides against the motor stay. Accordingly, a variation in the load imposed on the motor stay is decreased, thereby reducing noise produced by the motor stay.

Moreover, in the present invention, the housing of the fan includes a noise cancellation mechanism. Thus, noise produced by the fan can be canceled by this noise cancellation mechanism.

Thus, according to the present invention, it is possible to obtain an indoor unit that can reduce noise and an air-conditioning apparatus including this indoor unit.

Brief Description of the Drawings

[0010]

FIG. 1 is a longitudinal sectional view illustrating an indoor unit of an air-conditioning apparatus according to Embodiment 1 of the present invention.

FIG. 2 is a perspective view illustrating the outer appearance of an indoor unit of an air-conditioning apparatus according to Embodiment 1 of the present invention.

FIG. 3 is a perspective view illustrating an indoor unit according to Embodiment 1 of the present invention, as viewed from the right side of the front portion.

FIG. 4 is a perspective view illustrating an indoor unit according to Embodiment 1 of the present invention, as viewed from the right side of the back portion.

FIG. 5 is a perspective view illustrating an indoor unit according to Embodiment 1 of the present invention, as viewed from the left side of the front portion.

FIG. 6 is a perspective view illustrating a drain pan according to Embodiment 1 of the present invention.

FIG. 7 is a longitudinal sectional view illustrating a position at which condensation occurs in an indoor unit of an air-conditioning apparatus according to Embodiment 1 of the present invention.

FIG. 8 is a block diagram illustrating a signal processor according to Embodiment 1 of the present invention.

FIG. 9 is a longitudinal sectional view illustrating another example of an indoor unit of an air-conditioning apparatus according to Embodiment 1 of the present invention.

FIG. 10 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 2 of the present invention.

FIG. 11 is a longitudinal sectional view illustrating another example of an indoor unit according to Embodiment 2 of the present invention.

FIG. 12 is a front view illustrating an example of a motor stay (a plan view in the state in which the motor stay is fixed to an indoor unit) according to Embodiment 2 of the present invention.

FIG. 13 is a perspective view illustrating an example in which a fan motor is mounted on a fixing member of the motor stay according to Embodiment 2 of the present invention.

FIG. 14 is a perspective view illustrating an example in which a fan motor is mounted on a fixing member of the motor stay according to Embodiment 2 of the present invention.

FIG. 15 is a perspective view illustrating an example in which a fan motor is mounted on a fixing member of the motor stay according to Embodiment 2 of the present invention.

FIG. 16 is a perspective view illustrating an example in which a fan motor is mounted on a fixing member of the motor stay according to Embodiment 2 of the present invention.

FIG. 17 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 3 of the present invention.

FIG. 18 is a perspective view illustrating an outer appearance of an indoor unit according to Embodiment 3 of the present invention.

FIG. 19 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 4 of the present invention.

FIG. 20 is a front view illustrating an example of a fan according to Embodiment 5 of the present invention.

FIG. 21 illustrates the relationship between the configuration in which blades are disposed (the orientation and the number of blades disposed) and the aerodynamic performance.

FIG. 22 is a front view illustrating another example of a fan according to Embodiment 5 of the present invention.

FIG. 23 is a front view illustrating another example of a fan according to Embodiment 5 of the present invention.

FIG. 24 is a longitudinal sectional view illustrating an example of a fan according to Embodiment 6 of the present invention.

FIG. 25 is a front view illustrating an example of a fan according to Embodiment 7 of the present invention.

FIG. 26 is a front view illustrating another example of a fan according to Embodiment 7 of the present invention.

FIG. 27 is a front view illustrating an example of a fan according to Embodiment 8 of the present invention.

FIG. 28 is a front view illustrating another example of a fan according to Embodiment 8 of the present invention.

FIG. 29 is a longitudinal sectional view illustrating an example of a fan according to Embodiment 9 of the present invention.

FIG. 30 shows schematic diagrams of an example of a fan according to Embodiment 10 of the present invention.

FIG. 31 shows schematic diagrams of another example of a fan according to Embodiment 10 of the present invention.

FIG. 32 shows enlarged views (longitudinal sectional views) illustrating essential parts of examples of projections according to Embodiment 10 of the present invention.

FIG. 33 shows enlarged views (longitudinal sectional views) illustrating essential parts of other examples of projections according to Embodiment 10 of the present invention.

FIG. 34 shows enlarged views (longitudinal sectional views) illustrating essential parts of other examples of projections according to Embodiment 10 of the present invention.

FIG. 35 illustrates an example of airflow which is produced around a blade and which reduces the efficiency of the fan.

FIG. 36 is an enlarged view (longitudinal sectional views) illustrating an essential part of another example of a forward end of a projection according to Embodiment 10 of the present invention.

FIG. 37 is an enlarged view (longitudinal sectional view) illustrating an essential part of an example of an air-sending device according to Embodiment 11 of the present invention.

FIG. 38 is an enlarged view (longitudinal sectional view) illustrating an essential part of another example of an air-sending device according to Embodiment 11 of the present invention.

FIG. 39 is an enlarged view (longitudinal sectional view) illustrating an essential part of still another example of an air-sending device according to Embodiment 11 of the present invention.

FIG. 40 is an enlarged view (longitudinal sectional view) illustrating an essential part of an example of a fan according to Embodiment 12 of the present invention.

FIG. 41 is an enlarged view (longitudinal sectional view) illustrating an essential part of an example of a fan according to Embodiment 13 of the present invention.

FIG. 42 is a longitudinal sectional view illustrating a fan according to Embodiment 14 of the present invention.

FIG. 43 is a front sectional view illustrating another example of a fan according to Embodiment 14 of the present invention.

FIG. 44 is a longitudinal sectional view illustrating another example of a fan according to Embodiment 14 of the present invention.

FIG. 45 is a front sectional view illustrating another example of a fan according to Embodiment 14 of the present invention.

FIG. 46 shows longitudinal sectional views illustrating a fan according to Embodiment 15 of the present invention.

FIG. 47 is a longitudinal sectional view illustrating a fan according to Embodiment 16 of the present invention.

FIG. 48 is a longitudinal sectional view illustrating a fan according to Embodiment 17 of the present invention.

FIG. 49 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 18 of the present invention.

FIG. 50 illustrates an example of the air velocity distribution at the air outlet of an indoor unit according to Embodiment 19 of the present invention.

FIG. 51 illustrates another example of the air velocity distribution at the air outlet of an indoor unit according to Embodiment 19 of the present invention.

FIG. 52 is an enlarged view (front sectional view) illustrating an essential part near the air outlet of an indoor unit according to Embodiment 19 of the present invention.

FIG. 53 illustrates the air velocity distribution at the air outlet when the amounts of airflow of individual fans are the same in an indoor unit according to Embodiment 20 of the present invention.

FIG. 54 illustrates an example of the air velocity distribution at the air outlet when an indoor unit according to Embodiment 20 of the present invention is operated in the low airflow mode.

FIG. 55 is a characteristic diagram illustrating the relationship between the airflow reduction ratio of a fan disposed at the center and the noise reduction effects when the total amount of airflow is the same, in an indoor unit according to Embodiment 20 of the present invention.

FIG. 56 illustrates an example of the air velocity distribution at the air outlet of an indoor unit according to Embodiment 21 of the present invention.

FIG. 57 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 23 of the present invention.

FIG. 58 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 24 of the present invention.

FIG. 59 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 25 of the present invention.

FIG. 60 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 26 of the present invention.

FIG. 61 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 27 of the present invention.

FIG. 62 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 28 of the present invention.

FIG. 63 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 29 of the present invention.

FIG. 64 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 30 of the present invention.

FIG. 65 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 31 of the present invention.

FIG. 66 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 32 of the present invention.

FIG. 67 shows schematic views illustrating examples of shapes of a heat exchanger 50.

FIG. 68 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 33 of the present invention.

FIG. 69 is a block diagram illustrating a signal processor according to Embodiment 33 of the present invention.

FIG. 70 shows waveform diagrams illustrating a method for calculating noise to be canceled from sound subjected to interference processing.

FIG. 71 is a block diagram illustrating a method for estimating control sound in Embodiment 33 of the present invention.

FIG. 72 is a longitudinal sectional view illustrating another example of an indoor unit according to Embodiment 33 of the present invention.

FIG. 73 is a front view illustrating an indoor unit according to Embodiment 34 of the present invention.

FIG. 74 is a side view illustrating an indoor unit according to Embodiment 34 of the present invention.

FIG. 75 is a block diagram illustrating a controller according to Embodiment 34 of the present invention.

FIG. 76 is a front view illustrating another example of an indoor unit according to Embodiment 34 of the present invention.

FIG. 77 is a left side view illustrating the indoor unit shown in FIG. 76.

FIG. 78 is a front view illustrating an indoor unit according to Embodiment 35 of the present invention.

FIG. 79 is a block diagram illustrating a controller according to Embodiment 35 of the present invention.

FIG. 80 is a front view illustrating another example of an indoor unit according to Embodiment 35 of the present invention.

FIG. 81 is a left side view illustrating the indoor unit shown in FIG. 80.

FIG. 82 is a front view illustrating still another example of an indoor unit according to Embodiment 35 of the present invention.

FIG. 83 is a front view illustrating an indoor unit according to Embodiment 36 of the present invention.

Description of Embodiments

[0011] A description will be given below of specific embodiments of an air-conditioning apparatus (more specifically, an indoor unit of an air-conditioning apparatus) according to the present invention. In Embodiment 1, the basic configurations of individual units forming an indoor unit of an air-conditioning apparatus will be discussed. In Embodiment 5 through Embodiment 42, the detailed configurations of individual units and embodiments other than Embodiment 1 will be discussed.
In the following embodiments, the present invention will be described by using a wall-mounted air-conditioning apparatus as an example. In the drawings illustrating the individual embodiments, the shapes or the sizes of the units (or components of the units) may be partially different from one another.

Embodiment 1

Basic Configuration

[0012] FIG. 1 is a longitudinal sectional view illustrating an indoor unit (referred to as "indoor unit 100") of an air-conditioning apparatus according to Embodiment 1 of the present invention. FIG. 2 is a perspective view illustrating the outer appearance of this indoor unit. In Embodiment 1 and the embodiments described below, a description will be given, assuming that the left side of FIG. 1 is the front side of the indoor unit 100. The configuration of the indoor unit 100 will be described below with reference to FIGs. 1 and 2.

Overall Configuration

[0013] This indoor unit 100 supplies conditioned air to an air-conditioning subject area, such as an indoor room, by utilizing a refrigeration cycle in which a refrigerant circulates. The indoor unit 100 includes, as major parts, a casing 1, a fan 20, and a heat exchanger 50. In the casing 1, an air inlet 2 through which indoor air is sucked into the inside of the casing 1 and an air outlet 3 through which conditioned air is supplied to the air-conditioning subject area are formed. The fan 20 is stored within the casing 1 and sucks indoor air through the air inlet 2 and discharges conditioned air through the air outlet 3.
The heat exchanger 50 is disposed in a flow channel extending from the fan 20 to the air outlet 3, and produces conditioned

air by performing heat exchange between a refrigerant and indoor air. Then, the flow channel (indicated by the arrow Z) is continuously formed within the casing 1 via these components. The air inlet 2 is formed at a top portion of the casing 1 as an opening. The air outlet 3 is formed at a bottom portion (more specifically, the bottom side of the front portion of the casing 1) as an opening. The fan 20 is disposed on the downstream side of the air inlet 2 and on the upstream side of the heat exchanger 50, and is constituted by, for example, an axial-flow fan or a diagonal-flow fan.

[0014] The indoor unit 100 includes a controller 281 which controls the rotation speed of the fan 20, the directions (angles) of upper and lower vanes 70 and right and left vanes 80, which will be discussed later, etc. In some of the drawings illustrating Embodiment 1 and the subsequent embodiments, the controller 281 may not be shown.

[0015] In the indoor unit 100 configured as described above, since the fan 20 is disposed on the upstream side of the heat exchanger 50, it is possible to reduce the occurrence of rotational flow or the non-uniformity of the air velocity distribution in the air which is blown out of the air outlet 3, compared with an indoor unit provided in a known air-conditioning apparatus in which the fan 20 is provided at the air outlet 3. This makes it possible to implement smooth air sending to an air-conditioning subject area.

Additionally, since a complicated structure, such as a fan, is not disposed at the air outlet 3, it is easy to take measures against condensation occurring at a boundary between warm air and cool air during a cooling operation. Moreover, a fan motor 30 is not exposed to cool air or warm air, which is used for air-conditioning, thereby making the life in operating the air-conditioning apparatus longer.

Fan

[0016] Generally, in an indoor unit of an air-conditioning apparatus, in most cases, the size of a fan is small because of limitation in the installation space. Accordingly, in order to obtain a required amount of airflow, multiple fans having a suitable size are disposed in parallel. In the indoor unit 100 according to Embodiment 1, as shown in FIG. 2, three fans 20 are disposed in parallel in the longitudinal direction of the casing 1 (in other words, in the longitudinal direction of the air outlet 3).

With currently general dimensions of an indoor unit of an air-conditioning apparatus, about two to four fans 20 are preferably provided in order to obtain a desired level of heat exchange performance. In the indoor unit according to Embodiment 1, the fans 20 are all formed in the same shape, and by operating the fans 20 with the same operating rotation speed, all of the fans 20 can send almost the same amount of air.

[0017] With the fans 20 configured as described above, by combining the number, the shape, the size, etc. of the fans 20, in accordance with a required amount of airflow or the airflow resistance within the indoor unit 100, it is possible to design optimal fans compatible with various specifications of the indoor unit 100.

Bell Mouth

[0018] In the indoor unit 100 according to Embodiment 1, a bell mouth 5 on a duct is disposed around each of the fans 20. The bell mouth 5 serves to contribute to a smooth suction and exhaustion of air into and from the fan. As shown in FIG. 1, the bell mouth 5 according to Embodiment 1 is formed in a substantially circular shape as viewed from above. A longitudinal cross section of the bell mouth 5 according to Embodiment 1 is configured as follows. A top portion 5a is formed in a substantially arc shape such that the end thereof flares out toward the top. A middle portion 5b is a straight portion such that the diameter of the bell mouth is constant. A bottom portion 5c is formed in a substantially arc shape such that the end thereof flares out toward the bottom. The end of the top portion 5a (arc portion of the suction side) of the bell mouth 5 forms the air inlet 2.

The bell mouth 5 of Embodiment 1 shown in FIG. 1 is formed in the shape of a duct having a height higher than that of the impeller of the fan 20. However, the bell mouth 5 is not restricted to this configuration. Instead, the bell mouth 5 may be formed as a semi-opened bell mouth having a height lower than that of the impeller of the fan 20. Moreover, the bell mouth 5 may be constituted by only the top and bottom portions 5a and 5c at the ends without the straight part of the middle portion 5b shown in FIG. 1.

[0019] The bell mouth 5 may be formed integrally with, for example, the casing 1, in order to reduce the number of components or to improve the strength. Alternatively, the bell mouth 5, the fan 20, and the fan motor 30, for example, may be formed as a module, and these components may be formed to be attachable to and detachable from the casing 1, thereby improving the maintenance productivity.

[0020] In Embodiment 1, the end of the top portion 5a (arc portion of the suction side) of the bell mouth 5 is uniformly configured in the peripheral direction of the opened face of the bell mouth 5. That is, the bell mouth 5 does not have a structure, such as a notch or a rib, in the rotation direction around a rotational axis 20a of the fan 20, and is thus uniformly configured while having axis symmetry.

[0021] By forming the bell mouth 5 as described above, the end of the top portion 5a (arc portion of the suction side) of the bell mouth 5 is configured uniformly with respect to the rotation of the fan 20, thereby implementing a uniform suction flow of the fan 20. Accordingly, noise caused by a non-uniform suction flow of the fan 20 can be reduced.

Concerning Partition Board

[0022] As shown in FIG. 2, the indoor unit 100 according to Embodiment 1 is provided with partition boards 90 between adjacent fans 20. These partition boards 90 are disposed between the fans 20 and the respective separated portions of the heat exchanger 50. That is, a flow channel in-between the fans 20 and the heat exchanger 50 is divided into a plurality of flow channels (three in Embodiment 1). Since the partition boards 90 are disposed in-between the respective fans 20 and the respective separated portions of the heat exchanger 50, each shape of the side portions of the partition boards 90 which are in contact with the heat exchanger 50 is configured in accordance with the shape of the heat exchanger 50.
More specifically, as shown in FIG. 1, the heat exchanger 50 is provided in a substantially inverted V shape, as viewed from a longitudinal cross section in a direction from the front side to the back side of the indoor unit 100 (that is, a longitudinal cross section as viewed from the right side of the indoor unit 100, which will be hereinafter referred to as a "right-side longitudinal cross section"). Accordingly, the side portions of the partition boards 90 which are in contact with the heat exchanger 50 are also formed in a substantially inverted V shape.
[0023] The position of the side portions of the partition boards 90 which are adjacent to the fan 20 may be determined as follows. If the suction sides of adjacent fans 20 are sufficiently separated from each other to such a degree that they do not influence each other, it is sufficient that the side portion of the partition board 90 adjacent to the fan 20 is provided up to the outlet surface of the fan 20. However, if the suction sides of adjacent fanes 20 are disposed close to each other to such a degree that they influence each other, and if the end of the top portion 5a (arc portion of the suction side) of the bell mouth 5 can be formed sufficiently large, the side portion of the partition board 90 adjacent to the fan 20 may extend to the upstream side (suction side) of the fan 20 so that adjacent flow channels will not influence each other (so that the suction sides of the adjacent fans 20 will not influence each other).
[0024] Various materials may be used for forming the partition boards 90. For example, a metal, such as steel or aluminum, may be used for forming the partition boards 90. Alternatively, for example, a resin, may be used for forming the partition boards 90. However, the heat exchanger 50 becomes very hot during a heating operation, and if the partition boards 90 are made from a low-melting-point material, such as a resin, a small space may be formed between the partition boards 90 and the heat exchanger 50.
If the partition boards 90 are made from a high-melting-point material, such as aluminum or steel, the partition boards 90 may be disposed in contact with the heat exchanger 50. If the heat exchanger 50 is, for example, a finned tube heat exchanger, the partition boards 90 may be inserted between fins of the heat exchanger 50.
[0025] As described above, the flow channel is divided into a plurality of (three in Embodiment 1) flow channels between the fans 20 and the heat exchanger 50. An acoustic material may be provided in the flow channel, that is, in the partition boards 90 or the casing 1, so that noise occurring within the duct can be reduced.
[0026] The divided flow channels are each formed in a substantially quadrilateral shape having a side L1 and a side L2, as viewed from above. That is, the widths of the divided flow channels are L1 and L2. Accordingly, the airflow generated by the fan 20 which is disposed within the substantially quadrilateral shape defined by the widths L1 and L2 reliably passes through the heat exchanger 50, which is positioned in an area surrounded by the widths L1 and L2, on the downstream side the fan 20.
[0027] By dividing a flow channel within the casing 1 into a plurality of flow channels in this manner, even if a flow field produced by the fan 20 on the downstream side has rotational flow components, air blown out of the individual fans 20 cannot move freely in the longitudinal direction of the indoor unit 100 (in the direction perpendicular to the plane of FIG. 1). Accordingly, air blown out of the fan 20 can pass through the heat exchanger 50, which is positioned in an area surrounded by the widths L1 and L2, on the downstream side of the fan 20.
As a result, it is possible to reduce the non-uniformity of the distribution of the amounts of air, as a whole, which flows into the heat exchanger 50, in the longitudinal direction of the indoor unit 100 (in the direction perpendicular to the plane of FIG. 1), thereby exhibiting a high level of heat exchange performance. Additionally, by dividing the casing 1 by using the partition boards 90, it is possible to prevent rotational flows occurring in adjacent fans 20 from interfering with each other.
Accordingly, energy loss of a fluid caused by rotational flows interfering with each other can be reduced, thereby making it possible to decrease the pressure loss of the indoor unit 100 as well as improving the air velocity distribution. Each of the partition boards 90 does not have to be formed as one piece of board, but may be formed as a plurality of boards. For example, the partition board 90 may be divided into two boards at a position of a front-side heat exchanger 51 and at a position of a back-side heat exchanger 55. It is preferable that there is no gap between joint portions of the divided boards forming the partition board 90. By dividing the partition board 90 into a plurality of boards, the mountability of the partition board 90 is improved.

Fan Motor

[0028] The fan 20 is driven by the fan motor 30. The type of fan motor 30 may be an inner rotor or an outer rotor. If an outer rotor is used as the fan motor 30, a structure in which a rotor is integrated with a boss 21 of the fan 20 (boss 21 including a rotor) may be used. Additionally, the dimensions of the fan motor 30 are smaller than those of the boss 21 of the fan 20, thereby preventing loss of the airflow generated by the fan 20. Moreover, the motor is located within the boss 21, thereby also decreasing the axial dimension. By forming the fan motor 30 and the fan 20 to be easily attached and detached, the maintenance productivity can also be improved.

[0029] By using a relatively expensive DC brushless motor as the fan motor 30, the efficiency, the life, and the controllability can be improved. However, another type of motor may be used, which satisfies primary functions of an air-conditioning apparatus. A drive circuit for the fan motor 30 may be integrally formed with the fan motor 30, or may be externally formed, in which case, dust-prevention or fire-prevention measures can be taken.

[0030] The fan motor 30 is fixed to the casing 1 by way of a motor stay 16. The fan motor 30 may be formed as a box type (the fan 20, a housing, the fan motor 30, the bell mouth 5, the motor stay 16, etc. are integrally formed as a module) used for CPU cooling, etc. and may be formed to be attachable and detachable to and from the casing 1. Then, the maintenance productivity can be improved and the precision in the tip clearance of the fan 20 can be enhanced. Generally, with a narrower tip clearance, the air-sending performance becomes higher, which is preferable.

[0031] The drive circuit for the fan motor 30 may be formed within the fan motor 30 or may be formed outside the fan motor 30.

Motor Stay

[0032] The motor stay 16 includes a fixing member 17 and a support member 18. The fixing member 17 is used for mounting the fan motor 30 thereon. The support member 18 is used for securing the fixing member 17 to the casing 1. The support member 18 is, for example, a bar-like shape, and extends, for example, radially from the outer periphery of the fixing member 17. As shown in FIG. 1, the support member 18 according to Embodiment 1 extends in the substantially horizontal direction. The support member 18 may be formed in the shape of a wing or a plate, thereby providing effects of stator blades.

Heat Exchanger

[0033] The heat exchanger 50 for use in the indoor unit 100 according to Embodiment 1 is disposed on the downstream side of the fan 20. As the heat exchanger 50, a finned tube heat exchanger, for example, may be appropriately used. As shown in FIG. 1, the heat exchanger 50 is divided, with respect to a symmetric line 50a, as viewed from a right-side longitudinal cross section. The symmetric line 50a serves to divide the installation range of the heat exchanger 50 viewed from this cross section into right and left sides with respect to the substantially center of the installation range.
That is, the front-side heat exchanger 51 is disposed on the front side (left side of the plane of FIG. 1) with respect to the symmetric line 50a, while the back-side heat exchanger 55 is disposed on the back side (right side of the plane of FIG. 1) with respect to the symmetric line 50a. Then, the front-side heat exchanger 51 and the back-side heat exchanger 55 are disposed within the casing 1 such that the spacing therebetween increases in the air flowing direction, that is, such that the configuration of the right-side longitudinal cross section of the heat exchanger 50 is formed in a substantially inverted V shape. That is, the front-side heat exchanger 51 and the back-side heat exchanger 55 are disposed such that they tilt with respect to the flowing direction of air supplied from the fan 20.

[0034] One of the features of the heat exchanger 50 is that the area of the flow channel of the back-side heat exchanger 55 is larger than that of the front-side heat exchanger 51. That is, in the heat exchanger 50, the amount of airflow of the back-side heat exchanger 55 is greater than that of the front-side heat exchanger 51. In Embodiment 1, the length of the back-side heat exchanger 55 is longer than that of the front-side heat exchanger 51, as viewed from a right-side longitudinal cross section.
Accordingly, the area of the flow channel of the back-side heat exchanger 55 is larger than that of the front-side heat exchanger 51. The other configurations (for example, the depth in FIG. 1) of the front-side heat exchanger 51 are the same as those of the back-side heat exchanger 55. That is, the heat transfer area of the back-side heat exchanger 55 is larger than that of the front-side heat exchanger 51. The rotational axis 20a of the fan 20 is set above the symmetric line 50a.

[0035] By forming the heat exchanger 50 as described above, it is possible to reduce the occurrence of rotational flow or the air velocity distribution in the air which is blown out of the air outlet 3, compared with an indoor unit for use in a known air-conditioning apparatus in which a fan is disposed at an air outlet. Additionally, by forming the heat exchanger 50 as described above, the amount of airflow of the back-side heat exchanger 55 is larger than that of the front-side heat exchanger 51.

Because of this difference in the amount of airflow, after air passing through the front-side heat exchanger 51 joins air passing through the back-side heat exchanger 55, the joined air deflects toward the front side (air outlet 3). Accordingly, it is not necessary to suddenly deflect the airflow near the air outlet 3, thereby making it possible to decrease the pressure loss near the air outlet 3.

[0036] In the indoor unit 100 according to Embodiment 1, the direction in which air flows out from the back-side heat exchanger 55 is a direction of a flow from the back side to the front side. Accordingly, in the indoor unit 100 according to Embodiment 1, compared with a case in which the heat exchanger 50 is disposed such that the configuration of a right-side longitudinal cross section of the heat exchanger 50 is formed in a substantially V shape, the airflow after passing through the heat exchanger 50 can deflect more easily.

[0037] Since the indoor unit 100 includes a plurality of fans 20, it may be heavy. If the indoor unit 100 is heavy, the strength of a wall on which the indoor unit 100 is mounted is required, which is a restriction on mounting the indoor unit 100. Accordingly, it is desirable to reduce the weight of the heat exchanger 50. Additionally, in the indoor unit 100, since the fan 20 is disposed on the upstream side of the heat exchanger 50, the height of the indoor unit 100 becomes high, which may also be a restriction on mounting the indoor unit 100. It is thus desirable to reduce the weight of the heat exchanger 50. It is also desirable to reduce the size of the heat exchanger 50.

[0038] Thus, in Embodiment 1, by the use of a finned tube heat exchanger as the heat exchanger 50 (front-side heat exchanger 51 and back-side heat exchanger 55), the size of the heat exchanger 50 is reduced. More specifically, the heat exchanger 50 according to Embodiment 1 includes a plurality of fins 56 stacked on one another with a predetermined gap therebetween and a plurality of heat exchanger pipes 57 passing through these fins 56. In Embodiment 1, the fins 56 are stacked on one another in the horizontal direction (in the direction perpendicular to the plane of FIG. 1) of the casing 1.

That is, the heat exchanger pipes 57 pass through the fins 56 in the horizontal direction (in the direction perpendicular to the plane of FIG. 1) of the casing 1. Moreover, in Embodiment 1, in order to improve the heat exchange efficiency of the heat exchanger 50, the heat exchanger pipes 57 are provided in two lines in the airflow direction of the heat exchanger 50 (widthwise direction of the fins 56). These heat exchanger pipes 57 are arranged as a substantially staggered pattern as viewed from a right-side longitudinal cross section.

[0039] The heat exchanger pipes 57 are constituted by circular pipes having a small diameter (about 3 to 7 mm), and, as the refrigerant flowing through the heat exchanger pipes 57 (refrigerant used in the indoor unit 100 and in an air-conditioning apparatus including this indoor unit 100), R32 is used, thereby reducing the size of the heat exchanger 50. That is, the heat exchanger 50 exchanges heat between a refrigerant flowing through the heat exchanger pipes 57 and indoor air via the fins 56.

Accordingly, with the same circulating amount of refrigerant, when the heat exchanger pipes 57 are formed smaller, the pressure loss of the refrigerant becomes larger than when the heat exchanger pipes of a heat exchanger have a larger diameter. However, with the same temperature, the latent heat of vaporization of R32 is larger than that of R410A, and thus, R32 can achieve the same performance as R410A with a smaller circulating amount of refrigerant. Accordingly, by the use of R32, the amount of refrigerant to be used can be reduced, thereby making it possible to decrease the pressure loss in the heat exchanger 50. As a result, by forming the heat exchanger pipes 57 by small circular pipes and by using R32 as a refrigerant, the size of the heat exchanger 50 can be reduced.

[0040] In the heat exchanger 50 according to Embodiment 1, by forming the fins 56 and the heat exchanger pipes 57 of aluminum or an aluminum alloy, the weight of the heat exchanger 50 is reduced. If the weight of the heat exchanger 50 is not a restriction on mounting the indoor unit 100, the heat exchanger pipes 57 can be made of copper.

<u>Finger Guard and Filter</u>

[0041] In the indoor unit 100 according to Embodiment 1, a finger guard 15 and a filter 10 are provided at the air inlet 2. The finger guard 15 is disposed in order to protect a hand from the rotating fan 20. Accordingly, the shape of the finger guard 15 may be formed as desired as long as it protects a hand from the rotating fan 20. For example, the finger guard 15 may be formed in a lattice-like shape or a circular shape constituted by many rings having different sizes. The finger guard 15 may be made of a resin material or a metal material.

However, if the strength is required, the finger guard 15 is preferably made of metal. It is also preferable that the finger guard 15 is as thin as possible and is made of a highly resistant material and has a highly resistant shape, with a view to reducing the airflow resistance and maintaining the strength. The filter 10 is disposed in order to prevent the entry of dust particles into the inside of the indoor unit 100. The filter 10 is provided at the casing 1 such that it is attachable and detachable to and from the casing 1. Moreover, the indoor unit 100 according to Embodiment 1 may include an automatic cleaning mechanism which automatically cleans the filter 10, though such a mechanism is not shown.

Airflow Direction Control Vanes

[0042] The indoor unit 100 according to Embodiment 1 includes upper and lower vanes 70 and right and left vanes (not shown), which are mechanisms for controlling the airflow discharge directions, at the air outlet 3.

Drain Pans

[0043] FIG. 3 is a perspective view illustrating the indoor unit according to Embodiment 1 of the present invention, as viewed from the right side of the front portion. FIG. 4 is a perspective view illustrating this indoor unit as viewed from the right side of the back portion. FIG. 5 is a perspective view illustrating this indoor unit as viewed from the left side of the front portion. FIG. 6 is a perspective view illustrating a drain pan according to Embodiment 1 of the present invention. In order to facilitate the understanding of the shape of the drain pan, the right side of the indoor unit 100 is shown as a cross section in FIGs. 3 and 4, and the left side of the indoor unit 100 is shown as a cross section in FIG. 5.

[0044] A front-side drain pan 110 is provided below the bottom portion of the front-side heat exchanger 51 (end portion of the front side of the front-side heat exchanger 51). A back-side drain pan 115 is provided below the bottom portion of the back-side heat exchanger 55 (end portion of the back side of the back-side heat exchanger 55). In Embodiment 1, the back-side drain pan 115 and a back portion 1b of the casing 1 are integrally formed. A connecting portion 116 to which a drain hose 117 is connected is provided at each of the right and left ends of the back-side drain pan 115.
The drain hose 117 does not have to be connected to both the connecting portions 116, but may be connected to one of the connecting portions 116. For example, when installing the indoor unit 100, if it is desired that the drain hose 117 is pulled out to the right side of the indoor unit 100, the drain hose 117 is connected to the connecting portion 116 provided at the right side of the back-side drain pan 115, and the connecting portion 116 provided at the left side of the back-side drain pan 115 may be closed with, for example, a rubber stopper.

[0045] The front-side drain pan 110 is disposed at a position higher than the back-side drain pan 115. A drainage channel 111, which serves as a channel through which drain flows, is provided at each of the right side and the left side between the front-side drain pan 110 and the back-side drain pan 115. The drainage channel 111 is connected at its forward end to the front-side drain pan 110, and tilts downward from the front-side drain pan 110 to the back-side drain pan 115. A tongue portion 111a is formed at the end of the back side of the drainage channel 111. The end portion of the back side of the drainage channel 111 is disposed such that it covers the top surface of the back-side drain pan 115.

[0046] During a cooling operation, when indoor air is cooled by the heat exchanger 50, condensation occurs in the heat exchanger 50. Then, dewdrops adhering to the front-side heat exchanger 51 are dropped from the bottom portion of the front-side heat exchanger 51 and are recovered in the front-side drain pan 110. Dewdrops adhering to the back-side heat exchanger 55 are dropped from the bottom portion of the back-side heat exchanger 55 and are recovered in the back-side drain pan 115.
In Embodiment 1, since the front-side drain pan 110 is disposed at a position higher than the back-side drain pan 115, drain recovered in the front-side drain pan 110 flows through the drainage channel 111 toward the back-side drain pan 115. Then, this drain drops down from the tongue portion 111a to the back-side drain pan 115 and is recovered therein. The drain recovered in the back-side drain pan 115 is discharged to the outside of the casing 1 (indoor unit 100) through the drain hose 117.

[0047] As in Embodiment 1, by providing the front-side drain pan 110 at a position higher than the back-side drain pan 115, the drain recovered in both the drain pans can be collected in the back-side drain pan 115 (drain pan disposed at the backmost side of the casing 1). Accordingly, by providing the connecting portion 116 for the drain hose 117 at the back-side drain pan 115, the drain recovered in the front-side drain pan 110 and the back-side drain pan 115 can be discharged to the outside of the casing 1. Thus, when conducting maintenance of the indoor unit 100 (for example, cleaning the heat exchanger 50) by opening the front portion of the casing 1, it is not necessary to detach and attach the drain pan to which the drain hose 117 is connected, thereby improving the operability of the maintenance, etc.

[0048] The drainage channel 111 is provided at each of the left side and the right side. Accordingly, even if the indoor unit 110 is installed in the state in which it is tilted, drain collected in the front-side drain pan 110 is reliably guided to the back-side drain pan 115. Additionally, the connecting portion to which the drain hose 117 is connected is provided at each of the left side and the right side. Accordingly, the direction in which the hose is pulled out can be selected in accordance with the installation conditions of the indoor unit 100, thereby improving the operability when installing the indoor unit 100.
Moreover, since the drainage channel 111 is disposed such that it covers a portion above the back-side drain pan 115 (that is, since a connection mechanism between the drainage channel 111 and the back-side drain pan 115 is not necessary), it is easy to attach and detach the front-side drain pan 110, thereby improving the maintenance productivity.

[0049] Alternatively, the drainage channel 111 may be disposed such that the end of the back side of the drainage channel 111 is connected to the back-side drain pan 115 and such that the front-side drain pan 110 covers a portion above the drainage channel 111. With this configuration, advantages similar to those obtained by the configuration in

which the drainage channel 111 covers a portion above the back-side drain pan 115 can be achieved.
Additionally, the front-side drain pan 110 does not have to be higher than the back-side drain pan 115, and even if the front-side drain pan 110 and the back-side drain pan 115 have the same height, the drain collected in both the drain pans can be discharged from the drain hose connected to the back-side drain pan 115.

Nozzle

[0050] In the indoor unit 100 according to Embodiment 1, as viewed from a right-side longitudinal cross section, an opening length d1 (aperture length d1 defined between the front-side drain pan 110 and the back-side drain pan 115) at the inlet of a nozzle 6 is larger than an opening length d2 (length of the air outlet 3) at the outlet of the nozzle 6. That is, the relationship between the opening lengths d1 and d2 of the nozzle 6 of the indoor unit 100 is d1 > d2 (see FIG. 1).
[0051] The reason why the relationship between the opening lengths d1 and d2 of the nozzle 6 is d1 > d2 is as follows. Note that a description will be given below, assuming that d2 used in the indoor unit 100 according to Embodiment 1 is about the same length as that of an air outlet of a known indoor unit, since d2 influences airflow reachability, which is one of the basic functions of an indoor unit.
[0052] By defining the shape of the right-side longitudinal cross section of the nozzle 6 to be d1 > d2, the flow channel of air is increased, and also, the angle A of the heat exchanger 50 disposed on the upstream side (angle between the front-side heat exchanger 51 and the back-side heat exchanger 55 at the downstream part of the heat exchanger 50) can be increased. Accordingly, the air velocity distribution in the heat exchanger 50 can be decreased, and also, the flow channel of air in the downstream part of the heat exchanger 50 can be formed to be large, thereby making it possible to reduce the pressure loss of the indoor unit 100 as a whole. Moreover, the non-uniformity of the air velocity distribution near the inlet of the nozzle 6 can be reduced by the contracted flow effects and the airflow having a uniform air velocity distribution can be guided to the air outlet 3.
[0053] For example, if d1 = d2, the non-uniformity of the air velocity distribution occurring near the inlet of the nozzle 6 (for example, the flow biased toward the back side) remains the same at the air outlet 3. That is, if d1 = d2, air is blown out of the air outlet 3 while maintaining the non-uniformity of the air velocity distribution. If d1 < d2, when air passing through the front-side heat exchanger 51 joins air passing through the back-side heat exchanger 55 near the inlet of the nozzle 6, the contracted flow loss is increased. Accordingly, if d1 < d2, the same amount of loss as the contracted flow loss is incurred unless the diffusion effect is obtained at the air outlet 3.

ANC

[0054] In the indoor unit 100 according to Embodiment 1, an active noise cancellation mechanism is mounted, as shown in FIG. 1.
[0055] More specifically, the noise cancellation mechanism of the indoor unit 100 according to Embodiment 1 includes a noise detecting microphone 161, a control speaker 181, a noise-cancellation effect detecting microphone 191, and a signal processor 201. The noise detecting microphone 161 is a noise detecting device that detects operating sound (noise) of the indoor unit 100 including air-sending sound of the fan 20. This noise detecting microphone 161 is disposed between the fan 20 and the heat exchanger 50. In Embodiment 1, the noise detecting microphone 161 is provided at the front portion within the casing 1. The control speaker 181 is a control sound output device that outputs control sound for noise.
This control speaker 181 is disposed below the noise detecting microphone 161 and above the heat exchanger 50. In Embodiment 1, the control speaker 181 is provided at the front portion within the casing 1 such that it faces the center of the flow channel. The noise-cancellation effect detecting microphone 191 is a noise-cancellation effect detecting device that detects noise cancellation effects obtained by control sound. This noise-cancellation effect detecting microphone 191 is provided near the air outlet 3 in order to detect noise output from the air outlet 3.
The noise-cancellation effect detecting microphone 191 is fixed at a position at which it can avoid airflow so that it will not be exposed to air blown out of the air outlet 3. The signal processor 201 is a control sound generating device that causes the control speaker 181 to output control sound on the basis of detection results obtained by the noise detecting microphone 161 and the noise-cancellation effect detecting microphone 191. The signal processor 201 is stored in, for example, the controller 281.
[0056] FIG. 8 is a block diagram illustrating the signal processor according to Embodiment 1 of the present invention. An electric signal input from each of the noise detecting microphone 161 and the noise-cancellation effect detecting microphone 191 is amplified by a microphone amplifier 151, and is converted from an analog signal to a digital signal by an A/D converter 152. The converted digital signal is input into an FIR filter 158 and an LMS algorithm 159.
The FIR filter 158 generates a control signal obtained by making correction so that the amplitude of the control signal will be the same as the amplitude of noise detected by the noise detecting microphone 161 when reaching the position at which the noise-cancellation effect detecting microphone 191 is disposed and so that the phase of the control signal

will be opposite to the phase of the noise when reaching the position at which the noise-cancellation effect detecting microphone 191 is disposed. Then, the control signal is converted from a digital signal to an analog signal by a D/A converter 154. The analog signal is then amplified by an amplifier 155, and is output from the control speaker 181 as control sound.

[0057] As shown in FIG. 7, for example, when an air-conditioning apparatus performs a cooling operation, the temperature is dropped in an area B between the heat exchanger 50 and the air outlet 3 by cool air. Accordingly, condensation occurs in which vapor in air appears as water droplets. Thus, in the indoor unit 100, a bucket (not shown), for example, is attached near the air outlet 3 in order to prevent water droplets from dropping from the air outlet 3. Condensation does not occur in the area on the upstream side of the heat exchanger 50 in which the noise detecting microphone 161 and the control speaker 181 are disposed, since such an area is farther upstream than an area where the temperature is dropped by cool air.

[0058] A method for reducing operating sound in the indoor unit 100 will now be described below. Operating sound (noise) including air-sending sound of the fan 20 in the indoor unit 100 is detected by the noise detecting microphone 161 installed between the fan 20 and the heat exchanger 50 and is converted into a digital signal through the use of the microphone amplifier 151 and the A/D converter 152. The digital signal is then input into the FIR filter 158 and the LMS algorithm 159.

[0059] The tap coefficient of the FIR filter 158 is sequentially changed by the LMS algorithm 159. In the LMS algorithm 159, the tap coefficient is updated according to Equation 1 ($h(n+1) = h(n) + 2 \cdot \mu \cdot e(n) \cdot x(n)$), and the optimal tap coefficient is updated so that the error signal e may approximate to zero.

In Equation (1), h is a tap coefficient of the filter, e is an error signal, x is a filter input signal, and μ is a step size parameter. The step size parameter μ is used for controlling the amount by which the filter coefficient is updated every time sampling is performed.

[0060] After passing through the FIR filter 158 in which the tap coefficient has been updated by the LMS algorithm 159, the digital signal is converted into an analog signal by the D/A converter 154 and is amplified by the amplifier 155. The amplified analog signal is then output, as control sound, to the flow channel within the indoor unit 100 through the control speaker 181 fixed between the fan 20 and the heat exchanger 50.

[0061] The noise-cancellation effect detecting microphone 191 is provided at the bottom end of the indoor unit 100 and is fixed such that it faces the wall outside the air outlet 3 so as to avoid air output from the air outlet 3. The noise-cancellation effect detecting microphone 191 detects sound generated by causing the control sound output from the control speaker 181 to interfere with noise propagated from the fan 20 through the flow channel and output from the air outlet 3.

Sound detected by the noise-cancellation effect detecting microphone 191 is input into the error signal of the above-described LMS algorithm 159. Accordingly, the tap coefficient of the FIR filter 158 is updated so that sound subjected to the above-described interference processing may approximate to zero. As a result, noise near the air outlet 3 can be reduced by control sound passing through the FIR filter 158.

[0062] In this manner, in the indoor unit 100 to which an active noise cancellation method is applied, the noise detecting microphone 161 and the control speaker 181 are disposed between the fan 20 and the heat exchanger 50, and the noise-cancellation effect detecting microphone 191 is fixed at a position at which it can avoid airflow output from the air outlet 3. Accordingly, members required for performing active noise cancellation do not have to be fixed to the area B in which condensation occurs, and thus, adhesion of water droplets to the control speaker 181, the noise detecting microphone 161, and the noise-cancellation effect detecting microphone 191 can be avoided. As a result, degradation in the noise cancellation performance and faults of the speaker or the microphones can be prevented.

[0063] The mounting positions of the noise detecting microphone 161, the control speaker 181, and the noise-cancellation effect detecting microphone 191 discussed in Embodiment 1 are only examples. For example, as shown in FIG. 9, as well as the noise detecting microphone 161 and the control speaker 181, the noise-cancellation effect detecting microphone 191 may be disposed between the fan 20 and the heat exchanger 50. Additionally, as detection means for detecting the noise cancellation effects after noise is canceled out with noise or control sound, a microphone is used by way of example. However, an acceleration sensor for detecting vibration of the casing may be used.

Alternatively, it is possible to consider sound as turbulence of airflow, and the noise cancellation effects after noise is canceled out with noise or control sound may be detected as turbulence of airflow. That is, as the detection means for detecting noise cancellation effects after noise is canceled out with noise or control sound, a flow velocity sensor, a hot wire probe, etc. for detecting airflow may be used. The airflow may also be detected by increasing the gain of the microphone.

[0064] In Embodiment 1, in the signal processor 201, the FIR filter 158 and the LMS algorithm 159 are used. However, another type of adaptive signal processing circuit which approximates sound detected by the noise-cancellation effect detecting microphone 191 to zero may be used, and a processing circuit using a filtered-X algorithm, which is generally used in an active noise cancellation method, may be employed. Moreover, in the signal processor 201, instead of performing adaptive signal processing, control sound may be generated by a fixed tap coefficient. Additionally, the signal processor 201 does not have to be a digital signal processing circuit, but may be an analog signal processing circuit.

[0065] In Embodiment 1, a description has been given of a case in which the heat exchanger 50 for performing air cooling which is likely to cause condensation is disposed. However, Embodiment 1 is also applicable when a heat exchanger for performing air cooling which is not likely to cause condensation is disposed. Regardless of whether condensation occurs in the heat exchanger 50, Embodiment 1 has the effect of preventing degradation in the performance of the noise detecting microphone 161, the control speaker 181, and the noise-cancellation effect detecting microphone 191.

Embodiment 2

Motor Support Structure

[0066] Noise can be reduced by fixing the fan 20 to the casing 1 by way of, for example, the following motor stay 16. Embodiment 2 will be discussed by designating the same functions and configurations as those of Embodiment 1 by like reference numerals.

[0067] FIG. 10 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 2 of the present invention.

The indoor unit 100 according to Embodiment 2 includes a fan 20 having a boss 21 to which a fan motor 30 is connected. The fan motor 30 is fixed to the casing 1 by way of a motor stay 16. This motor stay 16 includes a fixing member 17 and a support member 18. The fixing member 17 is used for mounting the fan motor 30 thereon. The support member 18 is used for securing the fixing member 17 to the casing 1.

The support member 18 is, for example, a bar-like shape, and extends, for example, radially, from the outer periphery of the fixing member 17. As shown in FIG. 10, in the indoor unit 100 according to Embodiment 2, the filter 10 is provided on the downstream side of the fan 20. Additionally, in the indoor unit 10 according to Embodiment 2, the motor stay 16 and the filter 10 are disposed close to (for example, in contact with) each other. The support member 18 may be formed in the shape of a wing or a plate, thereby providing effects of stator blades.

[0068] Airflow blown out of the fan 20 has a velocity distribution. Then, airflow having this velocity distribution collides against a structure (for example, the motor stay 16) disposed downstream, thereby causing noise which synchronizes with the product of the rotation speed and the number of blades of the fan 20. On the other hand, if a member having airflow resistance is disposed on the downstream side of the fan 20, as airflow blown out of the fan 20 approaches closer such a member having airflow resistance, the velocity distribution becomes smaller due to the airflow resistance.

Accordingly, in Embodiment 2, the filter 10 (a member having airflow resistance) is disposed on the downstream side of the fan 20, and the motor stay 16, which is the major structure for causing noise, is disposed near the filter 10. Accordingly, since airflow having a smaller velocity distribution collides against the motor stay 16, a variation in the load imposed on the motor stay 16 is decreased, thereby reducing noise produced by the motor stay 16.

[0069] In Embodiment 2, the description "the motor stay 16 is disposed near the filter 10" indicates the following state. A sharp velocity defect region (region where the velocity is small) is produced in airflow at a position after the motor stay 16 (airflow on the downstream side of the motor stay 16). The length of the velocity defect region in the airflow direction is about the same as the dimension of the motor stay 16 projected in the airflow direction. The velocity defect region is a portion at which the airflow velocity changes sharply, and thus, sharp vortexes or airflow turbulence occurs by a shearing force produced due to the difference in the flow velocity. The occurrence of sharp vortexes or airflow turbulence increases the amount of noise.

[0070] Since airflow at a position after the fan 20 (airflow on the downstream side thereof) has a complicated velocity distribution, it collides against the motor stay 16 from various directions. Thus, if the support member 18 of the motor stay 16 is cut in cross section in a direction perpendicular to the longitudinal direction of the support member 18, among the projection dimensions of this cross section, the largest projection dimension is substantially the same as the length of the largest velocity defect region.

That is, by setting the distance between the motor stay 16 and the filter 10 to be smaller than the largest projection dimension, noise caused by airflow turbulence, etc., occurring in the velocity defect region can be reduced. Accordingly, in Embodiment 2, "the motor stay 16 is disposed near the filter 10" means that the motor stay 16 is disposed on the upstream side of the filter 10 such that the distance between the motor stay 16 and the filter 10 becomes smaller than the largest projection dimension.

[0071] In FIG. 10, the filter 10 is provided below (that is, downstream side thereof) the motor stay 16. However, as shown in FIG. 11, the filter 10 may be provided above (that is, upstream side thereof) the motor stay 16. If the filter 10 is provided above the motor stay 16, it is not necessary that the motor stay 16 and the filter 10 be disposed close to each other. Since the velocity distribution of airflow after passing through the filter is already small, noise produced by the motor stay 16 can be reduced in a manner similar to that described above.

[0072] Additionally, in the indoor unit 100 of Embodiment 2, if the filter 10 is formed to be attachable and detachable,

a guide for moving the filter 10 may be formed in the motor stay 16.
Moreover, the distance between the filter 10, which is an airflow resistor, and the fan 20 is desirably 25 % or greater of the diameter of the fan 20.

[0073] Noise produced by the motor stay 16 can be further reduced by forming the motor stay 16 in the following shape.

[0074] FIG. 12 is a front view illustrating an example of a motor stay (a plan view in the state in which the motor stay is fixed to an indoor unit) according to Embodiment 2.
In the motor stay 16 shown in FIG. 12, bar-like support members 18 extend radially from a substantially circular fixing member 17. These support members 18 are formed in a shape which does not coincide with that of a trailing edge of a blade 23 of the fan 20. Although in FIG. 12 the support members 18 are formed in a curved shape, they may be formed in a straight shape. With this configuration, the support members 18 overlap the trailing edges of the blades 23 of the fan 20 so as to prevent a large load from being imposed on the support members 18, thereby further reducing noise produced by the motor stay 16.

[0075] Additionally, the number of support members 18 of the motor stay 16 may be coprime to the number of blades 23 of the fans 20. By forming the motor stay 16 in this manner, the state in which a load imposed on all the support members 18 becomes maximum (the state in which among variations of the load, the largest load is imposed on the support members 18) can be avoided, thereby further reducing noise produced by the motor stay 16.

[0076] The cross section of the motor stay 16 may be obtuse with respect to the airflow direction so that it will be unlikely to cause the separation of airflow, thereby further reducing noise produced by the motor stay 16. Moreover, by providing a soft hair material on the surface of the motor stay 16, a variation in the pressure on the surface of the motor stay 16 can be reduced, thereby further reducing the noise.

[0077] In order to obtain the noise reduction effects (the effect of reducing noise produced by the motor stay 16) discussed in Embodiment 2, the mounting structure of the fan motor 30 on the fixing member 17 is not particularly restricted. For example, the fan motor 30 may be mounted on the fixing member 17, as shown in FIG. 13.

[0078] FIGs. 13 through 16 are perspective views illustrating examples in which the fan motor is mounted on a fixing member of the motor stay according to Embodiment 2.
For example, as shown in FIG. 13, through-holes 17a passing through the fixing member 17 in the vertical direction are formed in the fixing member 17, and the fan motor 30 is screwed by using screws fitted into the through-holes 17a, thereby fixing the fan motor 30. When screwing the fan motor 30, as shown in FIG. 14, the fan motor 30 may be inserted into the fixing member 17, and the through-holes 17a may be formed on the side surface of the fixing member 17, and then, the fan motor 30 may be screwed.

[0079] Alternatively, for example, as shown in FIG. 15, the fixing member may be constituted by two fixing members 17b divided from a ring member. Then, the fan motor 30 may be clamped between these fixing members 17b, and the fixing members 17b may be screwed to each other, thereby fixing the fan motor 30 to the fixing member 17. By fixing the fan motor 30 to the fixing member 17 in this manner, the strength of the shell portion, which is the weakest part of the fan motor 30, can be enhanced. The shell portion, which is the weakest part of the fan motor 30, is a portion that causes noise of the motor. Accordingly, by enhancing the strength of the shell portion, noise produced by the fan motor 30 can be reduced.

[0080] Alternatively, by combining a plurality of fixing structures shown in FIGs. 13 through 15, the fan motor 30 may be fixed to the fixing member 17. In FIG. 16, the fixing structure shown in FIG. 15 is doubly used, thereby fixing the fan motor 30 to the fixing member 17. In this manner, the fan motor 30 is fixed at two points, thereby obtaining the effect of suppressing whirling of the fan motor 30 caused by vibration or unbalance rotation.
The fixing members 17 shown in FIGs. 13 through 16 may preferably be provided with a vibration isolator, thereby weakening the conduction of vibration to the casing 1.

[0081] In Embodiment 2, the indoor unit 100 including the fan 20 having the boss 21 to which the fan motor 30 is connected has been discussed. However, the fan motor 30 for the fan 20 of the indoor unit 100 may be connected between the blade 23 and a housing 26. In this case, a support structure 35 (see FIG. 17, which will be discussed later) which is rotatably fixed to the boss 21 may be mounted on the fixing member of the motor stay 16.

[0082] Alternatively, the motor stay 16 and the filter 10 may be integrally formed, and the motor stay 16 may function as a reinforcing member for the filter 10. In this case, a reinforcing member used for a known filter is not necessary, thereby reducing the cost because of the absence of this reinforcing member.

Embodiment 3

[0083] The motor stay 16 used for fixing the motor 20 to the casing 1 may be formed as follows. In Embodiment 3, elements and features which will not be specifically described are similar to those of Embodiment 2, and the same functions and configurations as those of Embodiment 2 are designated by like reference numerals.

[0084] FIG. 17 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 3 of the present invention. FIG. 18 is a perspective view illustrating the outer appearance of this indoor unit. In FIG. 18, the casing 1 is transparent. FIGs. 17 and 18 illustrate the indoor unit 100 including the fan 20 provided with the fan motor 30 disposed between the blade 23 and the housing 26.

[0085] The motor stay 16 according to Embodiment 3 is constituted by the fixing member 17 provided along the longitudinal direction of the indoor unit 100. Both ends of the fixing member 17 in the longitudinal direction are fixed to the casing 1. The support structure 35 (which rotatably supports the boss 21 of the fan 20) used for each of the three fans 20 is mounted on this fixing member 17. The fixing member 17 is provided above a displacement portion of the heat exchanger 50 (a portion at which the gradient of the heat exchanger 50 is changed, that is, the joint portion between the front-side heat exchanger 51 and the back-side heat exchanger 55).

The motor stay 16 according to Embodiment 3 does not have the support member 18. It is noted that, however, the fixing member 17 may be fixed to the casing 1 by way of the support member 18.

[0086] If the front-side heat exchanger 51 and the back-side heat exchanger 55 are displaced from each other, as shown in FIGs. 17 and 18, a gap is produced between this displacement portion. Airflow passing through this gap does not (hardly) contribute to heat exchange, thereby decreasing the air-conditioning performance when the same amount of airflow is given. However, in Embodiment 3, since the motor stay 16 (more specifically, the fixing member 17) is provided above the displacement portion, there is no airflow passing through the gap of the displacement portion, thereby preventing degradation in the air-conditioning performance when the same amount of airflow is given. Additionally, if the motor stay 16 does not have the support member 18, due to the absence of the support member 18 near the air outlet of the fan 20, noise produced by the motor stay 16 can be further reduced.

Embodiment 4

[0087] The motor stay 16 used for fixing the fan 20 to the casing 1 may be formed as follows. In Embodiment 3, elements and features which will not be specifically discussed are similar to those of Embodiment 2 or Embodiment 3, and the same functions and configurations as those of Embodiment 2 or Embodiment 3 are designated by like reference numerals.

[0088] FIG. 19 is a longitudinal sectional view indicating an indoor unit according to Embodiment 4.

The support member 18 of the motor stay 16 according to Embodiment 4 is formed, as viewed from the lateral side, such that the distance between the support member 18 and the trailing edge of the blade 23 of the fan 20 increases toward the tip portion of the blade 23 (peripheral portion of an impeller 25).

[0089] Airflow produced by the fan 20 increases toward the tip portion of the blade 23 (peripheral portion of the impeller 25). That is, if the distance between the support member 18 and the root portion of the trailing edge of the blade 23 is the same as that between the support member 18 and the tip portion of the trailing edge of the blade 23, a variation in the load imposed on the motor stay 16 increases toward the tip portion of the blade 23 (peripheral portion of the impeller 25). However, in Embodiment 4, the distance between the support member 18 and the trailing edge of the blade 23 of the fan 20 increases toward the tip portion of the blade 23 (peripheral portion of the impeller 25), thereby reducing a variation in the load imposed on the motor stay 16. Accordingly, by the use of the motor stay 16 configured in Embodiment 4, compared with a motor stay 16 in which the distance between the support member 18 and the root portion of the trailing edge of the blade 23 is the same as that between the support member 18 and the tip portion of the trailing edge of the blade 23, noise produced by the motor stay 16 can be further reduced.

Embodiment 5

Fan & Fan Motor

[0090] In Embodiment 5 through Embodiment 17, examples of the fan 20 provided in the indoor unit 100 according to Embodiment 1 through Embodiment 4 will be discussed.

[0091] The fan 20 provided in the indoor unit 100 according to Embodiment 1 may be formed, for example, in the following manner. Embodiment 5 will be discussed by designating the same functions and configurations as those of Embodiment 1 by like reference numerals.

[0092] FIG. 20 is a front view illustrating an example of a fan according to Embodiment 5 of the present invention. In the drawings illustrating the fan 20, the fan 20 provided in the indoor unit 100 as viewed from above is illustrated as a front view of the fan 20.

The fan 20 according to Embodiment 5 is an axial-flow fan or a diagonal-flow fan in which a plurality of blades are provided around the outer peripheral surface of a boss, which is the center of rotation. This fan 20 includes an impeller 25 and a housing 26.

[0093] The impeller 25 includes the boss 21, which is the center of rotation, a plurality of blades 23 (major blades) supported by the outer peripheral surface of the boss 21, and a ring-like member 22 provided on the outer periphery of the blades 23. The impeller 25 according to Embodiment 5 also includes a plurality of sub blades 24 supported by the ring-like member 22 and extending toward the inner periphery (toward the boss 21). These sub blades 24 are not supported by the outer peripheral surface of the boss 21. Because of the provision of the sub blades 24, the number of blades (the number of blades 23 and the number of sub blades 24) provided in the fan 20 is increased.

[0094] The housing 26 is provided on the outer periphery of the impeller 25 with a predetermined gap therebetween. That is, the impeller 25 is stored in the housing 26. The boss 21 of the impeller 25 is connected to the fan motor 30 (not shown), and the impeller 25 is rotated by a driving force of this fan motor.

[0095] A description will now be given of the effect of increasing the number of blades of the fan 20 in the configuration discussed in Embodiment 5. FIG. 21 illustrates the relationship between the configuration in which blades are disposed (the orientation and the number of blades) and the aerodynamic performance. FIG. 21(a) is a front view illustrating a general impeller used in an axial-flow fan or a diagonal-flow fan. FIG. 21(b) includes sectional views of a blade cascade obtained by developing a cylindrical cross section taken along a long dashed dotted line in FIG. 21 (a) into a two-dimensional plane.

[0096] The aerodynamic performance of the blade cascade is related to the solidity $\sigma = L/t$ defined by the chord length L and the pitch t between adjacent blades, where the chord length L is a length of a straight line connecting the leading edge and the trailing edge of the blade 303. It has been validated that, generally, similar blade cascades having a constant solidity σ exhibit substantially the same aerodynamic performance. That is, it has been validated that, in order to obtain the same aerodynamic performance by using blades having a small chord length L as that by using blades having a large chord length L, the number of blades is increased.

[0097] However, in the configuration of a known fan, increasing the number of blades means increasing the number of blades 303 supported by the outer peripheral surface of a boss 301. There are constraints and limitations on decreasing the thickness of blades in terms of manufacturing conditions and the strength. Accordingly, by increasing the number of blades 303, the flow channel around the boss 301 is blocked. Thus, in the configuration of a known fan, if the number of blades 303 is increased, the amount of airflow around the boss 301 is decreased.

[0098] In order to decrease the chord length L without increasing the number of blades 303, the angle of incidence of the blades 303 may be changed. However, if the angle of incidence of the blades 303 is changed, the angle of attack between airflow and the blade 303 is also changed. Accordingly, the amount of airflow maintaining a high-efficiency operation in the fan is changed, and thus, the compatibility with known fans is lost.

[0099] In contrast, in the configuration employed in Embodiment 5, when the number of blades of the fan 20 (impeller 25) is increased, it is not necessary to increase the number of blades supported by the boss 21. The reason for this is that the sub blades 24 are connected to the ring-like member 22, which is a member other than the boss 21. Accordingly, the chord length L can be decreased without reducing the amount of airflow around the boss 21. Moreover, it is not necessary to change the angle of attack for the blades 23 and the sub blades 24.

[0100] In the fan 20 configured as described above, it is possible to decrease the chord length L of the blades 23 in a range in which the sub blades 24 are disposed while maintaining the efficiency of the fan 20. Thus, the thickness of the fan 20 (the dimension in the direction of the rotational axis of the impeller 25) can be decreased while maintaining the efficiency of the fan 20.

[0101] The configuration in which the sub blades 24 are supported is not restricted to the configuration shown in FIG. 20. FIG. 22 is a front view illustrating another example of a fan according to Embodiment 5.
The fan 20 shown in FIG. 22 includes a projecting piece 23a on the periphery of a blade 23. Then, a sub blade 24 is supported by this projecting piece 23a while extending toward the inner periphery (toward the boss 21). That is, the fan 20 is formed such that the ring-like member 22 is divided into a plurality of portions.

[0102] FIG. 23 is a front view illustrating still another example of a fan according to Embodiment 5. The fans 20 shown in FIGs. 20 and 22 are respectively supported by members (ring-like member 22 and projecting piece 23a) provided around the blades 23. In contrast, in the fan 20 shown in FIG. 23, a sub blade 24 is directly supported by a blade 23.

[0103] That is, it is sufficient that the sub blades 24 are supported by a member other than the boss 21. If the sub blades 24 are supported by a member other than the boss 21, the chord length L of the blades 23 in a range in which the sub blades 24 are disposed can be decreased while maintaining the efficiency of the fan 20. Thus, the thickness of the fan 20 (the dimension in the direction of the rotational axis of the impeller 25) can be decreased while maintaining the efficiency of the fan 20.

Embodiment 6

[0104] As discussed in Embodiment 5, for supporting the sub blades 24, various configurations may be employed. Among these configurations, the configuration in which the sub blades 24 are supported by the ring-like member 22 obtains the following advantages. In Embodiment 6, elements and features which will not be specifically described are similar to those of Embodiment 5, and the same functions and configurations as those of Embodiment 5 are designated by like reference numerals.

[0105] FIG. 24 is a longitudinal sectional view illustrating an example of a fan according to Embodiment 6 of the present invention. In the fan 20 according to Embodiment 6, the sub blades 24 are supported by the ring-like member 22, as in the fan 20 of Embodiment 5 shown in FIG. 20. That is, the outer peripheral portions of the blades 23 are interconnected by the ring-like member 22. In other words, the blades 23 are supported, not only by the boss 21, but also by the ring-like member 22.

[0106] A centrifugal force acts on the blades 23 supported by the boss 21 in accordance with the rotation of the impeller 25. Accordingly, measures have to be taken to ensure the strength at the joint portion between the blades 23 and the boss 21. Thus, designing restrictions, such as a necessity of increasing the chord length by increasing the thickness of the inner periphery of the blade 23 (adjacent to the boss 21) and decreasing the weight of the outer periphery of the blade 23 (adjacent to the housing 26), are imposed.

[0107] However, in the fan 20 according to Embodiment 6, a centrifugal force acting on the blades 23 in accordance with the rotation of the impeller 25 is also supported by the ring-like member 22. It is thus possible to increase the flexibility in designing the blades 23, such as designing the chord length and the thickness of the blades 23 at the joint portion between the blades 23 and the boss 21.

In FIG. 24, the shape of the blades 23 is different from that of the sub blades 24. However, the shape of the blades 23 and that of the sub blades 24 (more specifically, except for the shape of the joint portion) may be the same.

Embodiment 7

[0108] The sub blades 24 discussed in Embodiment 5 and Embodiment 6 may be supported, for example, in the following manner. In Embodiment 7, elements and features which will not be specifically described are similar to those of Embodiment 5 or Embodiment 6, and the same functions and configurations as those of Embodiment 5 or Embodiment 6 are designated by like reference numerals.

[0109] FIG. 25 is a front view illustrating an example of a fan according to Embodiment 7 of the present invention.

In the fan 20 according to Embodiment 7, a ring-like member 23b is added to the fan 20 shown in FIG. 20. The ring-like member 23b is provided for connecting the substantially central portions of the individual blades 23. The sub blades 24 are supported by this ring-like member 23b as well as by the ring-like member 22 provided on the outer periphery of the blades 23.

[0110] In the fan 20 configured as described above, each of the sub blades 24 can be supported at two points, and thus, vibration of the sub blades 24 can be suppressed, thereby enhancing the strength of the sub blades 24.

[0111] The configuration in which the sub blades 24 are supported is not restricted to that shown in FIG. 25.

FIG. 26 is a front view illustrating another example of the fan according to Embodiment 7.

In the fan 20 shown in FIG. 26, projecting pieces 23c are added to the fan 20 shown in FIG. 20. The projecting piece 23c is provided at the substantially central portion of each of the blades 23. Each of the sub blades 24 is supported, not only by the ring-like member 22 provided on the outer periphery of the blades 23, but also by this projecting piece 23c. That is, the fan 20 is configured such that the ring-like member 23b of the fan 20 is divided into a plurality of portions.

[0112] Alternatively, for example, the fan 20 shown in FIG. 22 may be provided with the ring-like member 23b or the projecting pieces 23c, and each of the sub blades 24 may be supported at two points. Alternatively, for example, the fan 20 shown in FIG. 23 may be provided with the ring-like member 22 or the projecting pieces 23a discussed in Embodiment 5, and each of the sub blades 24 may be supported at two points. Alternatively, for example, the sub blades 24 of the fan 20 shown in FIG. 25 or 26 may be directly supported by the blades 23 adjacent to the sub blades 24. With these configurations, each of the sub blades 24 can be supported at two or more points.

[0113] That is, any configuration may be employed as long as the sub blades 24 are supported at a plurality of points. If the sub blades 24 are supported at a plurality of points, vibration of the sub blades 24 can be suppressed, and the strength of the sub blades 24 can be enhanced.

Embodiment 8

[0114] In Embodiment 5 through Embodiment 7, the number of blades 23 and the number of sub blades 24 are the same, and they are alternately disposed in the rotation direction. The arrangement of the blades 23 and the sub blades 24 is not restricted to this, and may be disposed, for example, in the following manner. In Embodiment 8, elements and features which will not be specifically described are similar to those of Embodiment 5 through Embodiment 7, and the same functions and configurations as those of Embodiment 5 through Embodiment 7 are designated by like reference numerals.

[0115] FIG. 27 is a front view illustrating an example of a fan according to Embodiment 8 of the present invention.

In the fan 20 shown in FIG. 27, three sub blades 24 are provided, while six blades 23 are provided. As viewed from the rotation direction of the impeller 25, after two blades 23 are disposed, one sub blade 24 is disposed. Among the blades 23 and the sub blades 24, the interval between adjacent blades (the interval in the circumferential direction) is substantially uniform.

[0116] FIG. 28 is a front view illustrating another example of the fan according to Embodiment 8 of the present invention. In the fan 20 shown in FIG. 28, six sub blades 24 are provided, while three blades 23 are provided. As viewed from the rotation direction of the impeller 25, after one blade 23 is disposed, two sub blades 24 are disposed. Among the blades 23 and the sub blades 24, the interval between adjacent blades (the interval in the circumferential direction) is substantially uniform.
[0117] In this manner, the number of sub blades 24 is set to be a divisor or a multiple of the number of blades 23, and the interval between the blade 23 and the sub blades 24 (the interval in the circumferential direction) is set to be substantially uniform. With this configuration, in various design specifications of impellers, impellers that can perform a stable operation by maintaining the dynamic balance even during the rotation can be obtained.

Embodiment 9

[0118] In Embodiment 5 through Embodiment 8, the externally driving fan motor 30 is connected to the boss 21 so as to rotate the impeller 25. The fan motor 30 is not restricted to this type, and the impeller 25 may be rotated by the fan motor 30 configured, for example, in the following manner. In Embodiment 9, elements and features which will not be specifically described are similar to those of Embodiment 5 through Embodiment 8, and the same functions and configurations as those of Embodiment 5 through Embodiment 8 are designated by like reference numerals. In the following description, a fan motor 30 according to Embodiment 9 is used for the fan 20 discussed in Embodiment 6.
[0119] FIG. 29 is a longitudinal sectional view illustrating an example of a fan according to Embodiment 9 of the present invention.
The fan 20 according to Embodiment 9 is different from the fan 20 according to Embodiment 6 in the following points. First, the fan 20 according to Embodiment 9 is not provided with the externally driving fan motor 30 (motor connected to the boss 21) provided in the fan 20 of Embodiment 6. Instead of using the externally driving fan motor 30, a fan motor 30 including a rotor 31 and a stator 40, which will be discussed below, is provided.
[0120] More specifically, the rotor 31 is provided on the outer periphery of the impeller 25. The fan 20 according to Embodiment 9 is provided with the ring-like member 22 on the outer periphery of the fan 20, and thus, the rotor 31 is provided on the outer periphery of the ring-like member 22. The stator 40 is provided (disposed) in the housing 26 such that it opposes the rotor 31. Then, the impeller 25 is rotated by a driving force of the fan motor 30 including the rotor 31 and the stator 40.
[0121] In the fan 20 configured as described above, the pace in which an externally driving fan motor is installed is not necessary. It is thus possible to further reduce the thickness of the fan 20. Additionally, since the fan motor 30 can be formed at the outer diameter portion, a large torque can easily be generated if substantially the same magnetic attraction force is generated (if the same motor power is consumed). It is thus possible to implement higher efficiency with substantially the same cost, or it is possible to form a motor exhibiting comparable performance by using inexpensive magnets and armatures, thereby obtaining a small, inexpensive fan 20.
[0122] In Embodiment 9, an example in which the fan motor 30 according to Embodiment 9 is used for the fan 20 according to Embodiment 6 has been discussed. However, the fan motor 30 according to Embodiment 9 may be used for the fan 20 according to Embodiment 5, Embodiment 7, or Embodiment 8.

Embodiment 10

[0123] When the fan 20 includes the ring-like member 22, etc., the fan 20 may be formed, for example, in the following manner. In Embodiment 10, the same functions and configurations as those of Embodiment 1 through Embodiment 9 are designated by like reference numerals.
[0124] FIG. 30 shows schematic diagrams of an example of a fan according to Embodiment 10 of the present invention. FIG. 30(a) is a front view of the fan, and FIG. 30(b) is a side sectional view of the fan.
The fan 20 shown in FIG. 30 is, for example, an axial-flow fan or a diagonal-flow fan in which a plurality of blades 23 are disposed on the outer peripheral surface of the boss 21, which is the center of rotation. This fan 20 includes an impeller 25 and a housing 26.
[0125] The impeller 25 includes the boss 21, a plurality of blades 23 provided on the outer peripheral surface of the boss 21, and a rotor 31 provided on the outer periphery of the blades 23. The rotor 31 is constituted, for example, by forming a ring-like member 22, etc. provided on the outer periphery of the blades 23 by using a magnetic material. Alternatively, the rotor 31 is constituted, for example, by forming the ring-like member 22, etc. on the outer periphery of the blades 23 and then by attaching or embedding a magnet to or in the outer periphery of this ring-like member 22.
[0126] This impeller 25 is stored in the housing 26. In the housing 26, a stator 40 is provided on the surface (hereinafter referred to as an "inner periphery") facing the outer periphery of the impeller 25 (more specifically, on the outer periphery of the rotor 31). That is, the rotor 31 and the stator 40 are disposed such that they oppose each other. The impeller 25 is rotated by a driving force of the fan motor 30 including the rotor 31 and the stator 40.

[0127] The fan 20 shown in FIG. 30 is an example of the fan discussed in Embodiment 10 of the present invention. The fan according to Embodiment 10 may be, for example, the following fan.

[0128] FIG. 31 shows schematic diagrams of another example of the fan according to Embodiment 10 of the present invention. FIG. 31(a) is a front view of the fan, and FIG. 31 (b) is a perspective view of the outer periphery of a blade of the fan. The arrow shown in FIG. 31 (b) is a rotation direction of the blade.

The fan 20 shown in FIG. 31 includes a small wing 250, such as a winglet, on the outer periphery (outer periphery edge) of the blade 23. The rotor 31 is constituted, for example, by forming this small wing 250 from a magnetic material. Alternatively, the rotor 31 is constituted, for example, by attaching or embedding a magnet to or in the outer periphery of this small wing 250.

[0129] In the fan 20 configured as described above according to Embodiment 10, a projection 251 is provided in order to improve the fan efficiency. In FIGs. 32 through 34 illustrating examples in which the projection 251 is disposed (examples in which the projection 251 is formed), the fan 20 in which the ring-like member 22 is provided on the outer periphery of the blades 23 will be discussed by way of example.

[0130] As shown in FIG. 32, for example, the projection 251 may be provided at a position of the air suction side. The projection 251 may be provided, as shown in FIG. 32(a), on the outer periphery of the impeller 25 (for example, on the outer periphery of the ring-like member 22). Alternatively, the projection 251 may be provided, as shown in FIG. 32(b), on the inner periphery of the housing 26.

Alternatively, as shown in FIG. 33, for example, the projection 251 may be provided at a position of the air discharge side. The projection 251 may be provided, as shown in FIG. 33(a), on the outer periphery of the impeller 25 (for example, on the outer periphery of the ring-like member 22). Alternatively, the projection 251 may be provided, as shown in FIG. 33(b), on the inner periphery of the housing 26.

The projection 251 shown in FIG. 32 or 33 may be provided both on the outer periphery of the impeller 25 (for example, on the outer periphery of the ring-like member 22) and on the inner periphery of the housing 26. That is, the projections 251 may be provided on the outer periphery of the impeller 25 and on the inner periphery of the housing 26 such that they oppose each other.

[0131] Alternatively, as shown in FIG. 34, for example, the projection 251 may be provided both at the air suction side and at the air discharge side. The projection 251 may be provided, as shown in FIG. 34(a), on the outer periphery of the impeller 25 (for example, on the outer periphery of the ring-like member 22). Alternatively, the projection 251 may be provided, as shown in FIG. 34(b), on the inner periphery of the housing 26.

The projection 251 shown in FIG. 34 may be provided both on the outer periphery of the impeller 25 (for example, on the outer periphery of the ring-like member 22) and on the inner periphery of the housing 26. For example, the projection 251 at the air suction side may be provided on the outer periphery of the impeller 25 (for example, on the outer periphery of the ring-like member 22), and the projection 251 at the air discharge side may be provided on the outer periphery of the impeller 25. These formation positions may be reversed.

[0132] In the fan 20 configured as described above, by providing the projection 251, the shortest distance between the impeller 25 and the housing 26 can be made smaller than the distance between the rotor 31 and the stator 40. Accordingly, the following advantages can be obtained.

[0133] For improving the motor efficiency, it is preferable that the distance between a rotor and a stator is small (the gap formed between the rotor and the stator is small). However, in a known fan in which a rotor is provided on the outer periphery of an impeller and a stator is provided in a housing, if the distance between the rotor and the stator is made small, the impeller vibrates due to a magnetic force produced between the rotor and the stator, thereby causing noise. If the distance between the rotor and the stator is increased in order to prevent the occurrence of such vibration or noise, airflow which causes a reduction in the efficiency of the fan is produced around blades.

[0134] FIG. 35 illustrates an example of airflow which is produced around a blade and which reduces the efficiency of the fan. The solid arrows shown in FIGs. 35(a) and 35(b) indicate the directions of airflow. The white arrow shown in FIG. 35(b) indicates the rotation direction of the blade 303.

[0135] In a known fan motor in which a ring-like member 302 and a rotor 305 are provided on the outer periphery of the blade 303 formed on the boss 301, if the distance between the rotor 305 and a stator 309 is increased, a recirculating flow 252 shown in FIG. 35(a) is produced, thereby reducing the efficiency of the fan. More specifically, air flows between the rotor 305 and the stator 309 from the air discharge side, which is a high pressure, to the air suction side, which is a low pressure. Then, this air is discharged again. Accordingly, the recirculating flow 252 circulating around the ring-like member 302 and the rotor 305 is produced, thereby reducing the efficiency of the fan.

[0136] Additionally, in a known fan in which a small wing is formed on the outer periphery of the blade 303 or in a known fan in which a ring-like member or a small wing is not provided on the outer periphery of the blade 303, if the distance between a rotor and a stator is increased, a leakage flow 253 shown in FIG. 35(b) is produced, thereby reducing the efficiency of the fan. More specifically, the leakage flow 253 is produced on the outer periphery edge of the blade 303 from the air discharge side, which is a high pressure, to the air suction side, which is a low pressure, thereby reducing the efficiency of the fan.

[0137] However, in the fan 20 according to Embodiment 10, by providing the projection 251, the shortest distance between the impeller 25 and the housing 26 is smaller than the distance between the rotor 31 and the stator 40. Accordingly, the distance between the rotor 31 and the stator 40 can be a distance that reduces the vibration of the impeller 25 or noise caused by this vibration. Additionally, by making the distance between the impeller 25 and the housing 26 small, the recirculating flow 252 or the leakage flow 253 can be suppressed. That is, in the fan 20 according to Embodiment 10, the efficiency of the fan can be improved, independently of the distance between the rotor 31 and the stator 40, which is a designing factor of a motor.

[0138] Additionally, by providing the projection 251 both on the outer periphery of the impeller 25 (for example, the outer periphery of the ring-like member 22) and the inner periphery of the housing 26, the sealing performance between the impeller 25 and the housing 26 can be enhanced, thereby further improving the efficiency of the fan 20.

[0139] The forward end of the projection 251 shown in FIGs. 32 through 34 may be formed in a labyrinth structure, as shown in FIG. 36. FIG. 36 illustrates a projection 254 having a labyrinth structure at the forward end. FIG. 36 illustrates an example in which the projection 254 is provided at the air discharge side of the impeller 25. The above-described projection 251 or 254 may be continuously provided on the periphery of the impeller 25 or the inner periphery of the housing 26, or may be intermittently provided with predetermined gaps therebetween.

Embodiment 11

[0140] As well as the structure of Embodiment 10, in the structure in Embodiment 11, the shortest distance between the impeller 25 and the housing 26 can be made smaller than the distance between the rotor 31 and the stator 40. In Embodiment 11, elements and features which will not be specifically described are similar to those of Embodiment 10, and the same functions and configurations as those of Embodiment 10 are designated by like reference numerals.

[0141] In the fan 20 according to Embodiment 11, the ring-like member 22 or the small wing 250, for example, is formed on the outer periphery of a blade 23, and the rotor 31 is provided on the outer periphery of the ring-like member 22 or the small wing 250. That is, the basic configuration of the fan 20 is similar to that of the fan 20 according to Embodiment 10 or the fan 20. In the fan 20 according to Embodiment 11, instead of the projection 251 or 254 used in Embodiment 10, an insulating layer 257 made of, for example, a resin, is provided on at least one of the outer periphery of the rotor 31 or the inner periphery of the stator 40.

[0142] This insulating layer 257 is provided, for example, in the following manner. It is noted that, in FIGs. 37 through 39 illustrating examples in which the insulating layer 257 is disposed (examples in which the insulating layer 257 is formed), the fan 20 in which the ring-like member 22 is provided on the outer periphery of the blades 23 will be discussed by way of example.

For example, as shown in FIG. 37, the insulating layer 257 may be provided on the outer periphery of the rotor 31. Alternatively, as shown in FIG. 38, the insulating layer 257 may be provided on the inner periphery of the stator 40. Alternatively, as shown in FIG. 39, the insulating layer 257 may be provided both on the outer periphery of the rotor 31 and on the inner periphery of the stator 40.

[0143] In the fan 20 configured as described above, as in Embodiment 10, the shortest distance between the impeller 25 and the housing 26 can be made smaller than the distance between the rotor 31 and the stator 40. Thus, as in Embodiment 10, the efficiency of the fan can be improved, independently of the distance between the rotor 31 and the stator 40, which is a designing factor of a motor.

[0144] In the fan 20 configured as described above, the shortest distance between the impeller 25 and the housing 26 can be made smaller than the distance between the rotor 31 and the stator 40 without forming projections and depressions in the gap between the impeller 25 and the housing 26. This improves the ease of assembly in the manufacturing process and inhibits dust, etc. from staying. In particular, by providing the insulating layer 257 on the inner periphery of the stator 40, a coil wound around the stator 40 can be covered with the insulting layer 257 and the housing 26. By covering a complicated uneven surface of the coil, it is possible to further inhibit dust, etc. from staying.

Embodiment 12

[0145] The projection provided on the outer periphery of the impeller 25 may be formed as follows. In Embodiment 12, elements and features which will not be specifically described are similar to those of Embodiment 10 or Embodiment 11, and the same functions and configurations as those of Embodiment 10 or Embodiment 11 are designated by like reference numerals.

[0146] FIG. 40 is an enlarged view (longitudinal sectional view) of the essential part of an example of a fan according to Embodiment 12. The solid arrows shown in FIG. 40 indicate the direction of airflow.

The fan 20 according to Embodiment 12 includes a suction guide 255 on the suction side of the outer periphery of the impeller 25. This suction guide 255 is an example of the projection provided on the outer periphery of the impeller 25, and is formed integrally with, for example, the ring-like member 22.

[0147] The forward end of the suction guide 255 is formed such that it projects farther outward than the inner periphery of the housing 26. Moreover, the suction guide 255 is formed such that the diameter thereof increases toward the upstream side of the airflow. That is, the shortest distance between the impeller 25 and the housing 26 is a distance in the direction of the rotational axis of the impeller 25. More specifically, the distance between the forward end of the suction guide 255 and the housing 26 is the shortest distance between the impeller 25 and the housing 26.
In FIG. 40, a step portion is formed in a range of the housing 26 which opposes the forward end of the suction guide 255.
[0148] In the fan 20 configured as described above, as in Embodiment 10 and Embodiment 11, the shortest distance between the impeller 25 and the housing 26 can be made smaller than the distance between the rotor 31 and the stator 40. Thus, as in Embodiment 10 and Embodiment 11, the efficiency of the fan can be improved, independently of the distance between the rotor 31 and the stator 40, which is a designing factor of a motor.
[0149] In the fan 20 configured as described above, because of the shape of the suction guide 255 in which the diameter thereof increases toward the upstream side of airflow, airflow can be smoothly guided to the impeller 25. Accordingly, the efficiency of the fan 20 can be further improved.
[0150] The shortest distance between the impeller 25 and the housing 26 is a distance in the direction of the rotational axis of the impeller 25. Accordingly, even if the forward end of the suction guide 255 is formed in a labyrinth structure, the assembly of the fan 20 is easy. The reason for this is as follows. Normally, when fixing the impeller 25 to the housing 26, the impeller 25 is fit into the inner side of the housing 26 along the direction of the rotational axis of the impeller 25. In this case, with the configuration in Embodiment 12, when inserting the impeller 25 into the inner side of the housing 26 along the direction of the rotational axis of the impeller 25, projections and depressions at the forward end of the suction guide 255 forming the labyrinth structure can be engaged with depressions and projections of the housing 26.

<u>Embodiment 13</u>

[0151] The projection provided on the outer periphery of the impeller 25 may be configured as follows. In Embodiment 13, elements and features which will not be specifically described are similar to those of Embodiment 10 through Embodiment 12, and the same functions and configurations as those of Embodiment 10 through Embodiment 12 are designated by like reference numerals.
[0152] FIG. 41 is an enlarged view (longitudinal sectional view) illustrating the essential part of an example of a fan according to Embodiment 13. The solid arrows shown in FIG. 41 indicate the direction of airflow.
The fan 20 according to Embodiment 13 includes a discharge guide 256 on the discharge side of the outer periphery of the impeller 25. This discharge guide 256 is an example of the projection provided on the outer periphery of the impeller 25, and is formed integrally with, for example, the ring-like member 22.
[0153] The forward end of the discharge guide 256 is formed such that it projects farther outward than the inner periphery of the housing 26. Moreover, the discharge guide 256 is formed such that the diameter thereof increases toward the downstream side of the airflow. That is, the shortest distance between the impeller 25 and the housing 26 is a distance in the direction of the rotational axis of the impeller 25. More specifically, the distance between the forward end of the discharge guide 256 and the housing 26 is the shortest distance between the impeller 25 and the housing 26.
In FIG. 41, a step portion is formed in a range of the housing 26 which opposes the forward end of the discharge guide 256.
[0154] In the fan 20 configured as described above, as in Embodiment 10 through Embodiment 12, the shortest distance between the impeller 25 and the housing 26 can be made smaller than the distance between the rotor 31 and the stator 40. Thus, as in Embodiment 10 through Embodiment 12, the efficiency of the fan can be improved, independently of the distance between the rotor 31 and the stator 40, which is a designing factor of a motor.
[0155] In the fan 20 configured as described above, because of the shape of the discharge guide 256 in which the diameter thereof increases toward the downstream side of airflow, airflow discharged from the impeller 25 is decelerated while extending radially, thereby recovering the static pressure. Accordingly, the efficiency of the fan 20 can be further improved.
[0156] If the suction guide 255 discussed in Embodiment 12 is also provided on the suction side of the outer periphery of the impeller 25, the efficiency of the fan 20 is further improved. The shortest distance between the impeller 25 and the housing 26 is a distance in the direction of the rotational axis of the impeller 25. Accordingly, even if the forward end of the discharge guide 256 is formed in a labyrinth structure, the assembly of the fan 20 is easy. The reason for this is as follows. Normally, when fixing the impeller 25 to the housing 26, the impeller 25 is fit into the inner side of the housing 26 along the direction of the rotational axis of the impeller 25.
In this case, with the configuration in Embodiment 13, when inserting the impeller 25 into the inner side of the housing 26 along the direction of the rotational axis of the impeller 25, projections and depressions at the forward end of the discharge guide 256 forming the labyrinth structure can be engaged with depressions and projections of the housing 26.

Embodiment 14

[0157] If the housing 26 of the fan 20 serves as a noise cancellation function, noise produced by the fan 20 can be reduced. Moreover, if the housing 26 of the fan 20 serves as a noise cancellation function, noise produced by a motor stay can also be reduced. Accordingly, by combining the fan 20 with the structure of the motor stay discussed in one of Embodiment 2 through Embodiment 4, the noise cancellation effect of the indoor unit can be further enhanced. In Embodiment 14, the same functions and configurations as those of Embodiment 1 through Embodiment 13 are designated by like reference numerals.

[0158] FIG. 42 is a longitudinal sectional view according to Embodiment 14 of the present invention. The housing 26 of the fan 20 according to Embodiment 14 is divided into an upper housing 26a and a lower housing 26b. The upper housing 26a is constituted by the top surface of the housing 26 and the top portion 5a and the middle portion 5b of the bell mouth 5. The lower housing 26b is constituted by the outer periphery and the bottom surface of the housing 6 and the bottom portion 5c of the bell mouth 5. In the state in which the upper housing 26a and the lower housing 26b are combined, the inside of the housing 26 is formed in a hollow structure.

Moreover, in the state in which the upper housing 26a and the lower housing 26b are combined, a gap having a length 1 is formed between the middle portion 5b and the bottom portion 5c of the bell mouth 5. This gap communicates with the inside of the housing 26, and is formed, for example, along the circumferential direction of the bell mouth 5. That is, in Embodiment 14, the gap having a length 1 is formed as a slit.

[0159] When the impeller 25 of the fan 20 is rotated, unpleasant beat (noise) having a peak at a frequency of a multiple integral of "the product of the number of blades 23 and the rotation speed of the impeller 25" may occur. Accordingly, the housing 26 of the fan 20 according to Embodiment 14 is formed in a hollow structure and serves as a Helmholtz silencer, thereby reducing noise of the fan 20 (rotation sound of the impeller 25).

[0160] With this configuration, sound having a frequency f indicated by the following Equation (2) can be canceled.

$$f = (a/2\pi) \cdot (A/l \cdot V)^{1/2} \qquad \ldots (2).$$

In Equation (2), f is the frequency of noise, a is the sound velocity, A is the area of the gap (that is, in Embodiment 14, the length 1 of the gap x the length of the circumference of the middle portion 5b of the bell mouth 5), 1 is the length of the gap, and V is the volume of space within the housing 26.

[0161] By dividing the internal space (hollow space) of the housing 26, as shown in FIG. 43, more frequencies of noise levels can be canceled.

[0162] FIG. 43 is a front sectional view illustrating another example of the fan according to Embodiment 14 of the present invention.

As shown in FIG. 43, the inside of the housing 26 of the fan 20 is divided into a plurality of space areas (four in FIG. 43) by ribs 26c. By changing the volumes (V in the above-described Equation (2)) of these space areas, more frequencies of noise levels can be canceled at the same time. By adjusting the length 1 of the gap which communicates with the space areas shown in FIG. 43, the frequency to be canceled can be adjusted.

[0163] In Embodiment 14, the gap (gap having a length 1) which communicates with the housing 26 is formed between the middle portion 5b and the bottom portion 5c of the bell mouth 5. However, this gap (gap having a length 1) may be formed at any desired position. For example, the gap (gap having a length 1) which communicates with the housing 26 may be formed between the top portion 5a and the middle portion 5b of the bell mouth 5.

Alternatively, for example, the middle portion 5b of the bell mouth 5 may be divided, and the gap (gap having a length 1) which communicates with the housing 26 may be formed between the divided sections of the middle portion 5b. Alternatively, for example, a plurality of gaps may be formed between the top portion 5a and the middle portion 5b of the bell mouth 5 or between the middle portion 5b and the bottom portion 5c of the bell mouth 5.

[0164] Moreover, in order to use the housing 26 of the fan 20 as a Helmholtz silencer, it is sufficient that a communication channel which communicates with the housing 26 is provided. Accordingly, the fan 20 may be configured, for example, as shown in FIG. 44.

[0165] FIG. 44 is a longitudinal sectional view illustrating still another example of the fan according to Embodiment 14 of the present invention.

In the fan 20 shown in FIG. 44, instead of a gap having a length 1 which communicates with the housing 26, a plurality of through-holes 5d which communicate with the space within the housing 26 are formed at the middle portion 5b of the bell mouth 5. By forming the fan 20 in this manner, the housing 26 of the fan 20 can also serve as a Helmholtz silencer. Additionally, by forming a communication channel by using a plurality of through-holes, pressure fluctuation caused by the fan 20 can be decreased, thereby making it possible to further reduce noise produced by the fan 20. Instead of forming the plurality of through-holes 5d, the bell mouth 5 may be made from a porous material.

[0166] In the case of the fan 20 in which a plurality of impellers 25 are disposed within the housing 26, the space within the housing 26 may be divided by ribs 26c, as shown in FIG. 45. With this configuration, the volume of the space formed within the housing 26 can be made large, thereby canceling noise in a low frequency region.

Embodiment 15

[0167] If the housing 26 of the fan 20 serves as a Helmholtz silencer, the fan 20 may be configured as in Embodiment 15, thereby enhancing the air-sending performance of the fan 20. In Embodiment 15, elements and features which will not be specifically described are similar to those of Embodiment 14, and the same functions and configurations as those of Embodiment 14 are designated by like reference numerals.

[0168] FIG. 46 shows longitudinal sectional views illustrating a fan according to Embodiment 15 of the present invention. In the fan 20 according to Embodiment 15, at least part of the bell mouth 5 is integrally formed with the blade 23 of the impeller 25. The portion of the bell mouth 5 to be integrally formed with the blade 23 of the impeller 25 is not particularly restricted. For example, as shown in FIG. 46(a), the middle portion 5b of the bell mouth 5 may be integrally formed with the blade 23 of the impeller 25. Alternatively, for example, as shown in FIG. 46(b), the top portion 5a and the middle portion 5b of the bell mouth 5 may be integrally formed with the blade 23 of the impeller 25.
Alternatively, for example, as shown in FIG. 46(c), the middle portion 5b and the bottom portion 5c of the bell mouth 5 may be integrally formed with the blade 23 of the impeller 25. Alternatively, for example, as shown in FIG. 46(d), the entirety of the bell mouth 5 (the top portion 5a, the middle portion 5b, and the bottom portion 5c) may be integrally formed with the blade 23 of the impeller 25.

[0169] By forming the fan 20 in this manner, the occurrence of a leakage flow in a gap between the blade 23 of the impeller 25 and the bell mouth 5 (flow from the blade pressure surface to the blade suction surface), etc., can be prevented. Accordingly, the pressure difference between the suction side and the discharge side of the fan 20 can be maintained, thereby enhancing the air-sending performance. Moreover, by preventing the occurrence of a leakage flow, etc., noise produced by the fan 20 is also reduced. Thus, in addition to noise cancellation effects obtained by the housing 26 of the fan 20 which serves as a Helmholtz silencer, further noise cancellation effects can be obtained.

Embodiment 16

[0170] If the housing 26 of the fan 20 serves as a Helmholtz silencer, the space within the housing 26 can be effectively used in the following manner. In Embodiment 16, elements and features which will not be specifically described are similar to those of Embodiment 14 or Embodiment 15, and the same functions and configurations as those of Embodiment 14 or Embodiment 15 are designated by like reference numerals.

[0171] FIG. 47 is a longitudinal sectional view illustrating a fan according to Embodiment 16 of the present invention. As shown in FIG. 47, in the fan 20 according to Embodiment 16, a circuit board 30a and a noise detecting microphone 161 used in a noise cancellation mechanism are provided in the space within the housing 26. The circuit board 30a is a circuit board on which a circuit for controlling, for example, the fan motor 30, is mounted.

[0172] By forming the fan 20 in this manner, the efficiency in using the space within the indoor unit 100 can be improved, and miniaturization of the indoor unit and reduction in the flow channel loss can be realized, thereby enhancing power efficiency.
If the housing 26 does not serve as a Helmholtz silencer, it is not particularly necessary to provide a communication channel which communicates with the space within the housing 26. By detecting noise propagating from the fan 20 through the housing 26 by using the noise detecting microphone 161, noise produced by the fan 20 can be reduced by using the active noise cancellation method discussed in Embodiment 1. In this sense, it can be said that the housing 26 serves as part of the active noise cancellation mechanism.
The elements disposed in the space within the housing 26 are not restricted to the circuit board 30a or the noise detecting microphone 161. For example, a temperature measuring sensor may be disposed.

Embodiment 17

[0173] If the housing 26 of the fan 20 serves as a Helmholtz silencer, noise occurring in a wide band can be reduced by forming the fan 20 in the following manner. In Embodiment 17, elements and features which will not be specifically described are similar to those of Embodiment 14 through Embodiment 16, and the same functions and configurations as those of Embodiment 14 through Embodiment 16 are designated by like reference numerals.

[0174] FIG. 48 is a longitudinal sectional view illustrating a fan according to Embodiment 17 of the present invention. As shown in FIG. 48, in the fan 20 according to Embodiment 17, an acoustic material 260 is provided in the space within the housing 26. The acoustic material 260 is formed of, for example, urethane, a porous resin, or porous aluminum.

[0175] By forming the fan 20 as described above, pressure fluctuation produced by the fan 20 is absorbed by the acoustic material 260. Thus, in addition to noise cancellation effects obtained by the housing 26 of the fan 20 which serves as a Helmholtz silencer, noise cancellation effects of reducing noise occurring in a wide band by using the acoustic material 260 can also be obtained.

Embodiment 18

[0176] By providing one of the fans 20 discussed in Embodiment 5 through Embodiment 17 in the indoor unit 100 discussed in Embodiment 1, the following advantages can be obtained.

[0177] FIG. 49 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 18 of the present invention. FIG. 49 illustrates an example in which the fan 20 discussed in one of Embodiment 5 through Embodiment 17 is used in the indoor unit 100. In FIG. 49, the left side of the drawing is the front side of the indoor unit 100.

[0178] In the indoor unit 100 configured as described above, the fan 20 which can be reduced in size (thickness) and in cost is used. Accordingly, it is possible to reduce the size (thickness) of the indoor unit 100 according to Embodiment 18. It is also possible to reduce the cost of the indoor unit 100. In the indoor unit 100 configured as described above, the fan 20 which is reduced in size while maintaining its efficiency is used. Thus, when the indoor unit is manufactured with the same size as a known fan, an indoor unit having a larger amount of airflow than the known indoor unit can be obtained.

Embodiment 19

Fan Individual Control

[0179] As stated above, the indoor unit 100 according to the present invention includes a plurality of fans 20. By individually controlling these fans 20, the controllability of the direction of air in the indoor unit 100 can be enhanced. In Embodiment 19, a description will be given of an example of a specific embodiment in which the amounts of airflow of the fans 20 are individually controlled. In Embodiment 19, the indoor unit 100 including three fans 20 arranged side by side along the horizontal direction (longitudinal direction) of the casing 1 will be described by way of example.

For the sake of description, if it is necessary to distinguish between these fans 20, they may be sequentially referred to as a "fan 20A", a "fan 20B", and a "fan 20C" from the left side of the casing 1. In Embodiment 19, the same functions and configurations as those of Embodiment 1 through Embodiment 18 are designated by like reference numerals. The patentability of the invention discussed in Embodiment 19 is maintained when the number of fans arranged side by side in the indoor unit 100 is other than three.

[0180] FIG. 50 illustrates an example of the air velocity distribution at the air outlet of the indoor unit according to Embodiment 19 of the present invention. FIG. 50 is a front view of the indoor unit 100.

The indoor unit 100 according to Embodiment 19 includes three fans 20 in the horizontal direction (longitudinal direction) of the casing 1. If the amount of airflow of these fans 20 is increased in the order from the fan 20 of the left side to the fan 20 of the right side of FIG. 50, the air velocity distribution at the air outlet 3 of the indoor unit 100 is a distribution indicated by the arrows in FIG. 50.

That is, if the difference in the amounts of airflow of the fan 20A through the fan 20C is indicated by the order of "fan 20A < fan 20B < fan 20C", the air velocity distribution at the air outlet 3 is a distribution indicated by the arrows in FIG. 50. The directions of the arrows in FIG. 50 indicate the directions of airflow, and the lengths of the arrows in FIG. 50 indicate the magnitude of the air velocity. That is, the arrows in FIG. 50 indicate that, as the arrow is longer, the air velocity is higher (in other words, the amount of airflow is greater).

[0181] FIG. 51 illustrates another example of the air velocity distribution at the air outlet of the indoor unit according to Embodiment 19 of the present invention. FIG. 51 is a front view of the indoor unit 100.

If the amount of airflow of the fans 20 is increased in the order from the fan 20 of the right side to the fan 20 of the left side of FIG. 50, the air velocity distribution at the air outlet 3 of the indoor unit 100 is a distribution indicated by the arrows in FIG. 51. That is, if the difference in the amounts of airflow of the fan 20A through the fan 20C are in the order of "fan 20A > fan 20B > fan 20C", the air velocity distribution at the air outlet 3 is a distribution indicated by the arrows in FIG. 51. The directions of the arrows in FIG. 51 indicate the directions of airflow, and the lengths of the arrows in FIG. 51 indicate the magnitude of the air velocity. That is, the arrows in FIG. 51 indicate that, as the arrow is longer, the air velocity is higher (in other words, the amount of airflow is greater).

[0182] FIG. 52 is an enlarged view (front sectional view) of the essential part near the air outlet of the indoor unit according to Embodiment 19 of the present invention. FIG. 52 illustrates the state of the right and left vanes 80 when airflow blown out of the air outlet 3 is controlled in the right direction of FIG. 52.

As shown in FIG. 52, the airflow deflected by the right and left vanes 80 collides against the side wall of the casing 1 near the air outlet 3, thereby causing loss of airflow. In this case, the amounts of airflow of the individual fans 20 may be generated so that the air velocity at the end of the right side of the air outlet 3 will be decreased (see FIG. 51). When the total amount of airflow at the air outlet 3 is set to be the same as the amount of airflow of a known indoor unit (an indoor unit including only one fan or an indoor unit in which the amounts of airflow of a plurality of fans are not individually controlled), by individually controlling the amounts of airflow of the fans 20 in this manner, it is possible to reduce loss of airflow caused by the collision of airflow against the side wall of the casing 1.

[0183] As a result of the inventors studying the influence of the air velocity distribution (the difference in the amount of airflow among the fans 20) at the air outlet 3 on the heat exchange performance, it has been found that the influence on the heat exchange performance is small if the difference in the amount of airflow between adjacent fans 20 is about 20 % or lower. It has also been found that, if the difference in the amount of airflow between adjacent fans 20 is about 10 % or lower, the influence on the heat exchange performance is even smaller.

Accordingly, when individually controlling the amounts of airflow of the fans 20, it is preferable that the difference in the amount of airflow between adjacent fans 20 is about 20 % or lower. Further, when individually controlling the amounts of airflow of the fans 20, it is more preferable that the difference in the amount of airflow between adjacent fans 20 is about 10 % or lower.

[0184] The advantages obtained as a result of individually controlling the amounts of airflow of the fans 20 are not restricted to the above-described effect of reducing the loss of airflow. For example, if there is a place where intensive air conditioning is desirably performed (if spot air conditioning is desirably performed), the amounts of airflow of the fans 20 may be individually controlled so that the airflow reaching this place will become stronger. If, for example, there is a place where exposure to air-conditioning airflow is desirably avoided (if air-screening mild air-conditioning is performed), the amounts of airflow of the fans 20 may be individually controlled so that the airflow reaching this place will become weaker (or so that the airflow will be prevented from reaching this place).

[0185] In Embodiment 19, a plurality of fans 20 having the same shape (same specifications) are provided, and the rotation speeds of the fans 20 are changed, thereby individually controlling the amounts of airflow of the fans 20. In this case, "the product of the number of blades 23 of the fan 20 and the rotation speed of the impeller 25 of the fan 20" of one fan 20 may be set to be different from that of another fan 20 by about 10 Hz. With this arrangement, it may be possible to also obtain the effect of reducing beat (beat produced due to the interference of blade pass frequency noise (BPF)) produced by the individual fans 20.

Embodiment 20

[0186] Alternatively, the amounts of airflow of the fans 20 may be individually controlled in the following manner. In Embodiment 20, elements and features which will not be specifically described are similar to those of Embodiment 19, and the same functions and configurations as those of Embodiment 19 are designated by like reference numerals.

[0187] FIG. 53 illustrates the air velocity distribution at the air outlet when the amounts of airflow of the individual fans 20 are set to be the same in the indoor unit according to Embodiment 20 of the present invention. FIG. 53 is a front view of the indoor unit 100. The directions of the arrows in FIG. 53 indicate the directions of airflow, and the lengths of the arrows in FIG. 53 indicate the magnitude of the air velocity. That is, the arrows in FIG. 53 indicate that, as the arrow is longer, the air velocity is higher (in other words, the amount of airflow is greater).

If, as shown in FIG. 53, the amounts of airflow generated from the fans 20 are the same, it is seen that the air velocity is decreased near both ends of the air outlet 3. This is because the air velocity is decreased due to friction of airflow at, for example, the side wall of the casing 1 forming the flow channel. Accordingly, when the indoor unit 100 is operated at a low airflow (low performance) mode, backflow may occur in an area at which the velocity is decreased (near both ends of the air outlet 3). This backflow causes unusual sound, such as creaking sound. Moreover, during the cooling operation, this backflow causes inconvenience, such as condensation due to the mixing of warm air and cool air.

[0188] Accordingly, in the indoor unit 100 according to Embodiment 20, when the indoor unit 100 is operated in the low airflow (low performance) mode, the amounts of airflow of the fans 20 are controlled, as shown in FIG. 54.

[0189] FIG. 54 illustrates an example of the air velocity distribution at the air outlet when the indoor unit according to Embodiment 20 of the present invention is operated in the low airflow mode.

When the indoor unit 100 according to Embodiment 20 is operated in the low airflow (low performance) mode, the amount of airflow of the fan 20A and that of the fan 20C disposed at both ends are set to be greater than that of the fan 20B disposed at the center so that the air velocity near both ends of the air outlet 3 may become higher. When the total amount of airflow at the air outlet 3 in the low airflow (low performance) mode is set to be the same as the amount of airflow of a known indoor unit (an indoor unit including only one fan or an indoor unit in which the amounts of airflow of a plurality of fans are not individually controlled), the above-described problems caused in the low airflow (low performance) mode can be solved by controlling the amounts of airflow of the individual fans 20.

[0190] As a result of the inventors studying the influence of the air velocity distribution (the difference in the amount of airflow among the fans 20) at the air outlet 3 on the heat exchange performance, it has been found that the influence on the heat exchange performance is small if the difference in the amount of airflow between adjacent fans 20 is about 20 % or lower. It has also been found that, if the difference in the amount of airflow between adjacent fans 20 is about

10 % or lower, the influence on the heat exchange performance is even smaller.

Accordingly, when individually controlling the amounts of airflow of the fans 20, it is preferable that the difference in the amount of airflow between adjacent fans 20 is about 20 % or lower. Further, when individually controlling the amounts of airflow of the fans 20, it is more preferable that the difference in the amount of airflow between adjacent fans 20 is about 10 % or lower.

[0191] Moreover, in a manner similar to Embodiment 19, for example, if there is a place where intensive air conditioning is desirably performed (if spot air conditioning is desirably performed), the amounts of airflow of the fans 20 may be further individually controlled so that the airflow reaching this place will become stronger. If, for example, there is a place where exposure to air-conditioning airflow is desirably avoided (if air-screening mild air-conditioning is performed), the amounts of airflow of the fans 20 may be further individually controlled so that the airflow reaching this place will become weaker (or so that the airflow will be prevented from reaching this place).

[0192] Additionally, if the above-described noise cancellation mechanism or a noise cancellation mechanism which will be described below (for example, using an acoustic material, the housing 26 of the fan 20 which serves as a Helmholtz silencer, and an active noise cancellation mechanism) is provided in the indoor unit 100, by combining the configuration in which the amounts of airflow of the fans 20 are individually controlled with such a noise cancellation mechanism, the noise cancellation effects are further improved. For example, if an active noise cancellation mechanism is provided in the indoor unit 100, the same number of noise cancellation mechanisms as the number of sound sources (the number of fans 20) is preferably provided.

However, due to the restrictions on the dimensions of the indoor unit 100 or the cost, it may be difficult to provide the same number of noise cancellation mechanisms as the number of sound sources (the number of fans 20). Even in this case, by combining such a noise cancellation mechanism with the configuration in which the amounts of airflow of the fans 20 are individually controlled, sufficient noise cancellation effects can be obtained.

[0193] FIG. 55 is a characteristic diagram illustrating the relationship between the airflow reduction ratio of a fan disposed at the center and the noise reduction effects when the total amount of airflow is the same, in the indoor unit according to Embodiment 20 of the present invention. FIG. 55 illustrates a noise reduction volume when the amount of airflow of the fan 20B disposed at the center is reduced under the condition that the total amount of airflow at the air outlet 3 remains the same. Moreover, -1 dB, -2 dB, -3 dB, -4 dB, and -5 dB shown in FIG. 55 are noise cancellation effects obtained for noise levels which are most related to sound detected by this noise cancellation detecting device.

The noise detecting microphone 161 and a control speaker of a noise cancellation mechanism used for obtaining the results shown in FIG. 55 are stored within a machine box (a box (not shown) in which a control substrate, etc. are stored) provided at both right and left surfaces of the casing 1 so as not to influence airflow within the flow channel. Accordingly, -1 dB, -2 dB, -3 dB, -4 dB, and -5 dB shown in FIG. 55 are noise cancellation effects obtained for noise levels produced by the fan 20A and the fan 20C.

[0194] For example, if a noise cancellation mechanism having a noise cancellation effect of -5 dB is provided in the indoor unit 100, the noise produced by the fan 20A and that by the fan 20B disposed near both ends are reduced by 5 dB. In contrast, there is no noise cancellation effect for noise produced by the fan 20B disposed at the center. Accordingly, noise cancellation effects having a total of 2.7 dB are obtained in the overall indoor unit 100. At this time, as discussed in Embodiment 20, if the amount of airflow of the fan 20B disposed at the center is reduced by about 15 %, the amount of airflow of the fan 20A and that of the fan 20B disposed near both ends are each increased by 7.5 % in order to obtain the same total amount of airflow.

By individually controlling the amounts of airflow of the fans 20 in this manner, the noise produced by the fan 20A and that of the fan 20B disposed near both ends are increased by 1.9 dB, while noise produced by the fan 20B is reduced by 2 dB. As a result, noise cancellation effects having a total of 3.5 dB are obtained in the overall indoor unit 100, and noise cancellation effects are improved over those when the amounts of airflow of the fans 20 were not individually controlled.

[0195] In Embodiment 20, a plurality of fans 20 having the same shape (same specifications) are provided, and the rotation speeds of the fans 20 are changed, thereby individually controlling the amounts of airflow of the fans 20. In this case, "the product of the number of blades 23 of the fan 20 and the rotation speed of the impeller 25 of the fan 20" of one fan 20 may be set to be different from that of another fan 20 by about 10 Hz. With this arrangement, it may be possible to also obtain the effect of reducing beat (beat produced due to the interference of blade pass frequency noise (BPF)) produced by the individual fans 20.

Embodiment 21

[0196] Alternatively, the amounts of airflow of the fans 20 may be individually controlled in the following manner. In Embodiment 21, elements and features which will not be specifically described are similar to those of Embodiment 19 or Embodiment 20, and the same functions and configurations as those of Embodiment 19 or Embodiment 20 are designated by like reference numerals.

[0197] FIG. 56 illustrates an example of the air velocity distribution at the air outlet of the indoor unit according to Embodiment 21 of the present invention. FIG. 56 is a front view of the indoor unit 100. The directions of the arrows in FIG. 56 indicate the directions of airflow, and the lengths of the arrows in FIG. 56 indicate the magnitude of the air velocity. That is, the arrows in FIG. 56 indicate that, as the arrow is longer, the air velocity is higher (in other words, the amount of airflow is greater).
In the indoor unit 100 according to Embodiment 21, the amount of airflow of the fan 20B disposed at the center is set to be greater than that of the fan 20A and that of the fan 20C disposed at both ends so that the air velocity at the center of the air outlet 3 may become higher than that near both ends of the air outlet 3.
[0198] The airflow blown out of the air outlet 3 gradually loses velocity energy when it contacts indoor low velocity air or still air, and finally, the velocity of the center of the airflow is reduced. Accordingly, by arranging the airflow blown out of the air outlet 3 as discussed in Embodiment 21, the flow velocity at the center of the airflow can be higher than that of a known indoor unit (an indoor unit including only one fan or an indoor unit in which the amounts of airflow of a plurality of fans are not individually controlled) when the same amount of airflow is generated, thereby enhancing the airflow reachability.
[0199] As a result of the inventors studying the influence of the air velocity distribution (the difference in the amount of airflow among the fans 20) at the air outlet 3 on the heat exchange performance, it has been found that the influence on the heat exchange performance is small if the difference in the amount of airflow between adjacent fans 20 is about 20 % or lower. It has also been found that, if the difference in the amount of airflow between adjacent fans 20 is about 10 % or lower, the influence on the heat exchange performance is even smaller.
Accordingly, when individually controlling the amounts of airflow of the fans 20, it is preferable that the difference in the amount of airflow between adjacent fans 20 is about 20 % or lower. Further, when individually controlling the amounts of airflow of the fans 20, it is more preferable that the difference in the amount of airflow between adjacent fans 20 is about 10 % or lower.
[0200] Moreover, in a manner similar to Embodiment 19, for example, if there is a place where intensive air conditioning is desirably performed (if spot air conditioning is desirably performed), the amounts of airflow of the fans 20 may be further individually controlled so that the airflow reaching this place will become stronger. If, for example, there is a place where exposure to air-conditioning airflow is desirably avoided (if air-screening mild air-conditioning is performed), the amounts of airflow of the fans 20 may be further individually controlled so that the airflow reaching this place will become weaker (or so that the airflow will be prevented from reaching this place).
[0201] In Embodiment 21, a plurality of fans 20 having the same shape (same specifications) are provided, and the rotation speeds of the fans 20 are changed, thereby individually controlling the amounts of airflow of the fans 20. In this case, "the product of the number of blades 23 of the fan 20 and the rotation speed of the impeller 25 of the fan 20" of one fan 20 may be set to be different from that of another fan 20 by about 10 Hz. With this arrangement, it may be possible to also obtain the effect of reducing beat (beat produced due to the interference of blade pass frequency noise (BPF)) produced by the individual fans 20.

<u>Embodiment 22</u>

[0202] In Embodiment 19 through Embodiment 21, a plurality of fans 20 having the same shape (same specifications) are provided, and the rotation speeds of the fans 20 are changed, thereby individually controlling the amounts of airflow of the fans 20. However, this is only an example, and by the use of the fans 20 having different levels of air-sending performance (for example, fans 20 having different fan diameters, boss ratios, or angles of incidence), advantages similar to those of Embodiment 19 through Embodiment 21 are obtained.
By using a plurality of fans 20 having different levels of air-sending performance, advantages which cannot be obtained by Embodiment 19 through Embodiment 21, such as improving of the implementation density of the fans 20 and more detailed controlling of the air velocity distribution within the indoor unit 100 (casing 1), can further be obtained.
[0203] It is noted that the use of the fans 20 having different numbers of blades 23 is effective in order to implement the following both factors: preventing degradation in the heat exchange performance by setting the difference in the amount of airflow between adjacent fans 20 to be about 20 % or lower (more preferably, 10 % or lower); and preventing the occurrence of beat by setting "the product of the number of blades 23 of the fan 20 and the rotation speed of the impeller 25 of the fan 20" of one fan 20 to be different from that of another fan 20 by about 10 Hz.

<u>Embodiment 23</u>

<u>Heat Exchanger</u>

[0204] One of the features of the present invention is that the fan 20 is disposed on the upstream side of the heat exchanger 50. With this arrangement, the occurrence of rotational flow or the air velocity distribution in the air which is blown out of the air outlet 3 is reduced, compared with an indoor unit provided in a known air-conditioning apparatus in which the fan 20 is provided at the air outlet. Accordingly, the shape of the heat exchanger 50 is not restricted to that discussed in Embodiment 1, and may be configured as follows. In Embodiment 23, the same functions and configurations as those of Embodiment 1 through Embodiment 22 are designated by like reference numerals.

[0205] FIG. 57 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 23 of the present invention.

In an indoor unit 100 according to Embodiment 23, a heat exchanger 50 which is not divided into a front-side heat exchanger 51 and a back-side heat exchanger 55 is disposed on the downstream side of the fan 20.

[0206] With this configuration, air passing through the filter 10 flows into the fan 20. That is, the turbulence of air flowing into the fan 20 is smaller than that of air flowing into a known indoor unit (air passing through a heat exchanger). Accordingly, the turbulence of air passing through the outer periphery of the blades 23 of the fan 20 is smaller than that in a known indoor unit. Thus, it is possible to reduce noise in the indoor unit 100 according to Embodiment 23 compared with a known indoor unit.

[0207] Additionally, in the indoor unit 100, the fan 20 is provided on the upstream side of the heat exchanger 50. Accordingly, the occurrence of rotational flow or the air velocity distribution in the air which is blown out of the air outlet 3 is reduced, compared with an indoor unit provided in a known air-conditioning apparatus in which a fan is provided at the air outlet. Moreover, since a complicated structure, such as a fan, is not disposed at the air outlet 3, it is easy to take measures against condensation caused by backflow, etc.

Embodiment 24

[0208] By forming the heat exchanger 50 by using the front-side heat exchanger 51 and the back-side heat exchanger 55, it is possible to further reduce noise compared with the indoor unit 100 according to Embodiment 23. In this case, the shape of the heat exchanger is not restricted to that of the heat exchanger 50 discussed in Embodiment 1, and may be configured, for example, in the following manner. In Embodiment 24, points different from Embodiment 23 will be mainly discussed, and the same portions as those of Embodiment 23 are designated by like reference numerals.

[0209] FIG. 58 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 24.

As shown in FIG. 58, as viewed from a right-side longitudinal cross section of the heat exchanger 50, the front-side heat exchanger 51 and the back-side heat exchanger 55 forming the heat exchanger 50 are divided with respect to a symmetric line 50a. The symmetric line 50a serves to divide the installation range of the heat exchanger 50 viewed from this cross section into right and left sides with respect to the substantially center of the installation range.

That is, the front-side heat exchanger 51 is disposed on the front side (left side of the plane) with respect to the symmetric line 50a, while the back-side heat exchanger 55 is disposed on the back side (right side of the plane) with respect to the symmetric line 50a. Then, the front-side heat exchanger 51 and the back-side heat exchanger 55 are disposed within the casing 1 such that the spacing therebetween is decreased with respect to the air flowing direction, that is, such that the configuration of the right-side longitudinal cross section of the heat exchanger 50 is formed in a substantially V shape.

[0210] That is, the front-side heat exchanger 51 and the back-side heat exchanger 55 are disposed such that they tilt in the flowing direction of air supplied from the fan 20. Moreover, one of the features of the heat exchanger 50 is that the area of the flow channel of the back-side heat exchanger 55 is larger than that of the front-side heat exchanger 51.

In Embodiment 24, as viewed from a right-side longitudinal cross section of the heat exchanger 50, the length of the back-side heat exchanger 55 is longer than that of the front-side heat exchanger 51.

Accordingly, the area of the flow channel of the back-side heat exchanger 55 is larger than that of the front-side heat exchanger 51. The other configurations (for example, the depth in FIG. 58) of the front-side heat exchanger 51 are the same as those of the back-side heat exchanger 55. That is, the heat transfer area of the back-side heat exchanger 55 is larger than that of the front-side heat exchanger 51. The rotational axis 20a of the fan 20 is set above the symmetric line 50a.

[0211] With this configuration, since the fan 20 is provided on the upstream side of the heat exchanger 50, advantages similar to those of Embodiment 23 can be obtained.

Moreover, in the indoor unit 100 according to Embodiment 24, the amount of air corresponding to the area of the flow channel passes through each of the front-side heat exchanger 51 and the back-side heat exchanger 55. That is, the amount of airflow in the back-side heat exchanger 55 is greater than that in the front-side heat exchanger 51. Because of this difference in the amount of airflow, after air passing through the front-side heat exchanger 51 joins air passing through the back-side heat exchanger 55, the joined air deflects toward the front side (air outlet 3).

Accordingly, it is not necessary to suddenly deflect the airflow near the air outlet 3, thereby making it possible to reduce the pressure loss near the air outlet 3. Thus, in the indoor unit 100 according to Embodiment 24, noise can be further reduced, compared with the indoor unit 100 according to Embodiment 23. Additionally, in the indoor unit 100 according to Embodiment 24, since the pressure loss near the air outlet 3 can be reduced, power consumption can also be reduced.

[0212] Moreover, the amount of air corresponding to the heat transfer area passes through each of the front-side heat exchanger 51 and the back-side heat exchanger 55. Accordingly, the heat exchange performance of the heat exchanger 50 is improved.

[0213] The heat exchanger 50 shown in FIG. 58 is formed in a substantially V shape by using the front-side heat exchanger 51 and the back-side heat exchanger 55 which are separately formed. However, the heat exchanger 50 is not restricted to this configuration. For example, the front-side heat exchanger 51 and the back-side heat exchanger 55 may be formed as an integral heat exchanger (see FIG. 67). Alternatively, for example, each of the front-side heat exchanger 51 and the back-side heat exchanger 55 may be formed by a combination of a plurality of heat exchangers (see FIG. 67).

In the case of an integral heat exchanger, the front side is the front-side heat exchanger 51 and the back side is the back-side heat exchanger 55 with respect to the symmetric line 50a. That is, the length of the heat exchanger disposed farther backward than the symmetric line 50a is set to be longer than that of the heat exchanger disposed farther forward than the symmetric line 50a.

Moreover, if each of the front-side heat exchanger 51 and the back-side heat exchanger 55 is formed by a combination of a plurality of heat exchangers, the total length of the plurality of heat exchangers forming the front-side heat exchanger 51 is the length of the front-side heat exchanger 51, and the total length of the plurality of heat exchangers forming the back-side heat exchanger 55 is the length of the back-side heat exchanger 55.

[0214] It is not necessary to tilt all of the heat exchangers forming the heat exchanger 50 as viewed from a right-side longitudinal cross section. Instead, some heat exchangers forming the heat exchanger 50 may be disposed vertically as viewed from a right-side longitudinal cross section (see FIG. 67).

Additionally, when the heat exchanger 50 is formed by a plurality of heat exchangers (for example, the front-side heat exchanger 51 and the back-side heat exchanger 55), it is not necessary that the heat exchangers be completely in contact with each other at a portion at which the gradient of the heat exchanger 50 is changed (for example, a substantially joint portion between the front-side heat exchanger 51 and the back-side heat exchanger 55), and there may be a slight gap at such a joint portion.

Moreover, a right-side longitudinal cross section of the heat exchanger 50 may be formed entirely or partially in a curved shape (see FIG. 67).

[0215] FIG. 67 shows schematic views illustrating examples of the shapes of the heat exchanger 50. FIG. 67 shows the heat exchanger 50 as viewed from a right-side longitudinal cross section. The heat exchangers 50 shown in FIG. 67 are formed, as a whole, in a substantially inverted V shape. However, this configuration is only an example.

As shown in FIG. 67(a), the heat exchanger 50 may be formed by a plurality of heat exchangers. As shown in FIG. 67 (b), the heat exchanger 50 may be formed by an integral heat exchanger. As shown in 12(c), each of the heat exchangers forming the heat exchanger 50 may also be formed by a plurality of heat exchangers. Moreover, as shown in FIG. 67 (c), some heat exchangers forming the heat exchanger 50 may be disposed vertically. As shown in FIG. 67(d), the heat exchanger 50 may be formed in a curved shape.

<u>Embodiment 25</u>

[0216] Alternatively, the heat exchanger 50 may be configured as follows. In Embodiment 25, points different from Embodiment 24 will be mainly discussed, and the same portions as those of Embodiment 24 are designated by like reference numerals.

[0217] FIG. 59 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 25 of the present invention.

The indoor unit 100 according to Embodiment 25 is different from that of Embodiment 24 in the arrangement of the heat exchanger 50.

[0218] The heat exchanger 50 according to Embodiment 25 is formed by three heat exchangers, and these heat exchangers are disposed such that they tilt at different angles with respect to the flowing direction of air supplied from the fan 20. The heat exchanger 50 is formed in a substantially N shape as viewed from a right-side longitudinal cross section. A heat exchanger 51a and a heat exchanger 51b disposed farther forward than the symmetric line 50a form the front-side heat exchanger 51, while a heat exchanger 55a and a heat exchanger 55b disposed farther backward than the symmetric line 50a form the back-side heat exchanger 55.

That is, in Embodiment 25, the heat exchanger 51b and the heat exchanger 55b are formed as an integral heat exchanger. The symmetric line 50a serves to divide the installation range of the heat exchanger 50 viewed from a right-side longitudinal cross section into right and left sides with respect to the substantially center of the installation range.

[0219] Moreover, as viewed from a right-side longitudinal cross section, the length of the back-side heat exchanger 55 is longer than that of the front-side heat exchanger 51. That is, the amount of airflow in the back-side heat exchanger 55 is greater than that in the front-side heat exchanger 51. For the comparison of the length, the total length of the heat exchanger group forming the front-side heat exchanger 50 is compared with the total length of the heat exchanger group forming the back-side heat exchanger 55.

[0220] With this configuration, the amount of airflow of the back-side heat exchanger 55 is greater than that of the front-side heat exchanger 51. Accordingly, as in Embodiment 24, because of this difference in the amount of airflow, after air passing through the front-side heat exchanger 51 joins air passing through the back-side heat exchanger 55, the joined air deflects toward the front side (air outlet 3).
Thus, it is not necessary to suddenly deflect the airflow near the air outlet 3, thereby making it possible to reduce the pressure loss near the air outlet 3. Therefore, in the indoor unit 100 according to Embodiment 25, noise can be further reduced compared with the indoor unit 100 according to Embodiment 23. Additionally, in the indoor unit 100 according to Embodiment 25, since the pressure loss near the air outlet 3 can be reduced, power consumption can also be reduced.
[0221] Further, the shape of the heat exchanger 50 is formed in a substantially N shape as viewed from a right-side longitudinal cross section. Accordingly, the areas passing through the front-side heat exchanger 51 and the back-side heat exchanger 55 can be made large, and thus, the velocity of air passing through each of the front-side heat exchanger 51 and the back-side heat exchanger 55 can be decreased compared with that of Embodiment 24. Therefore, compared with Embodiment 24, the pressure loss in the front-side heat exchanger 51 and the back-side heat exchanger 55 can be reduced, thereby making it possible to further reduce power consumption and noise.
[0222] The heat exchanger 50 shown in FIG. 59 is formed in a substantially N shape by using three heat exchangers which are separately formed. However, the heat exchanger 50 is not restricted to this configuration. For example, three heat exchangers forming the heat exchanger 50 may be formed as an integral heat exchanger (see FIG. 67). Alternatively, for example, each of the three heat exchangers forming the heat exchanger 50 may be formed by a combination of a plurality of heat exchangers (see FIG. 67).
In the case of an integral heat exchanger, the front side is the front-side heat exchanger 51 and the back side is the back-side heat exchanger 55 with respect to the symmetric line 50a. That is, the length of the heat exchanger disposed farther backward than the symmetric line 50a is set to be longer than that of the heat exchanger disposed farther forward than the symmetric line 50a.
Moreover, when each of the front-side heat exchanger 51 and the back-side heat exchanger 55 is formed by a combination of a plurality of heat exchangers, the total length of the plurality of heat exchangers forming the front-side heat exchanger 51 is the length of the front-side heat exchanger 51, and the total length of the plurality of heat exchangers forming the back-side heat exchanger 55 is the length of the back-side heat exchanger 55.
[0223] It is not necessary to tilt all of the heat exchangers forming the heat exchanger 50 as viewed from a right-side longitudinal cross section. Instead, some heat exchangers forming the heat exchanger 50 may be disposed vertically as viewed from a right-side longitudinal cross section (see FIG. 67).
Additionally, when the heat exchanger 50 is formed by a plurality of heat exchangers, it is not necessary that the heat exchangers be completely in contact with each other at a portion at which the gradient of the heat exchanger 50 is changed, and there may be a slight gap at such a portion.
Moreover, a right-side longitudinal cross section of the heat exchanger 50 may be formed entirely or partially in a curved shape (see FIG. 67).

Embodiment 26

[0224] Alternatively, the heat exchanger 50 may be configured as follows. In Embodiment 26, points different from Embodiment 24 or Embodiment 25 will be mainly discussed, and the same portions as those of Embodiment 24 or Embodiment 25 are designated by like reference numerals. A wall-mounted indoor unit, which is mounted on a wall surface in an air conditioning area, will be discussed by way of example.
[0225] FIG. 60 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 26 of the present invention.
The indoor unit 100 according to Embodiment 26 is different from that of Embodiment 24 or Embodiment 25 in the arrangement of the heat exchanger 50.
[0226] The heat exchanger 50 according to Embodiment 26 is formed by four heat exchangers, and these heat exchangers are disposed such that they tilt at different angles with respect to the flowing direction of air supplied from the fan 20. The heat exchanger 50 is formed in a substantially W shape as viewed from a right-side longitudinal cross section. A heat exchanger 51a and a heat exchanger 51b disposed farther forward than the symmetric line 50a form the front-side heat exchanger 51, while a heat exchanger 55a and a heat exchanger 55b disposed farther backward than the symmetric line 50a form the back-side heat exchanger 55. The symmetric line 50a serves to divide the installation range of the heat exchanger 50 viewed from a right-side longitudinal cross section into right and left sides with respect to the substantially center of the installation range.
[0227] As viewed from a right-side longitudinal cross section, the length of the back-side heat exchanger 55 is longer than that of the front-side heat exchanger 51. That is, the amount of airflow in the back-side heat exchanger 55 is greater than that in the front-side heat exchanger 51. For the comparison of the length, the total length of the heat exchanger group forming the front-side heat exchanger 51 is compared with the total length of the heat exchanger group forming

the back-side heat exchanger 55.

[0228] With this configuration, the amount of airflow of the back-side heat exchanger 55 is greater than that of the front-side heat exchanger 51. Accordingly, as in Embodiment 24 or Embodiment 25, because of this difference in the amount of airflow, after air passing through the front-side heat exchanger 51 joins air passing through the back-side heat exchanger 55, the joined air deflects toward the front side (air outlet 3).

Thus, it is not necessary to suddenly deflect the airflow near the air outlet 3, thereby making it possible to reduce the pressure loss near the air outlet 3. Therefore, in the indoor unit 100 according to Embodiment 26, noise can be further reduced compared with the indoor unit 100 according to Embodiment 23. Additionally, in the indoor unit 100, since the pressure loss near the air outlet 3 can be reduced, power consumption can also be reduced.

[0229] Further, the shape of the heat exchanger 50 is formed in a substantially W shape as viewed from a right-side longitudinal cross section. Accordingly, the areas passing through the front-side heat exchanger 51 and the back-side heat exchanger 55 can be made large, and thus, the velocity of air passing through each of the front-side heat exchanger 51 and the back-side heat exchanger 55 can be decreased compared with that of Embodiment 24 or Embodiment 25. Therefore, compared with Embodiment 24 or Embodiment 25, the pressure loss in the front-side heat exchanger 51 and the back-side heat exchanger 55 can be reduced, thereby making it possible to further reduce power consumption and noise.

[0230] The heat exchanger 50 shown in FIG. 60 is formed in a substantially W shape by using four heat exchangers which are separately formed. However, the heat exchanger 50 is not restricted to this configuration. For example, four heat exchangers forming the heat exchanger 50 may be formed as an integral heat exchanger (see FIG. 67). Alternatively, for example, each of the four heat exchangers forming the heat exchanger 50 may be formed by a combination of a plurality of heat exchangers (see FIG. 67).

In the case of an integral heat exchanger, the front side is the front-side heat exchanger 51 and the back side is the back-side heat exchanger 55 with respect to the symmetric line 50a. That is, the length of the heat exchanger disposed farther backward than the symmetric line 50a is set to be longer than that of the heat exchanger disposed farther forward than the symmetric line 50a.

Moreover, when each of the front-side heat exchanger 51 and the back-side heat exchanger 55 is formed by a combination of a plurality of heat exchangers, the total length of the plurality of heat exchangers forming the front-side heat exchanger 51 is the length of the front-side heat exchanger 51, and the total length of the plurality of heat exchangers forming the back-side heat exchanger 55 is the length of the back-side heat exchanger 55.

[0231] It is not necessary to tilt all of the heat exchangers forming the heat exchanger 50 as viewed from a right-side longitudinal cross section,. Instead, some heat exchangers forming the heat exchanger 50 may be disposed vertically as viewed from a right-side longitudinal cross section (see FIG. 67).

Additionally, when the heat exchanger 50 is formed by a plurality of heat exchangers, it is not necessary that the heat exchangers be completely in contact with each other at a portion at which the gradient of the heat exchanger 50 is changed, and there may be a slight gap at such a portion.

Moreover, a right-side longitudinal cross section of the heat exchanger 50 may be formed entirely or partially in a curved shape (see FIG. 67).

Embodiment 27

[0232] Alternatively, the heat exchanger 50 may be configured as follows, as discussed in Embodiment 1. In Embodiment 27, points different from Embodiment 24 through Embodiment 26 will be mainly discussed, and the same portions as those of Embodiment 24 through Embodiment 26 are designated by like reference numerals. A wall-mounted indoor unit, which is mounted on a wall surface in an air conditioning area, will be discussed by way of example.

[0233] FIG. 61 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 27 of the present invention.

The indoor unit 100 according to Embodiment 27 is different from those of Embodiment 24 through Embodiment 26 in the arrangement of the heat exchanger 50.

More specifically, as in Embodiment 24, the indoor unit 100 of Embodiment 27 includes two heat exchanges (the front-side heat exchanger 51 and the back-side heat exchanger 55). However, the indoor unit 100 of Embodiment 27 is different from that of Embodiment 24 in the arrangement of the front-side heat exchanger 51 and the back-side heat exchanger 55.

[0234] That is, the front-side heat exchanger 51 and the back-side heat exchanger 55 are disposed such that they tilt at different angles with respect to the flowing direction of air supplied from the fan 20. The front-side heat exchanger 51 is disposed farther forward than the symmetric line 50a, while the back-side heat exchanger 55 is disposed farther backward than the symmetric line 50a. The heat exchanger 50 is formed in a substantially inverted V shape as viewed from a right-side longitudinal cross section.

The symmetric line 50a serves to divide the installation range of the heat exchanger 50 viewed from a right-side longitudinal cross section into right and left sides with respect to the substantially center of the installation range.

[0235] Further, as viewed from a right-side longitudinal cross section, the length of the back-side heat exchanger 55 is longer than that of the front-side heat exchanger 51. That is, the amount of airflow in the back-side heat exchanger 55 is greater than that in the front-side heat exchanger 51. For the comparison of the length, the total length of the heat exchanger group forming the front-side heat exchanger 51 is compared with the total length of the heat exchanger group forming the back-side heat exchanger 55.

[0236] In the indoor unit 100 configured as described above, air flows within the indoor unit 100 as follows.
First, indoor air sucked by the fan 20 flows into the indoor unit 100 (casing 1) through the air inlet 2 formed at the top portion of the casing 1. At this time, dust contained in air is removed by the filter 10. This indoor air is heated or cooled by a refrigerant circulating within the heat exchanger 50 while passing through the heat exchanger 50 (the front-side heat exchanger 51 and the back-side heat exchanger 55), thereby being transformed into conditioned air. At this time, air passing through the front-side heat exchanger 51 flows from the front side to the back side of the indoor unit 100. In contrast, air passing through the back-side heat exchanger 55 flows from the back side to the front side of the indoor unit 100.
Conditioned air passing through the heat exchanger 50 (the front-side heat exchanger 51 and the back-side heat exchanger 55) is blown out of the air outlet 3 formed at the bottom portion of the casing 1 to the outside of the indoor unit 100, that is, to the air-conditioning subject area.

[0237] With this configuration, the amount of airflow of the back-side heat exchanger 55 is greater than that of the front-side heat exchanger 51. Accordingly, as in Embodiment 24 through Embodiment 26, because of this difference in the amount of airflow, after air passing through the front-side heat exchanger 51 joins air passing through the back-side heat exchanger 55, the joined air deflects toward the front side (air outlet 3). Thus, it is not necessary to suddenly deflect the airflow near the air outlet 3, thereby making it possible to reduce the pressure loss near the air outlet 3.
Therefore, in the indoor unit 100 according to Embodiment 27, noise can be further reduced compared with the indoor unit 100 according to Embodiment 23. Additionally, in the indoor unit 100, since the pressure loss near the air outlet 3 can be reduced, power consumption can also be reduced.

[0238] Moreover, in the indoor unit 100 according to Embodiment 27, the direction of airflow flowing out of the back-side heat exchanger 55 is from the back side to the front side. Accordingly, in the indoor unit 100 according to Embodiment 27, it is even easier to deflect the airflow which has passed through the heat exchanger 50. That is, in the indoor unit 100 according to Embodiment 27, it is even easier to control airflow blown out of the air outlet 3 than in the indoor unit 100 according to Embodiment 24. Accordingly, in the indoor unit 100 according to Embodiment 27, it is not even necessary to suddenly deflect the airflow near the air outlet 3 compared with the indoor unit 100 according to Embodiment 24, thereby further reducing power consumption and noise.

[0239] The heat exchanger 50 shown in FIG. 61 is formed in a substantially inverted V shape by using the front-side heat exchanger 51 and the back-side heat exchanger 55 which are separately formed. However, the heat exchanger 50 is not restricted to this configuration. For example, the front-side heat exchanger 51 and the back-side heat exchanger 55 may be formed as an integral heat exchanger (see FIG. 67). Alternatively, for example, each of the front-side heat exchanger 51 and the back-side heat exchanger 55 may be formed by a combination of a plurality of heat exchangers (see FIG. 67).
In the case of an integral heat exchanger, the front side is the front-side heat exchanger 51 and the back side is the back-side heat exchanger 55 with respect to the symmetric line 50a. That is, the length of the heat exchanger disposed farther backward than the symmetric line 50a is set to be longer than that of the heat exchanger disposed farther forward than the symmetric line 50a.
Moreover, if each of the front-side heat exchanger 51 and the back-side heat exchanger 55 is formed by a combination of a plurality of heat exchangers, the total length of the plurality of heat exchangers forming the front-side heat exchanger 51 is the length of the front-side heat exchanger 51, and the total length of the plurality of heat exchangers forming the back-side heat exchanger 55 is the length of the back-side heat exchanger 55.

[0240] It is not necessary to tilt all of the heat exchangers forming the heat exchanger 50 as viewed from a right-side longitudinal cross section. Instead, some heat exchangers forming the heat exchanger 50 may be disposed vertically as viewed from a right-side longitudinal cross section (see FIG. 67).
Additionally, when the heat exchanger 50 is formed by a plurality of heat exchangers, it is not necessary that the heat exchangers be completely in contact with each other at a portion at which the gradient of the heat exchanger 50 is changed, and there may be a slight gap at such a portion.
Moreover, a right-side longitudinal cross section of the heat exchanger 50 may be formed entirely or partially in a curved shape (see FIG. 67).

Embodiment 28

[0241] Alternatively, the heat exchanger 50 may be configured as follows. In Embodiment 28, points different from

Embodiment 24 through Embodiment 27 will be mainly discussed, and the same portions as those of Embodiment 24 through Embodiment 27 are designated by like reference numerals.

[0242] FIG. 62 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 28 of the present invention.

The indoor unit 100 according to Embodiment 28 is different from those of Embodiment 24 through Embodiment 27 in the arrangement of the heat exchanger 50.

More specifically, as in Embodiment 25, the indoor unit 100 of Embodiment 28 includes three heat exchanges. However, the indoor unit 100 of Embodiment 28 is different from that of Embodiment 25 in the arrangement of these three heat exchangers.

[0243] That is, the three heat exchangers forming the heat exchanger 55 are disposed such that they tilt at different angles with respect to the flowing direction of air supplied from the fan 20. Then, the heat exchanger 50 is formed in a substantially horizontally flipped N shape, as viewed from a right-side longitudinal cross section. A heat exchanger 51a and a heat exchanger 51b disposed farther forward than the symmetric line 50a form the front-side heat exchanger 51, while a heat exchanger 55a and a heat exchanger 55b disposed farther backward than the symmetric line 50a form the back-side heat exchanger 55.

That is, in Embodiment 28, the heat exchanger 51b and the heat exchanger 55b are formed as an integral heat exchanger. The symmetric line 50a serves to divide the installation range of the heat exchanger 50 viewed from a right-side longitudinal cross section into right and left sides with respect to the substantially center of the installation range.

[0244] Further, as viewed from a right-side longitudinal cross section, the length of the back-side heat exchanger 55 is longer than that of the front-side heat exchanger 51. That is, the amount of airflow in the back-side heat exchanger 55 is greater than that in the front-side heat exchanger 51. For the comparison of the length, the total length of the heat exchanger group forming the front-side heat exchanger 51 is compared with the total length of the heat exchanger group forming the back-side heat exchanger 55.

[0245] With this configuration, the amount of airflow of the back-side heat exchanger 55 is greater than that of the front-side heat exchanger 51. Accordingly, as in Embodiment 24 through Embodiment 27, because of this difference in the amount of airflow, after air passing through the front-side heat exchanger 51 joins air passing through the back-side heat exchanger 55, the joined air deflects toward the front side (air outlet 3).

Thus, it is not necessary to suddenly deflect the airflow near the air outlet 3, thereby making it possible to reduce the pressure loss near the air outlet 3. Therefore, in the indoor unit 100 according to Embodiment 28, noise can be further reduced compared with the indoor unit 100 according to Embodiment 23. Additionally, in the indoor unit 100, since the pressure loss near the air outlet 3 can be reduced, power consumption can also be reduced.

[0246] Moreover, in the indoor unit 100 according to Embodiment 28, the direction of airflow flowing out of the back-side heat exchanger 55 is from the back side to the front side. Accordingly, in the indoor unit 100 according to Embodiment 28, it is even easier to deflect the airflow which has passed through the heat exchanger 50. That is, in the indoor unit 100 according to Embodiment 28, it is even easier to control airflow blown out of the air outlet 3 than in the indoor unit 100 according to Embodiment 25.

Accordingly, in the indoor unit 100 according to Embodiment 28, it is not even necessary to suddenly deflect the airflow near the air outlet 3 compared with the indoor unit 100 according to Embodiment 25, thereby further reducing power consumption and noise.

[0247] Further, the shape of the heat exchanger 50 is formed in a substantially horizontally flipped N shape as viewed from a right-side longitudinal cross section. Accordingly, the areas passing through the front-side heat exchanger 51 and the back-side heat exchanger 55 can be made large, and thus, the velocity of air passing through each of the front-side heat exchanger 51 and the back-side heat exchanger 55 can be decreased compared with Embodiment 27. Therefore, compared with Embodiment 27, the pressure loss in the front-side heat exchanger 51 and that in the back-side heat exchanger 55 can be reduced, thereby making it possible to further reduce power consumption and noise.

[0248] The heat exchanger 50 shown in FIG. 62 is formed in a substantially horizontally flipped N shape by using three heat exchangers which are separately formed. However, the heat exchanger 50 is not restricted to this configuration. For example, the three heat exchangers may be formed as an integral heat exchanger (see FIG. 67). Alternatively, for example, each of the three heat exchangers may be formed by a combination of a plurality of heat exchangers (see FIG. 67).

In the case of an integral heat exchanger, the front side is the front-side heat exchanger 51 and the back side is the back-side heat exchanger 55 with respect to the symmetric line 50a. That is, the length of the heat exchanger disposed farther backward than the symmetric line 50a is set to be longer than that of the heat exchanger disposed farther forward than the symmetric line 50a.

Moreover, if each of the front-side heat exchanger 51 and the back-side heat exchanger 55 is formed by a combination of a plurality of heat exchangers, the total length of the plurality of heat exchangers forming the front-side heat exchanger 51 is the length of the front-side heat exchanger 51, and the total length of the plurality of heat exchangers forming the back-side heat exchanger 55 is the length of the back-side heat exchanger 55.

[0249] It is not necessary to tilt all of the heat exchangers forming the heat exchanger 50 as viewed from a right-side longitudinal cross section. Instead, some heat exchangers forming the heat exchanger 50 may be disposed vertically as viewed from a right-side longitudinal cross section (see FIG. 67).
Additionally, when the heat exchanger 50 is formed by a plurality of heat exchangers, it is not necessary that the heat exchangers be completely in contact with each other at a portion at which the gradient of the heat exchanger 50 is changed, and there may be a slight gap at such a portion.
Moreover, a right-side longitudinal cross section of the heat exchanger 50 may be formed entirely or partially in a curved shape (see FIG. 67).

Embodiment 29

[0250] Alternatively, the heat exchanger 50 may be configured as follows. In Embodiment 29, points different from Embodiment 24 through Embodiment 28 will be mainly discussed, and the same portions as those of Embodiment 24 through Embodiment 28 are designated by like reference numerals.
[0251] FIG. 63 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 29 of the present invention.
The indoor unit 100 according to Embodiment 29 is different from those of Embodiment 24 through Embodiment 28 in the arrangement of the heat exchanger 50.
More specifically, as in Embodiment 26, the indoor unit 100 of Embodiment 29 includes four heat exchanges. However, the indoor unit 100 of Embodiment 29 is different from that of Embodiment 26 in the arrangement of these four heat exchangers.
[0252] That is, the four heat exchangers forming the heat exchanger 55 are disposed such that they tilt at different angles with respect to the flowing direction of air supplied from the fan 20. Then, the heat exchanger 50 is formed in a substantially M shape, as viewed from a right-side longitudinal cross section. A heat exchanger 51a and a heat exchanger 51b disposed farther forward than the symmetric line 50a form the front-side heat exchanger 51, while a heat exchanger 55a and a heat exchanger 55b disposed farther backward than the symmetric line 50a form the back-side heat exchanger 55. The symmetric line 50a serves to divide the installation range of the heat exchanger 50 viewed from a right-side longitudinal cross section into right and left sides with respect to the substantially center of the installation range.
[0253] Further, as viewed from a right-side longitudinal cross section, the length of the back-side heat exchanger 55 is longer than that of the front-side heat exchanger 51. That is, the amount of airflow in the back-side heat exchanger 55 is greater than that in the front-side heat exchanger 51. For the comparison of the length, the total length of the heat exchanger group forming the front-side heat exchanger 51 is compared with the total length of the heat exchanger group forming the back-side heat exchanger 55.
[0254] With this configuration, the amount of airflow of the back-side heat exchanger 55 is greater than that of the front-side heat exchanger 51. Accordingly, as in Embodiment 24 through Embodiment 28, because of this difference in the amount of airflow, after air passing through the front-side heat exchanger 51 joins air passing through the back-side heat exchanger 55, the joined air deflects toward the front side (air outlet 3).
Thus, it is not necessary to suddenly deflect the airflow near the air outlet 3, thereby making it possible to reduce the pressure loss near the air outlet 3. Therefore, in the indoor unit 100 according to Embodiment 29, noise can be further reduced compared with the indoor unit 100 according to Embodiment 23. Additionally, in the indoor unit 100, since the pressure loss near the air outlet 3 can be reduced, power consumption can also be reduced.
[0255] Moreover, in the indoor unit 100 according to Embodiment 29, the direction of airflow flowing out of the back-side heat exchanger 55 is from the back side to the front side. Accordingly, in the indoor unit 100 according to Embodiment 29, it is even easier to deflect the airflow which has passed through the heat exchanger 50. That is, in the indoor unit 100 according to Embodiment 29, it is even easier to control airflow blown out of the air outlet 3 than in the indoor unit 100 according to Embodiment 26. Accordingly, in the indoor unit 100 according to Embodiment 29, it is not even necessary to suddenly deflect the airflow near the air outlet 3 compared with the indoor unit 100 according to Embodiment 26, thereby further reducing power consumption and noise.
[0256] Further, the shape of the heat exchanger 50 is formed in a substantially M shape as viewed from a right-side longitudinal cross section. Accordingly, the areas passing through the front-side heat exchanger 51 and the back-side heat exchanger 55 can be made large, and thus, the velocity of air passing through each of the front-side heat exchanger 51 and the back-side heat exchanger 55 can be decreased compared with Embodiment 27 or Embodiment 28.
Therefore, compared with Embodiment 27 or Embodiment 28, the pressure loss in the front-side heat exchanger 51 and that in the back-side heat exchanger 55 can be reduced, thereby making it possible to further reduce power consumption and noise.
[0257] The heat exchanger 50 shown in FIG. 63 is formed in a substantially M shape by using four heat exchangers which are separately formed. However, the heat exchanger 50 is not restricted to this configuration. For example, the four heat exchangers forming the heat exchanger 50 may be formed as an integral heat exchanger (see FIG. 67).

Alternatively, for example, each of the four heat exchangers forming the heat exchanger 50 may be formed by a combination of a plurality of heat exchangers (see FIG. 67).

In the case of an integral heat exchanger, the front side is the front-side heat exchanger 51 and the back side is the back-side heat exchanger 55 with respect to the symmetric line 50a. That is, the length of the heat exchanger disposed farther backward than the symmetric line 50a is set to be longer than that of the heat exchanger disposed farther forward than the symmetric line 50a.

Moreover, if each of the front-side heat exchanger 51 and the back-side heat exchanger 55 is formed by a combination of a plurality of heat exchangers, the total length of the plurality of heat exchangers forming the front-side heat exchanger 51 is the length of the front-side heat exchanger 51, and the total length of the plurality of heat exchangers forming the back-side heat exchanger 55 is the length of the back-side heat exchanger 55.

[0258] It is not necessary to tilt all of the heat exchangers forming the heat exchanger 50 as viewed from a right-side longitudinal cross section. Instead, some heat exchangers forming the heat exchanger 50 may be disposed vertically as viewed from a right-side longitudinal cross section (see FIG. 67).

Additionally, when the heat exchanger 50 is formed by a plurality of heat exchangers, it is not necessary that the heat exchangers be completely in contact with each other at a portion at which the gradient of the heat exchanger 50 is changed, and there may be a slight gap at such a portion.

Moreover, a right-side longitudinal cross section of the heat exchanger 50 may be formed entirely or partially in a curved shape (see FIG. 67).

Embodiment 30

[0259] Alternatively, the heat exchanger 50 may be configured as follows. In Embodiment 30, points different from Embodiment 24 through Embodiment 29 will be mainly discussed, and the same portions as those of Embodiment 24 through Embodiment 29 are designated by like reference numerals.

[0260] FIG. 64 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 30 of the present invention.

The indoor unit 100 according to Embodiment 30 is different from those of Embodiment 24 through Embodiment 29 in the arrangement of the heat exchanger 50.

More specifically, as in Embodiment 27, the indoor unit 100 of Embodiment 30 includes two heat exchanges (the front-side heat exchanger 51 and the back-side heat exchanger 55), and is formed in a substantially inverted V shape, as viewed from a right-side longitudinal cross section. However, in the indoor unit 100 of Embodiment 30, the pressure loss of the front-side heat exchanger 51 is set to be different from that of the back-side heat exchanger 55, thereby making the amount of airflow in the front-side heat exchanger 51 different from the amount of airflow in the back-side heat exchanger 55.

[0261] That is, the front-side heat exchanger 51 and the back-side heat exchanger 55 are disposed such that they tilt at a different angle with respect to the flowing direction of air supplied from the fan 20. The front-side heat exchanger 51 is disposed farther forward than the symmetric line 50a, while the back-side heat exchanger 55 is disposed farther backward than the symmetric line 50a. The heat exchanger 50 is formed in a substantially inverted V shape as viewed from a right-side longitudinal cross section.

[0262] Further, as viewed from a right-side longitudinal cross section, the length of the back-side heat exchanger 55 is the same as that of the front-side heat exchanger 51. The specifications of the front-side heat exchanger 51 and the back-side heat exchanger 55 are decided so that the pressure loss of the back-side heat exchanger 55 may become smaller than that of the front-side heat exchanger 51. If finned tube heat exchangers are used as the front-side heat exchanger 51 and the back-side heat exchanger 55, the width of the back-side heat exchanger 55 (the width of the fin 56 of the back-side heat exchanger 55) may be set to be smaller than that of the front-side heat exchanger 51 (the width of the fin 56 of the front-side heat exchanger 51), as viewed from a right-side longitudinal cross section.

Alternatively, for example, the interval between the fins 56 of the back-side heat exchanger 55 may be set to be greater than that of the front-side heat exchanger 51. Alternatively, for example, the diameter of the heat exchanger pipe 57 of the back-side heat exchanger 55 may be set to be smaller than that of the front-side heat exchanger 51. Alternatively, for example, the number of heat exchanger pipes 57 of the back-side heat exchanger 55 may be set to be smaller than that of the front-side heat exchanger 51.

The symmetric line 50a serves to divide the installation range of the heat exchanger 50 viewed from a right-side longitudinal cross section into right and left sides with respect to the substantially center of the installation range.

[0263] With this configuration, since the fan 20 is disposed on the upstream side of the heat exchanger 50, advantages similar to those of Embodiment 23 can be obtained.

In the indoor unit 100 according to Embodiment 30, the amount of air corresponding to the pressure loss passes through each of the front-side heat exchanger 51 and the back-side heat exchanger 55. That is, the amount of airflow of the back-side heat exchanger 55 is greater than that of the front-side heat exchanger 51. Because of this difference in the amount of airflow, after air passing through the front-side heat exchanger 51 joins air passing through the back-side heat exchanger 55, the joined air deflects toward the front side (air outlet 3).

Thus, it is not necessary to suddenly deflect the airflow near the air outlet 3, thereby making it possible to reduce the pressure loss near the air outlet 3. Therefore, in the indoor unit 100 according to Embodiment 30, without having to make the length of the back-side heat exchanger 55 longer as viewed from a right-side longitudinal cross section, noise can be further reduced compared with the indoor unit 100 according to Embodiment 23. Additionally, in the indoor unit 100, since the pressure loss near the air outlet 3 can be reduced, power consumption can also be reduced.

[0264] The heat exchanger 50 shown in FIG. 64 is formed in a substantially inverted V shape by using the front-side heat exchanger 51 and the back-side heat exchanger 55 which are separately formed. However, the heat exchanger 50 is not restricted to this configuration. For example, a right-side longitudinal cross section of the heat exchanger 50 may be formed in a substantially V shape, a substantially N shape, a substantially W shape, a substantially horizontally flipped N shape, or a substantially M shape. Alternatively, for example, the front-side heat exchanger 51 and the back-side heat exchanger 55 may be formed as an integral heat exchanger (see FIG. 67).

Alternatively, for example, each of the front-side heat exchanger 51 and the back-side heat exchanger 55 may be formed by a combination of a plurality of heat exchangers (see FIG. 67). In the case of an integral heat exchanger, the front side is the front-side heat exchanger 51 and the back side is the back-side heat exchanger 55 with respect to the symmetric line 50a. That is, the pressure loss of the heat exchanger disposed farther backward than the symmetric line 50a is set to be smaller than that of the heat exchanger disposed farther forward than the symmetric line 50a.

Moreover, if each of the front-side heat exchanger 51 and the back-side heat exchanger 55 is formed by a combination of a plurality of heat exchangers, the total pressure loss of the plurality of heat exchangers forming the front-side heat exchanger 51 is the pressure loss of the front-side heat exchanger 51, and the total pressure loss of the plurality of heat exchangers forming the back-side heat exchanger 55 is the pressure loss of the back-side heat exchanger 55.

[0265] It is not necessary to tilt all of the heat exchangers forming the heat exchanger 50 as viewed from a right-side longitudinal cross section. Instead, some heat exchangers forming the heat exchanger 50 may be disposed vertically as viewed from a right-side longitudinal cross section (see FIG. 67).

Additionally, when the heat exchanger 50 is formed by a plurality of heat exchangers (for example, the front-side heat exchanger 51 and the back-side heat exchanger 55), it is not necessary that the heat exchangers be completely in contact with each other at a portion at which the gradient of the heat exchanger 50 is changed (for example, a substantially joint portion between the front-side heat exchanger 51 and the back-side heat exchanger 55), and there may be a slight gap at such a joint portion.

Moreover, a right-side longitudinal cross section of the heat exchanger 50 may be formed entirely or partially in a curved shape (see FIG. 67).

Embodiment 31

[0266] In Embodiment 24 through Embodiment 30, the fan 20 may be arranged as follows. In Embodiment 31, points different from Embodiment 24 through Embodiment 30 will be mainly discussed, and the same portions as those of Embodiment 24 through Embodiment 30 are designated by like reference numerals.

[0267] FIG. 65 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 31 of the present invention. The arrangement of the fan 20 in the indoor unit 100 will be described below with reference to FIG. 65(a) through FIG. 65(c).

[0268] The arrangement of the heat exchanger 50 provided in the indoor unit 100 according to Embodiment 31 is similar to that of the indoor unit 100 of Embodiment 27. However, the indoor unit 100 according to Embodiment 31 is different from that of Embodiment 27 in the arrangement of the fan 20.

That is, in the indoor unit 100 according to Embodiment 31, the position of the fan 20 is decided in accordance with the amount of airflow or the heat transfer area of the front-side heat exchanger 51 and that of the back-side heat exchanger 55.

[0269] For example, in the state shown in FIG. 65(a) (the state in which the position of the rotational axis 20a of the fan 20 substantially coincides with the position of the symmetric line 50a as viewed from a right-side longitudinal cross section), the amount of airflow of the back-side heat exchanger 55 having a larger heat transfer area than the front-side heat exchanger 51 may become insufficient. If the amount of airflow of the back-side heat exchanger 55 becomes insufficient, the heat exchanger 50 (the front-side heat exchanger 51 and the back-side heat exchanger 55) may fail to achieve a desired level of heat exchange performance. In this case, the position of the fan 20 may be moved toward the backward direction, as shown in FIG. 65(b).

With this arrangement, the amount of airflow can be distributed in accordance with the heat transfer areas of the front-side heat exchanger 51 and the back-side heat exchanger 55, thereby improving the heat exchange performance of the heat exchanger 50 (the front-side heat exchanger 51 and the back-side heat exchanger 55).

[0270] Moreover, in the state shown in FIG. 65(a), for example, if the pressure loss of the back-side heat exchanger 55 is large, the amount of airflow of the back-side heat exchanger 55 becomes insufficient. Further, because of limitation of space within the casing 1, even if the amount of airflow is adjusted through the arrangement of the front-side heat exchanger 51 and the back-side heat exchanger 55, it may be difficult to adjust joined air of air passing through the front-side heat exchanger 51 and air passing through the back-side heat exchanger 55 at a desired angle.

If the amount of airflow of the back-side heat exchanger 55 becomes insufficient as described above, air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 may not be deflected at an angle as large as a desired angle. In this case, the position of the fan 20 may be moved toward the backward direction, as shown in FIG. 65(b).

[0271] With this configuration, it is possible to fine-control the amount of airflow of each of the front-side heat exchanger 51 and the back-side heat exchanger 55, thereby making it possible to deflect air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 at a desired angle. As a result, the flowing direction of air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 can be adjusted to a suitable direction in accordance with the position at which the air outlet 3 is formed.

[0272] There may also be a case in which the heat transfer area of the front-side heat exchanger 51 is larger than that of the back-side heat exchanger 55. In this case, the position of the fan 20 may be moved toward the front direction, as shown in FIG. 65(c).

With this arrangement, the amount of airflow can be distributed in accordance with the heat transfer areas of the front-side heat exchanger 51 and the back-side heat exchanger 55, thereby improving the heat exchange performance of the heat exchanger 50 (the front-side heat exchanger 51 and the back-side heat exchanger 55).

[0273] Additionally, in the state shown in FIG. 65(a), for example, there may be a case in which the amount of airflow of the back-side heat exchanger 55 becomes larger than necessary. Further, because of limitation of space within the casing 1, even if the amount of airflow is adjusted through the arrangement of the front-side heat exchanger 51 and the back-side heat exchanger 55, it may be difficult to adjust air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 at a desired angle.

Accordingly, air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 may be deflected at an angle greater than a desired angle. In this case, the position of the fan 20 may be moved toward the frontward direction, as shown in FIG. 65(c).

[0274] With this configuration, it is possible to fine-control the amount of airflow of each of the front-side heat exchanger 51 and the back-side heat exchanger 55, thereby making it possible to deflect air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 at a desired angle. As a result, the flowing direction of air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 can be adjusted to a suitable direction in accordance with the position at which the air outlet 3 is formed.

[0275] The heat exchanger 50 shown in FIG. 65 is formed in a substantially inverted V shape by using the front-side heat exchanger 51 and the back-side heat exchanger 55 which are separately formed. However, the heat exchanger 50 is not restricted to this configuration. For example, a right-side longitudinal cross section of the heat exchanger 50 may be formed in a substantially V shape, a substantially N shape, a substantially W shape, a substantially horizontally flipped N shape, or a substantially M shape. Alternatively, for example, the front-side heat exchanger 51 and the back-side heat exchanger 55 may be formed as an integral heat exchanger (see FIG. 67).

Alternatively, for example, each of the front-side heat exchanger 51 and the back-side heat exchanger 55 may be formed by a combination of a plurality of heat exchangers (see FIG. 67). In the case of an integral heat exchanger, the front side is the front-side heat exchanger 51 and the back side is the back-side heat exchanger 55 with respect to the symmetric line 50a. That is, the length of the heat exchanger disposed farther backward than the symmetric line 50a is set to be longer than that of the heat exchanger disposed farther forward than the symmetric line 50a.

Moreover, if each of the front-side heat exchanger 51 and the back-side heat exchanger 55 is formed by a combination of a plurality of heat exchangers, the total length of the plurality of heat exchangers forming the front-side heat exchanger 51 is the length of the front-side heat exchanger 51, and the total length of the plurality of heat exchangers forming the back-side heat exchanger 55 is the length of the back-side heat exchanger 55.

[0276] It is not necessary to tilt all of the heat exchangers forming the heat exchanger 50 as viewed from a right-side longitudinal cross section. Instead, some heat exchangers forming the heat exchanger 50 may be disposed vertically as viewed from a right-side longitudinal cross section (see FIG. 67).

Additionally, when the heat exchanger 50 is formed by a plurality of heat exchangers (for example, the front-side heat exchanger 51 and the back-side heat exchanger 55), it is not necessary that the heat exchangers be completely in contact with each other at a portion at which the gradient of the heat exchanger 50 is changed (for example, a substantially joint portion between the front-side heat exchanger 51 and the back-side heat exchanger 55), and there may be a slight gap at such a joint portion.

Moreover, a right-side longitudinal cross section of the heat exchanger 50 may be formed entirely or partially in a curved shape (see FIG. 67).

Embodiment 32

[0277] In Embodiment 24 through Embodiment 30, the fan 20 may be arranged as follows. In Embodiment 32, points different from Embodiment 24 through Embodiment 31 will be mainly discussed, and the same portions as those of Embodiment 24 through Embodiment 31 are designated by like reference numerals.

[0278] FIG. 66 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 32 of the present invention.

The arrangement of the heat exchanger 50 provided in the indoor unit 100 according to Embodiment 32 is similar to that of the indoor unit 100 of Embodiment 27. However, the indoor unit 100 according to Embodiment 31 is different from that of Embodiment 27 in the arrangement of the fan 20.

That is, in the indoor unit 100 according to Embodiment 32, the gradient of the fan 20 is determined in accordance with the amount of airflow or the heat transfer area of the front-side heat exchanger 51 and that of the back-side heat exchanger 55.

[0279] For example, the amount of airflow of the back-side heat exchanger 55 having a larger heat transfer area than the front-side heat exchanger 51 may become insufficient. Moreover, because of limitation of space within the casing 1, the amount of airflow may not be adjustable by moving the fan 20 in the forward or backward direction. If the amount of airflow of the back-side heat exchanger 55 becomes insufficient, the heat exchanger 50 (the front-side heat exchanger 51 and the back-side heat exchanger 55) may fail to achieve a desired level of heat exchange performance. In this case, as shown in FIG. 66, the fan 20 may be tilted toward the back-side heat exchanger 55, as viewed from a right-side longitudinal cross section.

With this arrangement, even if the fan 20 cannot be moved in the forward or backward direction, the amount of airflow can be distributed in accordance with the heat transfer areas of the front-side heat exchanger 51 and the back-side heat exchanger 55, thereby improving the heat exchange performance of the heat exchanger 50 (the front-side heat exchanger 51 and the back-side heat exchanger 55).

[0280] Moreover, for example, if the pressure loss of the back-side heat exchanger 55 is large, the amount of airflow of the back-side heat exchanger 55 may become insufficient. Further, because of limitation of space within the casing 1, even if the amount of airflow is adjusted through the arrangement of the front-side heat exchanger 51 and the back-side heat exchanger 55, it may be difficult to adjust air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 at a desired angle.

Moreover, because of limitation of space within the casing 1, the amount of airflow may not be adjustable by moving the fan 20 in the forward or backward direction. If the amount of airflow of the back-side heat exchanger 55 becomes insufficient as described above, air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 may not be deflected at an angle as large as a desired angle. In this case, as shown in FIG. 66, the fan 20 may be tilted toward the back-side heat exchanger 55, as viewed from a right-side longitudinal cross section.

[0281] With this configuration, even if the fan 20 cannot be moved in the forward or backward direction, it is possible to fine-control the amount of airflow of each of the front-side heat exchanger 51 and the back-side heat exchanger 55, thereby making it possible to deflect air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 at a desired angle. As a result, the flowing direction of air joined after passing through the front-side heat exchanger 51 and after passing through the back-side heat exchanger 55 can be adjusted to a suitable direction in accordance with the position at which the air outlet 3 is formed.

[0282] The heat exchanger 50 shown in FIG. 66 is formed in a substantially inverted V shape by using the front-side heat exchanger 51 and the back-side heat exchanger 55 which are separately formed. However, the heat exchanger 50 is not restricted to this configuration. For example, a right-side longitudinal cross section of the heat exchanger 50 may be formed in a substantially V shape, a substantially N shape, a substantially W shape, a substantially horizontally flipped N shape, or a substantially M shape.

Alternatively, for example, the front-side heat exchanger 51 and the back-side heat exchanger 55 may be formed as an integral heat exchanger (see FIG. 67). Alternatively, for example, each of the front-side heat exchanger 51 and the back-side heat exchanger 55 may be formed by a combination of a plurality of heat exchangers (see FIG. 67). In the case of an integral heat exchanger, the front side is the front-side heat exchanger 51 and the back side is the back-side heat exchanger 55 with respect to the symmetric line 50a. That is, the length of the heat exchanger disposed farther backward than the symmetric line 50a is set to be longer than that of the heat exchanger disposed farther forward than the symmetric line 50a.

Moreover, if each of the front-side heat exchanger 51 and the back-side heat exchanger 55 is formed by a combination of a plurality of heat exchangers, the total length of the plurality of heat exchangers forming the front-side heat exchanger 51 is the length of the front-side heat exchanger 51, and the total length of the plurality of heat exchangers forming the back-side heat exchanger 55 is the length of the back-side heat exchanger 55.

[0283] It is not necessary to tilt all of the heat exchangers forming the heat exchanger 50 as viewed from a right-side longitudinal cross section. Instead, some heat exchangers forming the heat exchanger 50 may be disposed vertically as viewed from a right-side longitudinal cross section (see FIG. 67).

Additionally, when the heat exchanger 50 is formed by a plurality of heat exchangers (for example, the front-side heat exchanger 51 and the back-side heat exchanger 55), it is not necessary that the heat exchangers be completely in contact with each other at a portion at which the gradient of the heat exchanger 50 is changed (for example, a substantially joint portion between the front-side heat exchanger 51 and the back-side heat exchanger 55), and there may be a slight gap at such a joint portion.

Moreover, a right-side longitudinal cross section of the heat exchanger 50 may be formed entirely or partially in a curved shape (see FIG. 67).

Embodiment 33

ANC

[0284] Another embodiment of the active noise cancellation method will be described below. In Embodiment 33, the same functions and configurations as those of Embodiment 1 through Embodiment 32 are designated by like reference numerals.

[0285] FIG. 68 is a longitudinal sectional view illustrating an indoor unit according to Embodiment 33 of the present invention. In FIG. 68, the right side of the drawing is the front side of the indoor unit 100.

The indoor unit 100 discussed in Embodiment 33 is different from that of Embodiment 1 in the following points. In Embodiment 1, control sound is produced in the signal processor 201 by using two microphones for performing active noise cancellation, that is, the noise detecting microphone 161 and the noise-cancellation effect detecting microphone 191. In the indoor unit 100 of Embodiment 33, these two microphones are replaced by one microphone, which is a noise/noise-cancellation effect detecting microphone 211. Accordingly, a signal processing method is also different, and thus, the content of a signal processor 204 is also different.

[0286] The control speaker 181 which outputs control sound for noise is provided on the wall portion below the fan 20 such that it faces the center of the flow channel. Below the control speaker 181, the noise/noise-cancellation effect detecting microphone 211 is provided. The noise/noise-cancellation effect detecting microphone 211 detects sound generated by causing control sound output from the control speaker 181 to interfere with noise propagating from the fan 20 through the flow channel and output from the air outlet 3. The control speaker 181 and the noise/noise-cancellation effect detecting microphone 211 are fixed between the fan 20 and the heat exchanger 50.

[0287] An output signal from the noise/noise-cancellation effect detecting microphone 211 is input into the signal processor 204, which serves as control sound generating means for generating a signal (control sound) for controlling the control speaker 181.

[0288] FIG. 69 is a block diagram illustrating the signal processor according to Embodiment 33 of the present invention. FIG. 69 illustrates a block diagram of the signal processor 204. An electric signal converted from an audio signal by the noise/noise-cancellation effect detecting microphone 211 is amplified by a microphone amplifier 151, and is converted from an analog signal to a digital signal by an A/D converter 152.

The converted digital signal is input into an LMS algorithm 159. Also, a difference signal between this converted digital signal and a signal generated by convoluting an FIR filter 160 on an output signal from an FIR filter 158 is input into the FIR filter 158 and the LMS algorithm 159. Then, the FIR filter 158 performs a convolution operation on the difference signal by using a tap coefficient calculated by the LMS algorithm 159. Then, the difference signal is converted from a digital signal to an analog signal by a D/A converter 154. The analog signal is then amplified by an amplifier 155, and is output from the control speaker 181 as control sound.

[0289] A method for reducing operating sound in the indoor unit 100 will now be discussed below. Sound generated by causing control sound output from the control speaker 181 to interfere with operating sound (noise) including air-sending sound of the fan 20 in the indoor unit 100 is detected by the noise/noise-cancellation effect detecting microphone 211 fixed between the fan 20 and the heat exchanger 50, and is converted into a digital signal through the microphone amplifier 151 and the A/D converter 152.

[0290] In order to perform an operating-sound reducing method equivalent to the operating-sound reducing method discussed in Embodiment 1, it is necessary that sound to be canceled be input into the FIR filter 158, and that sound generated by causing control sound, which is an error signal, to interfere with noise to be canceled, which is an input signal, be input into the LMS algorithm 159, as expressed by Equation (1). However, since the noise/noise-cancellation effect detecting microphone 211 only detects sound generated by causing control sound to interfere with noise to be canceled, it is necessary to produce noise to be canceled from sound detected by the noise/noise-cancellation effect detecting microphone 211.

[0291] FIG. 70 illustrates a waveform of sound generated by causing control sound to interfere with noise (**a** in FIG. 70), a waveform of control sound (**b** in FIG. 70), and a waveform of noise (**c** in FIG. 70). According to the principle of superposition of sound, b + c = a holds true, and thus, in order to obtain **c** from **a,** the difference between **a** and **b** is found, thereby obtaining **c.** That is, noise to be canceled can be produced from the difference between control sound and sound subjected to the interference processing which is detected by the noise/noise-cancellation effect detecting microphone 211.

[0292] FIG. 71 illustrates a path in which a control signal output from the FIR filter 158 is output from the control speaker 181 as control sound, and then, the control sound is detected by the noise/noise-cancellation effect detecting microphone 211 and is input into the signal processor 204. The signal passes through the D/A converter 154, the amplifier 155, the path from the control speaker 181 to the noise/noise-cancellation effect detecting microphone 211, the noise/noise-cancellation effect detecting microphone 211, the microphone amplifier 151, and the A/D converter 152.

[0293] If the transfer characteristic H of this path is indicated by H, the FIR filter 160 shown in FIG. 69 is a filter obtained by estimating this transfer characteristic H. By convoluting the FIR filter 160 on an output signal from the FIR filter 158, control sound can be estimated as a signal b detected by the noise/noise-cancellation effect detecting microphone 211. Then, the difference between the signal b and sound **a** subjected to interference processing which is detected by the noise/noise-cancellation effect detecting microphone 211 is found, thereby generating noise c to be canceled.

[0294] In this manner, noise c to be canceled is input into the LMS algorithm 159 and the FIR filter 158 as an input signal. After passing through the FIR filter 158 in which the tap coefficient has been updated by the LMS algorithm 159, the digital signal is converted into an analog signal by the D/A converter 154 and is amplified by the amplifier 155. The amplified analog signal is then output, as control sound, to the flow channel within the indoor unit 100 through the control speaker 181 fixed between the fan 20 and the heat exchanger 50.

[0295] Meanwhile, the noise/noise-cancellation effect detecting microphone 211, which is fixed below the control speaker 181, detects sound generated by causing control sound output from the control speaker 181 to interfere with noise propagating from the fan 20 through the flow channel and output from the air outlet 3. Sound detected by the noise/noise-cancellation effect detecting microphone 211 is input into the error signal of the above-described LMS algorithm 159. Accordingly, the tap coefficient of the FIR filter 158 is updated so that sound subjected to the interference processing may approximate to zero. As a result, noise near the air outlet 3 can be reduced by control sound passing through the FIR filter 158.

[0296] In this manner, in the indoor unit 100 to which an active noise cancellation method is applied, the noise/noise-cancellation effect detecting microphone 211 and the control speaker 181 are disposed between the fan 20 and the heat exchanger 50. Accordingly, members required for performing active noise cancellation do not have to be fixed to the area B in which condensation occurs, and thus, adhesion of water droplets to the control speaker 181 and the noise/noise-cancellation effect detecting microphone 211 can be avoided. As a result, degradation in the noise cancellation performance and faults of the speaker or the microphones can be prevented.

[0297] In Embodiment 33, the noise/noise-cancellation effect detecting microphone 211 is disposed on the upstream side of the heat exchanger 50. However, as shown in FIG. 72, the noise/noise-cancellation effect detecting microphone 211 may be disposed at the bottom portion of the indoor unit 100 where it is not exposed to air output from the air outlet 3 (at a position at which it can avoid airflow). Additionally, as detection means for detecting the noise cancellation effects after noise is canceled out with noise or control sound, a microphone is used by way of example.

However, an acceleration sensor for detecting vibration of the casing may be used. Alternatively, it is possible to consider sound as turbulence of airflow, and the noise cancellation effects after noise is canceled out with noise or control sound may be detected as turbulence of airflow. That is, as the detection means for detecting noise cancellation effects after noise is canceled out with noise or control sound, a flow velocity sensor, a hot wire probe, etc. for detecting airflow may be used. The airflow may also be detected by increasing the gain of the microphone.

[0298] In Embodiment 33, in the signal processor 204, the FIR filter 158 and the LMS algorithm 159 are used as an adaptive signal processing circuit of the signal processor 204. However, another type of adaptive signal processing circuit which approximates sound detected by the noise/noise-cancellation effect detecting microphone 211 to zero may be used, and a processing circuit using a filtered-X algorithm, which is generally used in an active noise cancellation method, may be employed. Moreover, in the signal processor 204, instead of performing adaptive signal processing, control sound may be generated by a fixed tap coefficient. Additionally, the signal processor 204 does not have to be a digital signal processing circuit, but may be an analog signal processing circuit.

[0299] In Embodiment 33, a description has been given of a case in which the heat exchanger 50 for performing air cooling which is likely to cause condensation is disposed. However, Embodiment 33 is also applicable when a heat exchanger for performing air cooling which is not likely to cause condensation is disposed. Regardless of whether condensation occurs in the heat exchanger 50, Embodiment 33 has the effect of preventing degradation in the performance of the noise/noise-cancellation effect detecting microphone 211, the control speaker 181, etc.

Embodiment 34

Fan Individual Control

[0300] By individually controlling the rotation speeds of the fans 20 provided in the indoor unit 100, noise cancellation effects of an active noise cancellation mechanism are further improved. In Embodiment 34, the same functions and configurations of Embodiment 1 through Embodiment 33 are designated by like reference numerals.

[0301] FIG. 73 is a front view illustrating an indoor unit according to Embodiment 34 of the present invention. FIG. 74 is a side view illustrating the indoor unit shown in FIG. 73. FIG. 74 illustrates the indoor unit as viewed in the direction of the hatched arrow of FIG. 73, and the side wall of the casing 1 of the indoor unit 100 is transparent in FIG. 74. In FIG. 74, a remote controller 280, a controller 281, and motor drivers 282A through 282C illustrated in FIG. 73 are not shown.

[0302] In the indoor unit shown in FIGs. 73 and 74, at the top portion of the indoor unit 100 (more specifically, at the top portion of the casing 1 of the indoor unit 100), the air inlet 2, which is open, is formed. At the bottom portion of the indoor unit 100 (more specifically, at the bottom portion of the casing 1 of the indoor unit 100), the air outlet 3, which is open, is formed. That is, in the indoor unit 100, a flow channel used for allowing the air inlet 2 and the air outlet 3 to communicate with each other is formed.

Then, under the air inlet 2 of the flow channel, a plurality of fans 20 each including an impeller 25 are disposed in the horizontal direction (longitudinal direction). In Embodiment 34, three fans (fans 20A through 20C) are provided. These fans 20A through 20C are provided such that the center of the rotational axis of the impeller 25 is substantially vertical. These fans 20A through 20C are connected to air-sending fan control means 171 of the controller 281 via the motor drivers 282A through 282C, respectively. Details of the controller 281 will be given later.

[0303] Below the fans 20A through 20C, the heat exchanger 50 which cools or heats air by performing a heat exchange operation is disposed. When the fans 20A through 20C start, as indicated by the empty arrows shown in FIG. 73, indoor air is sucked into the flow channel of the indoor unit 100 through the air inlet 2. Then, after this suction air is cooled or heated in the heat exchanger 50 disposed below the fans 20A through 20C, it is discharged to the indoor room through the air outlet 3.

[0304] The indoor unit 100 according to Embodiment 34 includes a noise cancellation mechanism used for performing active noise cancellation. The noise cancellation mechanism of the indoor unit 100 according to Embodiment 34 includes noise detecting microphones 161 and 162, control speakers 181 and 182, noise-cancellation effect detecting microphones 191 and 192, and signal processors 201 and 202. That is, the noise cancellation mechanism of the indoor unit 100 according to Embodiment 34 includes two noise detecting microphones, two control speakers, and two noise-cancellation effect detecting microphones.

Hereinafter, the noise cancellation mechanism including the noise detecting microphone 161, the control speaker 181, the noise-cancellation effect detecting microphone 191, and the signal processor 201 will be referred to as a "noise cancellation mechanism A". The noise cancellation mechanism including the noise detecting microphone 162, the control speaker 182, the noise-cancellation effect detecting microphone 192, and the signal processor 202 will be referred to as a "noise cancellation mechanism B".

[0305] The noise detecting microphones 161 and 162 are noise detecting devices which detect operating sound (noise) of the indoor unit 100 including air-sending sound of the fans 20A through 20C (noise output from the fans 20A through 20C). The noise detecting microphones 161 and 162 are provided at positions downstream of the fans 20A through 20C (for example, at positions between the fans 20A through 20C and the heat exchanger 50). The noise detecting microphone 161 is provided on the left side surface of the indoor unit 100, while the noise detecting microphone 162 is provided on the right side surface of the indoor unit 100.

[0306] The control speakers 181 and 182 are control sound output devices which output control sound for noise. The control speakers 181 and 182 are provided at positions downstream of the noise detecting microphones 161 and 162 (for example, at positions downstream of the heat exchanger 50), respectively. The control speaker 181 is provided on the left side surface of the indoor unit 100, while the control speaker 182 is provided on the right side surface of the indoor unit 100. The control speakers 181 and 182 are disposed such that they face the center of the flow channel as viewed from the wall surfaces of the casing 1 of the indoor unit 100.

[0307] The noise-cancellation effect detecting microphones 191 and 192 are noise-cancellation effect detecting devices which detect noise cancellation effects obtained by control sound. The noise-cancellation effect detecting microphones 191 and 192 are provided at positions downstream of the control speakers 181 and 182, respectively. The noise-cancellation effect detecting microphone 191 is provided substantially on a line extending from the rotational axis of the fan 20A, while the noise-cancellation effect detecting microphone 192 is provided substantially on a line extending from the rotational axis of the fan 20C. In Embodiment 34, the noise-cancellation effect detecting microphones 191 and 192 are provided on the nozzle 6 forming the air outlet 3. That is, the noise-cancellation effect detecting microphones 191 and 192 detect noise output from the air outlet 3 and detect noise cancellation effects.

[0308] The configuration of the signal processors 201 and 202 are exactly the same as that shown in FIG. 8 discussed in Embodiment 1.

[0309] FIG. 75 is a block diagram illustrating the controller according to Embodiment 34 of the present invention. Various operations and means described below are implemented by executing a program stored in the controller 281 included in the indoor unit 100. The controller 281 includes, as major parts, an input section 130 into which a signal from an external input device, such as the remote controller 280, is input, a CPU 131 that executes operations in accordance with a built-in program, and a memory 132 in which data and programs are stored. The CPU 131 includes the air-sending fan control means 171.

[0310] The air-sending fan control means 171 includes identical-rotation-speed determining means 133, fan-individual-control rotation speed determining means 134, and a plurality of SWs 135 (the same number as that of the fans 20). The identical-rotation-speed determining means 133 determines the rotation speed used for rotating all of the fans 20A through 20C at the same rotation speed, on the basis of operation information input from the remote controller 280. The operation information input from the remote controller 280 includes, for example, operation mode information indicating a cooling operation mode, a heating operation mode, or a dehumidifying operation mode, and also includes air amount information indicating the amount of air represented by the level, such as high, middle, or low.
The fan-individual-control rotation speed determining means 134 determines the rotation speed of each of the fans 20A through 20C when the rotation speeds of the fans 20A through 20C are individually controlled. The SWs 135 switch rotation control signals for the fans 20A through 20B to be supplied to the motor drivers 282A through 282C, respectively, on the basis of a signal input from, for example, the remote controller 280. That is, the SWs 135 determine whether the fans 20A through 20C are all operated at the same rotation speed or whether the fans 20A through 20C are individually operated at different rotation speeds.

[0311] The operation of the indoor unit 100 will now be described below.
When the indoor unit 100 starts, the impellers of the fans 20A through 20C rotate, and indoor air is sucked through the upper sides of the fans 20A through 20C and is supplied to the lower sides of the fans 20A through 20C, thereby generating airflow. Accordingly, operating sound (noise) is produced near the air outlets of the fans 20A through 20C and propagates toward the downstream side.
Air supplied from the fans 20A through 20C passes through the flow channel and is supplied to the heat exchanger 50. In the case of a cooling operation, for example, a low-temperature refrigerant is supplied from a pipe connected to an outdoor unit (not shown) to the heat exchanger 50. Air supplied to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 and is transformed into cool air, which is directly output to the indoor room through the air outlet 3.

[0312] The operation of the noise cancellation mechanism A and that of the noise cancellation mechanism B are exactly the same as that discussed in Embodiment 1. The noise cancellation mechanisms A and B are operated as follows. The noise cancellation mechanisms A and B respectively output control sound so that noise detected by the noise-cancellation effect detecting microphones 191 and 192 may approximate to zero, thereby reducing noise detected by the noise-cancellation effect detecting microphones 191 and 192.
In the active noise cancellation method, control sound is output from the control speakers 181 and 182 such that the phase thereof is opposite to the phase of noise at the positions (control points) at which the noise-cancellation effect detecting microphones 191 and 192, respectively, are disposed. Accordingly, noise cancellation effects are high around the noise-cancellation effect detecting microphones 191 and 192, but the phase of control sound changes as the position is farther away from the control points. Thus, at positions farther away from the noise-cancellation effect detecting microphones 191 and 192, the phase shift between noise and control sound becomes larger, thereby decreasing the noise cancellation effects.

[0313] A description will now be given of a control method for individually controlling the rotation speeds of the fans 20A through 20C (hereinafter may also referred to as "fan individual control").
Operation information selected by using the remote controller 280 is input into the controller 281. The operation information is operation mode information indicating a cooling operation mode, a heating operation mode, or a dehumidifying operation mode. Additionally, as the operation information, air amount information indicating the amount of air represented by the level, such as high, middle, or low, is also input into the controller 281 from the remote controller 280.
The operation information input into the controller 281 is input into the identical-rotation-speed determining means 133 through the input section 130. Upon receiving the operation information, the identical-rotation-speed determining means 133 determines, on the basis of the received operation information, the rotation speed used for operating all of the fans 20A through 20C at the same operation speed. If fan individual control is not performed, the fans 20A through 20C are all controlled at the same rotation speed (hereinafter may also referred to as "identical rotation speed control").

[0314] Information concerning the rotation speed determined by the identical-rotation-speed determining means 133 (rotation speed used for performing identical rotation speed control) is input into the fan-individual-control rotation speed determining means 134. The fan-individual-control rotation speed determining means 134 also reads air-sending fan information which was stored in the memory 132 at the time of the shipping of the product.
This air-sending fan information is information concerning the fans 20 that output noise which is highly likely to be

canceled when control sound is caused to interfere with the noise. That is, this air-sending fan information indicates information concerning the fans 20 which are highly related to the noise-cancellation effect detecting microphones 191 and 192. The identification numbers of such fans are associated with the noise-cancellation effect detecting microphones in a one-to-one correspondence.
In Embodiment 34, as air-sending fan information, the identification numbers of the fans 20 which are positioned closest to (most highly related to) the noise-cancellation effect detecting microphones 191 and 192 are used. More specifically, the identification number of the fan 20A which is positioned closest to the noise-cancellation effect detecting microphone 191 and the identification number of the fan 20C which is positioned closest to the noise-cancellation effect detecting microphone 192 are used.

[0315] The fan-individual-control rotation speed determining means 134 determines the rotation speeds of the individual fans 20 used for performing fan individual control, on the basis of the rotation speed information determined by the identical-rotation-speed determining means 133 and the air-sending fan information read from the memory 132. More specifically, the fan-individual-control rotation speed determining means 134 increases the rotation speeds of the fans 20A and 20C positioned closer to the noise-cancellation effect detecting microphones 191 and 192, respectively, and decreases the rotation speed of the fan 20B positioned farther away from the noise-cancellation effect detecting microphones 191 and 192.
In this case, the fan-individual-control rotation speed determining means 134 may determine the rotation speeds of the individual fans 20A through 20C so that the amount of air obtained when fan individual control is performed will become the same as that when identical rotation speed control is performed. The amount of air and the rotation speed are proportional to each other. Thus, in the configuration shown in FIG. 73, for example, if each of the rotation speeds of the fans 20A and 20C is increased by 10 %, the rotation speed of the fan 20B is decreased by 20 %. Then, the amount of air when fan individual control is performed becomes the same as that when identical rotation speed control is performed.

[0316] If an operation information signal indicating that fan individual control will be performed (for example, a low-noise mode signal) is input from the remote controller 280, the SWs 135 are switched so that rotation control signals indicating that identical rotation speed control will be performed may be switched to rotation control signals indicating that fan individual control will be performed.
These rotation control signals are output from the controller 281 to the fans 20A through 20C. The rotation control signals output from the controller 281 are input into the motor drivers 282A through 282C, and the fans 20A through 20C are controlled so that they may be operated at rotation speeds in accordance with the rotation control signals.

[0317] As stated above, when active noise cancellation is performed, noise cancellation effects become high at and around the noise-cancellation effect detecting microphones 191 and 192, which serve as control points of noise control, but at positions farther away from the control points, the phase shift between control sound and noise output from the control speakers 181 and 182 becomes larger, thereby decreasing the noise cancellation effects.
However, in the configuration of Embodiment 34, since the indoor unit 100 includes the plurality of fans 20A through 20C, the rotation speeds of the fans 20A and 20C (fans that output noise which is likely to be canceled) positioned closer to the noise-cancellation effect detecting microphones 191 and 192 which exhibit high noise cancellation effects, respectively, can be increased, and the rotation speed of the fan 20B (fan that outputs noise which is not likely to be canceled) positioned farther away from the noise-cancellation effect detecting microphones 191 and 192 can be decreased.

[0318] As a result, in the indoor unit 100 according to Embodiment 34, in an area where noise cancellation effects are high, noise cancellation effects become even higher, and in an area where noise cancellation effects are low, noise becomes smaller. It is thus possible to further reduce noise output from the air outlet 3, as a whole, compared with an indoor unit which uses a single fan or an indoor unit which does not perform fan individual control. Moreover, the rotation speeds of the plurality of fans 20A through 20C are controlled so that the amount of air may become constant, and thus, noise reduction can be implemented without causing degradation in aerodynamic performance.

[0319] Further, as shown in FIGs. 76 and 77, the flow channel of the indoor unit 100 is divided into a plurality of regions, thereby making it possible to further improve noise cancellation effects.

[0320] FIG. 76 is a front view illustrating another example of an indoor unit according to Embodiment 34 of the present invention. FIG. 77 is a left side view illustrating the indoor unit shown in FIG. 76. In FIG. 77, the side wall of the casing 1 of the indoor unit 100 is transparent. In the indoor unit 100 shown in FIGs. 76 and 77, the flow channel is divided by partition boards 90 and 90a so that it may be separated into a region through which air is blown out of the fan 20A passes, a region through which air is blown out of the fan 20B passes, and a region through which air is blown out of the fan 20C passes.
Then, the noise detecting microphone 161, the control speaker 181, and the noise-cancellation effect detecting microphone 191 of the noise cancellation mechanism A are positioned in the region through which air blown out of the fan 20A passes. The noise detecting microphone 162, the control speaker 182, and the noise-cancellation effect detecting microphone 192 of the noise cancellation mechanism B are positioned in the region through which air blown out of the

fan 20C passes.

[0321] By forming the indoor unit 100 as described above, noise components output from the fans 20A through 20C can be separated into the respective regions, and the noise cancellation mechanism A reduces noise only output from the fan 20A, while the noise cancellation mechanism B reduces noise only output from the fan 20C. This prevents noise output from the fan 20B from being detected by the noise detecting microphones 161 and 162 and the noise-cancellation effect detecting microphones 191 and 192, thereby decreasing crosstalk noise components of the noise detecting microphones 161 and 162 and the noise-cancellation effect detecting microphones 191 and 192.

[0322] Moreover, since the flow channel becomes closer to a duct structure, noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby increasing noise cancellation effects. Additionally, by decreasing the rotation speed of the fan 20B, which is not provided with a noise cancellation mechanism, noise in an area where a noise cancellation mechanism is not provided can be reduced.

Thus, by forming the indoor unit 100 as shown in FIGs. 76 and 77, noise can be further reduced compared with the configuration shown in FIG. 73. In FIGs. 76 and 77, partition boards are inserted in the entire flow channel. However, only part of the flow channel, for example, only the upstream side or the downstream side of the heat exchanger 50, may be divided by using partition boards.

[0323] In Embodiment 34, the noise detecting microphones 161 and 162 are each mounted on either side surface of the indoor unit 100. However, the noise detecting microphones 161 and 162 may be mounted at any positions as long as they are mounted on the upstream side of the control speakers 181 and 182, respectively. In Embodiment 34, the control speakers 181 and 182 are each mounted on either side surface of the indoor unit 100. However, the control speakers 181 and 182 may be respectively mounted at any positions as long as they are mounted on the downstream side of the noise detecting microphones 161 and 162 and on the upstream side of the noise-cancellation effect detecting microphones 191 and 192.

In Embodiment 34, the noise-cancellation effect detecting microphones 191 and 192 are disposed substantially on lines extending from the rotational axes of the fans 20A and 20C, respectively. However, the noise-cancellation effect detecting microphones 191 and 192 may be mounted at any positions as long as they are on the downstream side of the control speakers 181 and 182, respectively. In Embodiment 34, two noise detecting microphones, two control speakers, two noise-cancellation effect detecting microphones, and two signal processors are provided. However, Embodiment 34 is not restricted to this configuration.

[0324] In Embodiment 34, the air-sending fan control means 171 is constituted by the CPU 131 within the controller 281. However, the air-sending fan control means 171 may be constituted by hardware, such as a LSI (Large Scale Integration) or a FPGA (Field Programmable Gate Array). Moreover, the configuration of the air-sending fan control means 171 is not restricted to the configuration shown in FIG. 75.

[0325] In Embodiment 34, the air-sending fan control means 171 is configured so that the rotation speeds of the fans 20A and 20C positioned closer to the noise-cancellation effect detecting microphones 191 and 192, respectively, may be increased and so that the rotation speed of the fan 20B positioned farther away from the noise-cancellation effect detecting microphones 191 and 192 may be decreased. However, the air-sending fan control means 171 may be configured so that the rotation speeds of the fans 20A and 20C will be increased or so that the rotation speed of the fan 20B will be decreased.

[0326] As described above, in the indoor unit 100 according to Embodiment 34, the plurality of fans 20A through 20C are provided, and the controller 281 (more specifically, the air-sending fan control means 171) which individually controls the rotation speeds of the fans 20A through 20C is provided. The air-sending fan control means 171 controls the rotation speeds of the fans 20A through 20C so that the rotation speeds of the fans 20A and 20C that send air to an area near the noise-cancellation effect detecting microphones 191 and 192, respectively, where noise cancellation effects are high may be increased, and so that the rotation speed of the fan 20B that sends air to an area farther away from the noise-cancellation effect detecting microphones 191 and 192 where noise cancellation effects are low may be decreased.

Accordingly, in an area where the noise cancellation effects are high, noise cancellation effects become even higher, and in an area where noise cancellation effects are low, noise becomes smaller. It is thus possible to obtain higher noise reduction effects than an indoor unit which has a noise cancellation mechanism having the same configuration as that of Embodiment 34 but uses only a single fan or an indoor unit which does not perform fan individual control.

[0327] Additionally, the air-sending fan control means 171 controls the rotation speeds of the fans 20A through 20C so that the amount of air output from the air outlet 3 when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce noise without causing degradation in aerodynamic performance.

[0328] Moreover, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated, and the noise cancellation mechanism A reduces noise only output from the fan 20A, while the noise cancellation mechanism B reduces noise only output from the fan 20C. This decreases crosstalk noise components caused by noise output from the fan 20B.

[0329] Further, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, the flow channel becomes closer to a duct structure, and noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller.
Additionally, by reducing the rotation speed of the fan 20B, which is not provided with a noise cancellation mechanism, noise in an area where a noise cancellation mechanism is not provided can be reduced. Thus, even higher noise reduction effects can be obtained compared with the configuration shown in FIG. 73.

Embodiment 35

[0330] Fan individual control may be performed without having to restrict to the configuration of Embodiment 34, on the basis of noise cancellation effects detected by noise-cancellation effect detecting microphones. In Embodiment 35, points different from Embodiment 34 will be mainly discussed, and the same portions as those of Embodiment 34 are designated by like reference numerals.
[0331] FIG. 78 is a front view illustrating an indoor unit according to Embodiment 35 of the present invention.
The indoor unit 100 according to Embodiment 35 is different from that of Embodiment 34 in that a noise cancellation mechanism C (a noise detecting microphone 163, a control speaker 183, a noise-cancellation effect detecting microphone 193, and a signal processor 203) is provided. The configuration of the signal processor 203 is exactly the same as that of the signal processor 201 or 202. As in Embodiment 34, the noise detecting microphone 163, the control speaker 183, and the noise-cancellation effect detecting microphone 193 may be mounted at any positions as long as they are mounted in the order of the noise detecting microphone 163, the control speaker 183, and the noise-cancellation effect detecting microphone 193 toward the downstream side from the position of the fan 20B.
[0332] The indoor unit 100 of Embodiment 35 is also different from that of Embodiment 34 in that signal lines (signal lines through which signals S1, S2, and S3 are supplied) connected from the signal processors 201, 203, and 202, respectively, to air-sending fan control means 172 are provided. Accordingly, the configuration of the air-sending fan control means 172 is also different from that of the air-sending fan control means 171 according to Embodiment 34.
More specifically, the signals S1, S2, and S3 sent from the signal processors 201, 203, and 202, respectively, to the air-sending fan control means 172 are digital signals converted by the A/D converters 152 from signals input from the noise-cancellation effect detecting microphones 191, 193, and 192, respectively, via the microphone amplifiers 151. That is, the signals S1, S2, and S3 indicate digital values having sound pressure levels detected by the noise-cancellation effect detecting microphones 191, 193, and 192, respectively.
[0333] The configuration of the air-sending fan control means 172 will be discussed below.
FIG. 79 is a block diagram illustrating the controller according to Embodiment 35 of the present invention. Various operations and means described below are implemented by executing a program stored in the controller 281 included in the indoor unit 100. As in the configuration discussed in Embodiment 34, the controller 281 includes, as major parts, an input section 130 into which a signal from an external input device, such as the remote controller 280, is input, a CPU 131 that executes operations in accordance with a built-in program, and a memory 132 in which data and programs are stored. The CPU 131 includes the air-sending fan control means 172.
[0334] The air-sending fan control means 172 includes identical-rotation-speed determining means 133, a plurality of averaging means 136 (the same number as that of noise-cancellation effect detecting microphones), fan-individual-control rotation speed determining means 134A, and a plurality of SWs 135 (the same number as that of the fans 20).
The identical-rotation-speed determining means 133 determines the rotation speed used for rotating all of the fans 20A through 20C at the same rotation speed, on the basis of operation information input from the remote controller 280.
The operation information input from the remote controller 280 includes, for example, operation mode information indicating a cooling operation mode, a heating operation mode, or a dehumidifying operation mode, and also includes air amount information indicating the amount of air represented by the level, such as high, middle, or low. The averaging means 136 receive digital values S 1, S2, and S3 indicating sound pressure levels detected by the noise-cancellation effect detecting microphones 191, 193, and 192, respectively, and perform an averaging operation on these signals S1, S2, and S3 for a certain period of time.
[0335] The fan-individual-control rotation speed determining means 134A determines the rotation speed of each of the fans 20A through 20C when the rotation speeds of the fans 20A through 20C are individually controlled, on the basis of each of the signals S 1, S2, and S3 averaged by the averaging means 136 and the rotation speed information input from the identical-rotation-speed determining means 133. The SWs 135 switch rotation control signals for the fans 20A through 20C to be supplied to the motor drivers 282A through 282C, respectively, on the basis of a signal input from, for example, the remote controller 280.
That is, the SWs 135 determine whether the fans 20A through 20C are all operated at the same rotation speed (whether identical rotation speed control is performed) or whether the fans 20A through 20C are individually operated at different rotation speeds (whether fan individual control is performed).

[0336] The operation of the indoor unit 100 will now be described below.
As in Embodiment 34, when the indoor unit 100 starts, the impellers of the fans 20A through 20C rotate, and indoor air is sucked through the upper sides of the fans 20A through 20C and is supplied to the lower sides of the fans 20A through 20C, thereby generating airflow. Accordingly, operating sound (noise) is produced near the air outlets of the fans 20A through 20C and propagates toward the downstream side.
Air supplied from the fans 20A through 20C passes through the flow channel and is supplied to the heat exchanger 50. In the case of a cooling operation, for example, a low-temperature refrigerant is supplied from a pipe connected to an outdoor unit (not shown) to the heat exchanger 50. Air supplied to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 and is transformed into cool air, which is directly output to the indoor room through the air outlet 3.
[0337] The operation of the noise cancellation mechanisms A through C are exactly the same as that discussed in Embodiment 34. The noise cancellation mechanisms A through C are operated as follows. The noise cancellation mechanisms A through C respectively output control sound so that noise detected by the noise-cancellation effect detecting microphones 191 through 193 may approximate to zero, thereby reducing noise detected by the noise-cancellation effect detecting microphones 191 through 193.
[0338] In the indoor unit 100 according to Embodiment 35, not only noise output from the fan 20B, but also noise (crosstalk noise components) output from the adjacent fans 20A and 20C, is input into the noise-cancellation effect detecting microphone 193. In contrast, crosstalk noise components detected by the noise-cancellation effect detecting microphones 191 and 192 are smaller than those detected by the noise-cancellation effect detecting microphone 193. This is because the noise-cancellation effect detecting microphones 191 and 192 have only one adjacent fan (fan 20B). Thus, noise cancellation effects of the noise cancellation mechanisms A and B become higher than the noise cancellation mechanism C.
[0339] Fan individual control to be performed on the fans 20A through 20C according to Embodiment 35 will now be described below.
Operation information selected by using the remote controller 280 is input into the controller 281. As described above, the operation information is operation mode information indicating a cooling operation mode, a heating operation mode, or a dehumidifying operation mode. Additionally, as the operation information, air amount information indicating the amount of air represented by the level, such as high, middle, or low, is also input into the controller 281 from the remote controller 280.
The operation information input into the controller 281 is input into the identical-rotation-speed determining means 133 through the input section 130. Upon receiving the operation information, the identical-rotation-speed determining means 133 determines, on the basis of the received operation information, the rotation speed used for operating all of the fans 20A through 20C at the same operation speed.
[0340] Meanwhile, S1 through S3 (digital values indicating sound pressure levels detected by the noise-cancellation effect detecting microphones 191, 193, and 192, respectively) input from the signal processors 201, 203, and 202, respectively, into the averaging means 136 are averaged for a certain period of time by the respective averaging means 136.
[0341] Information concerning the sound pressure level averaged from each of S1 through S3 and information concerning the rotation speed determined by the identical-rotation-speed determining means 133 (rotation speed used for performing identical rotation speed control) are input into the fan-individual-control rotation speed determining means 134A. The fan-individual-control rotation speed determining means 134A determines the rotation speeds of the fans 20 used for performing fan individual control, on the basis of these items of information.
More specifically, the fan-individual-control rotation speed determining means 134A determines the rotation speeds of the fans so that the rotation speed of a fan positioned close to (highly related to) the noise-cancellation effect detecting microphone which has detected a smaller averaged sound pressure level may be increased, and so that the rotation speed of a fan positioned close to (highly related to) the noise-cancellation effect detecting microphone which has detected a larger averaged sound pressure level may be decreased.
In this case, the fan-individual-control rotation speed determining means 134A may determine the rotation speeds of the individual fans 20A through 20C so that the amount of air obtained when fan individual control is performed will become the same as that when identical rotation speed control is performed.
[0342] In the indoor unit 100 according to Embodiment 35, for example, if the average value of the noise levels detected by the noise-cancellation effect detecting microphone 191 is 45 dB, if the average value of the noise levels detected by the noise-cancellation effect detecting microphone 192 is 45 dB, and if the average value of the noise levels detected by the noise-cancellation effect detecting microphone 193 is 50 dB, the fan-individual-control rotation speed determining means 134A determines the rotation speeds of the fans 20 so that the rotation speeds of the fans 20A and 20C may be increased and so that the rotation speed of the fan 20B may be decreased.
The amount of air and the rotation speed are proportional to each other. Thus, in the configuration shown in FIG. 78, for example, if each of the rotation speeds of the fans 20A and 20C is increased by 10 %, the rotation speed of the fan

20B is decreased by 20 %. Then, the amount of air when fan individual control is performed becomes the same as that when identical rotation speed control is performed.

[0343] The above-described approach to determining the rotation speeds of the fans 20A through 20C is only an example. For example, if the average value of the noise levels detected by the noise-cancellation effect detecting microphone 191 is 45 dB, if the average value of the noise levels detected by the noise-cancellation effect detecting microphone 192 is 47 dB, and if the average value of the noise levels detected by the noise-cancellation effect detecting microphone 193 is 50 dB, the rotation speeds of the fans 20 may be determined so that the rotation speed of the fan 20A will be increased, so that the rotation speed of the fan 20B will be decreased, and so that the rotation speed of the fan 20C will remain the same.

That is, the rotation speeds of the fans 20 may be determined so that the rotation speed of the fan 20A positioned close to the noise-cancellation effect detecting microphone 191 which has detected the smallest noise level will be increased, and so that the rotation speed of the fan 20B positioned close to the noise-cancellation effect detecting microphone 193 which has detected the largest noise level will be decreased, and so that the rotation speed of the fan 20C positioned close to the noise-cancellation effect detecting microphone 192 which has detected neither of the smallest noise level nor the largest noise level will remain the same.

[0344] If an operation information signal indicating that fan individual control will be performed (for example, a low-noise mode signal) is input from the remote controller 280, the SWs 135 are switched so that rotation control signals indicating that identical rotation speed control will be performed may be switched to rotation control signals indicating that fan individual control will be performed. These rotation control signals are output from the controller 281 to the fans 20A through 20C. The rotation control signals output from the controller 281 are input into the motor drivers 282A through 282C, and the fans 20A through 20C are controlled so that they may be operated at rotation speeds in accordance with the rotation control signals.

[0345] As stated above, in the indoor unit 100 according to Embodiment 35, because of the difference in the amount of crosstalk noise components from adjacent fans, noise cancellation effects in areas around the noise-cancellation effect detecting microphones 191 and 192 become higher than those in an area around the noise-cancellation effect detecting microphone 193. That is, in the indoor unit 100 according to Embodiment 35, the noise levels detected in the areas around the noise-cancellation effect detecting microphones 191 and 192 become smaller than those detected in the area around the noise-cancellation effect detecting microphone 193.

In contrast, the noise cancellation effects in the area around the noise-cancellation effect detecting microphone 193 are low. Accordingly, in the indoor unit 100 including the plurality of fans 20A through 20C according to Embodiment 35, among the averaged noise level values detected by the noise-cancellation effect detecting microphones 191 through 193, the rotation speeds of the fans 20A and 20C positioned close to the noise-cancellation effect detecting microphones 191 and 192, respectively, which have detected smaller averaged noise levels are increased, and the rotation speed of the fan 20B positioned close to the noise-cancellation effect detecting microphone 193 which has detected a larger averaged noise level is decreased.

[0346] As a result, in the indoor unit 100 according to Embodiment 35, in an area where noise cancellation effects are high, noise cancellation effects become even higher, and in an area where noise cancellation effects are low, noise becomes smaller. It is thus possible to further reduce noise output from the air outlet 3, as a whole, compared with an indoor unit which uses a single fan or an indoor unit which does not perform fan individual control.

[0347] Further, as shown in FIGs. 80 and 81, the flow channel of the indoor unit 100 is divided into a plurality of regions, thereby making it possible to further improve noise cancellation effects.

[0348] FIG. 80 is a front view illustrating another example of an indoor unit according to Embodiment 35 of the present invention. FIG. 81 is a left side view illustrating the indoor unit shown in FIG. 80. In FIG. 81, the side wall of the casing 1 of the indoor unit 100 is transparent. In the indoor unit 100 shown in FIGs. 80 and 81, the flow channel is divided by partition boards 90 and 90a so that it may be separated into a region through which air blown out of the fan 20A passes, a region through which air blown out of the fan 20B passes, and a region through which air blown out of the fan 20C passes. Then, the noise detecting microphone 161, the control speaker 181, and the noise-cancellation effect detecting microphone 191 of the noise cancellation mechanism A are positioned in the region through which air blown out of the fan 20A passes. The noise detecting microphone 162, the control speaker 182, and the noise-cancellation effect detecting microphone 192 of the noise cancellation mechanism B are positioned in the region through which air blown out of the fan 20C passes. The noise detecting microphone 163, the control speaker 183, and the noise-cancellation effect detecting microphone 193 of the noise cancellation mechanism C are positioned in the region through which air blown out of the fan 20B passes.

[0349] By forming the indoor unit 100 as described above, noise components output from the fans 20A through 20C can be separated into the respective regions, and the noise cancellation mechanism A reduces noise only output from the fan 20A, the noise cancellation mechanism B reduces noise only output from the fan 20C, and the noise cancellation mechanism C reduces noise only output from the fan 20B. With this configuration, crosstalk noise components (noise output from a fan provided in an adjacent flow channel) detected by the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193 are decreased.

[0350] Moreover, since the flow channel becomes closer to a duct structure, noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby increasing noise cancellation effects. Thus, by forming the indoor unit 100 as shown in FIGs. 80 and 81, noise can be further reduced compared with the configuration shown in FIG. 78. In FIGs. 80 and 81, partition boards are inserted in the entire flow channel. However, only part of the flow channel, for example, only the upstream side or the downstream side of the heat exchanger 50, may be divided by using partition boards. Additionally, as in Embodiment 34, even if there is a fan 20 which is not provided with a noise cancellation mechanism (in FIG. 82, the fan 20B is not provided with the noise cancellation mechanism C), the rotation speed of such a fan 20 is decreased, thereby reducing noise in an area where a noise cancellation mechanism is not provided. As a result, effects similar to those described above can be obtained.

[0351] The noise detecting microphones 161 through 163 may be mounted at any positions as long as they are mounted on the upstream side of the control speakers 181 through 183, respectively. The control speakers 181 through 183 may be respectively mounted at any positions as long as they are mounted on the downstream side of the noise detecting microphones 161 through 163 and on the upstream side of the noise-cancellation effect detecting microphones 191 through 193. In Embodiment 35, the noise-cancellation effect detecting microphones 191 through 193 are disposed substantially on lines extending from the rotational axes of the fans 20A, 20C, and 20B, respectively. However, the noise-cancellation effect detecting microphones 191 through 193 may be mounted at any positions as long as they are on the downstream side of the control speakers 181 through 183, respectively. In Embodiment 35, two or three noise detecting microphones, two or three control speakers, two or three noise-cancellation effect detecting microphones, and two or three signal processors are provided. However, Embodiment 35 is not restricted to this configuration.

[0352] In Embodiment 35, the air-sending fan control means 172 is constituted by the CPU 131 within the controller 281. However, the air-sending fan control means 172 may be constituted by hardware, such as a LSI (Large Scale Integration) or a FPGA (Field Programmable Gate Array). Moreover, the configuration of the air-sending fan control means 172 is not restricted to the configuration shown in FIG. 79.

[0353] In Embodiment 35, the air-sending fan control means 172 is configured so that the rotation speeds of the fans 20A and 20C positioned close to the noise-cancellation effect detecting microphones 191 and 192, respectively, which have detected smaller noise levels may be increased and so that the rotation speed of the fan 20B positioned close to the noise-cancellation effect detecting microphone 193 which has detected larger noise levels may be decreased. However, the air-sending fan control means 172 may be configured so that the rotation speeds of the fans 20A and 20C will be increased or so that the rotation speed of the fan 20B will be decreased.

[0354] As described above, in the indoor unit 100 according to Embodiment 35, the plurality of fans 20A through 20C are provided, and the controller 281 (more specifically, the air-sending fan control means 172) which individually controls the rotation speeds of the fans 20A through 20C is provided. The air-sending fan control means 172 controls the rotation speeds so that, among averaged noise levels detected by the noise-cancellation effect detecting microphones 191 through 193, the rotation speed of a fan positioned close to a noise-cancellation effect detecting microphone which has detected an averaged smaller noise level may be increased, and so that the rotation speed of a fan positioned close to a noise-cancellation effect detecting microphone which has detected an averaged larger noise level may be decreased. Accordingly, in an area where noise cancellation effects are high (that is, noise levels are smaller), noise cancellation effects become even higher, and in an area where noise cancellation effects are low (that is, noise levels are larger), noise becomes smaller. It is thus possible to further reduce noise compared with an indoor unit which has a noise cancellation mechanism having the same configuration as that of Embodiment 35 but uses only a single fan or an indoor unit which does not perform fan individual control.

[0355] Additionally, the air-sending fan control means 172 controls the rotation speeds of the fans 20A through 20C so that the amount of air output from the air outlet 3 when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce noise without causing degradation in aerodynamic performance.

[0356] Moreover, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated, and the noise cancellation mechanism A reduces noise only output from the fan 20A, the noise cancellation mechanism B reduces noise only output from the fan 20C, and the noise cancellation mechanism C reduces noise only output from the fan 20B. With this configuration, in each region, crosstalk noise components caused by noise output to an adjacent region can be decreased.

[0357] Further, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, the flow channel becomes closer to a duct structure, and noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby making it possible to obtain even higher noise reduction effects than the configuration shown in FIG. 78. Additionally, even if there is a fan 20 which is not provided with a noise cancellation mechanism, such as that shown in FIG. 82, the rotation speed of such a fan 20 is decreased, thereby reducing noise in an area where a noise cancellation mechanism is not provided. As a result, effects similar to those described above can be obtained.

Embodiment 36

[0358] When performing fan individual control in accordance with noise cancellation effects detected by noise-cancellation effect detecting microphones, fan individual control may be performed, for example, in the following manner. In Embodiment 36, points different from Embodiment 34 or Embodiment 35 will be mainly discussed, and the same portions as those of Embodiment 34 or Embodiment 35 are designated by like reference numerals.

[0359] FIG. 83 is a front view illustrating an indoor unit according to Embodiment 36 of the present invention. The indoor unit 100 according to Embodiment 36 is different from that of Embodiment 35 in that signal lines (signal lines through which signals T1, T2, and T3 are supplied) connected from the signal processors 201, 203, and 202, respectively, to air-sending fan control means 173 are further provided. Accordingly, the configuration of the air-sending fan control means 173 is also different from that of the air-sending fan control means 172 according to Embodiment 35.

More specifically, as in Embodiment 35, the signals S1, S2, and S3 sent from the signal processors 201, 203, and 202, respectively, to the air-sending fan control means 173 are digital signals converted by the A/D converters 152 from signals input from the noise-cancellation effect detecting microphones 191, 193, and 192, respectively, via the microphone amplifiers 151. That is, the signals S1, S2, and S3 are digital values indicating sound pressure levels detected by the noise-cancellation effect detecting microphones 191, 193, and 192, respectively.

Further, the newly added signals T1, T2, and T3 are digital signals converted by the A/D converters 152 from signals input from the noise detecting microphones 161, 163, and 162, respectively, via the microphone amplifiers 151. That is, the signals T1, T2, and T3 are digital values indicating sound pressure levels detected by the noise detecting microphones 161, 163, and 162, respectively.

[0360] The configuration of the air-sending fan control means 173 will be discussed below.

FIG. 84 is a block diagram illustrating the controller according to Embodiment 36 of the present invention. Various operations and means described below are implemented by executing a program stored in the controller 281 included in the indoor unit 100. As in the configuration discussed in Embodiment 35, the controller 281 includes, as major parts, an input section 130 into which a signal from an external input device, such as the remote controller 280, is input, a CPU 131 that executes operations in accordance with a built-in program, and a memory 132 in which data and programs are stored. The CPU 131 includes the air-sending fan control means 173.

[0361] The air-sending fan control means 173 includes identical-rotation-speed determining means 133, a plurality of coherence calculating means 137 (the same number as that of noise-cancellation effect detecting microphones), fan-individual-control rotation speed determining means 134B, and a plurality of SWs 135 (the same number as that of the fans 20). The identical-rotation-speed determining means 133 determines the rotation speed used for rotating all of the fans 20A through 20C at the same rotation speed, on the basis of operation information input from the remote controller 280.

The operation information input from the remote controller 280 includes, for example, operation mode information indicating a cooling operation mode, a heating operation mode, or a dehumidifying operation mode, and also includes air amount information indicating the amount of air represented by the level, such as high, middle, or low.

The coherence calculating means 137 receive digital values S1, S2, and S3 indicating sound pressure levels detected by the noise-cancellation effect detecting microphones 191, 193, and 192, respectively, and digital values T1, T2, and T3 indicating sound pressure levels detected by the noise detecting microphones 161, 163, and 162, respectively. The coherence calculating means 137 calculate coherence between S1 and T1, S2 and T2, and S3 and T3.

[0362] The fan-individual-control rotation speed determining means 134B determines the rotation speed of each of the fans 20A through 20C when the rotation speeds of the fans 20A through 20C are individually controlled, on the basis of coherence values calculated by the coherence calculating means 137 and the rotation speed information input from the identical-rotation-speed determining means 133.

The SWs 135 switch rotation control signals for the fans 20A through 20C to be supplied to the motor drivers 282A through 282C, respectively, on the basis of a signal input from, for example, the remote controller 280. That is, the SWs 135 determine whether the fans 20A through 20C are all operated at the same rotation speed (whether identical rotation speed control is performed) or whether the fans 20A through 20C are individually operated at different rotation speeds (whether fan individual control is performed).

[0363] The operation of the indoor unit 100 will now be described below.

As in Embodiment 35, when the indoor unit 100 starts, the impellers of the fans 20A through 20C rotate, and indoor air is sucked through the upper sides of the fans 20A through 20C and is supplied to the lower sides of the fans 20A through 20C, thereby generating airflow. Accordingly, operating sound (noise) is produced near the air outlets of the fans 20A through 20C and propagates toward the downstream side. Air supplied from the fans 20A through 20C passes through the flow channel and is supplied to the heat exchanger 50.

In the case of a cooling operation, for example, a low-temperature refrigerant is supplied from a pipe connected to an outdoor unit (not shown) to the heat exchanger 50. Air supplied to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 and is transformed into cool air, which is directly output to the indoor room through the air outlet 3.

[0364] The operation of the noise cancellation mechanisms A through C are exactly the same as that discussed in Embodiment 35. The noise cancellation mechanisms A through C are operated as follows. The noise cancellation mechanisms A through C respectively output control sound so that noise detected by the noise-cancellation effect detecting microphones 191 through 193 may approximate to zero, thereby reducing noise detected by the noise-cancellation effect detecting microphones 191 through 193.

[0365] Generally, noise cancellation effects obtained by performing active noise cancellation are greatly influenced by coherence values between the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193, respectively. That is, noise cancellation effects cannot be expected if coherence between the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193, respectively, is not high. Conversely, noise cancellation effects can be estimated from coherence values between the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193, respectively.

[0366] Thus, in the indoor unit 100 (more specifically, the air-sending fan control means 173 of the controller 281) according to Embodiment 36, the rotation speeds of the fans 20A through 20C are controlled, on the basis of coherence values between the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193, respectively, so that the rotation speed of a fan positioned in an area in which noise cancellation effects are high may be increased and so that the rotation speed of a fan positioned in an area in which noise cancellation effects are low may be decreased.

[0367] Fan individual control to be performed on fans 20A through 20C according to Embodiment 36 will now be described below.

Operation information selected by using the remote controller 280 is input into the controller 281. As described above, the operation information is operation mode information indicating a cooling operation mode, a heating operation mode, or a dehumidifying operation mode. Additionally, as the operation information, air amount information indicating the amount of air represented by the level, such as high, middle, or low, is also input into the controller 281 from the remote controller 280.

The operation information input into the controller 281 is input into the identical-rotation-speed determining means 133 through the input section 130. Upon receiving the operation information, the identical-rotation-speed determining means 133 determines, on the basis of the received operation information, the rotation speed when identical rotation speed control is performed for operating all of the fans 20A through 20C at the same operation speed.

[0368] Meanwhile, coherence values between digital values S1 through S3 and digital values T1 through T3, respectively, input from the signal processors 201, 203, and 202, respectively, are calculated by the coherence calculating means 137. The digital values S1 through S3 indicate sound pressure levels detected by the noise-cancellation effect detecting microphones 191, 193, 192, respectively, and the digital values T1 through T3 indicate sound pressure levels detected by the noise detecting microphones 161, 163, and 162, respectively.

[0369] Information concerning the coherence values calculated by the coherence calculating means 137 and information concerning the rotation speed determined by the identical-rotation-speed determining means 133 (rotation speed used for performing identical rotation speed control) are input into the fan-individual-control rotation speed determining means 134B. The fan-individual-control rotation speed determining means 134B determines the rotation speeds of the fans used for performing fan individual control, on the basis of these items of information.

More specifically, the fan-individual-control rotation speed determining means 134B determines the rotation speeds of the fans so that the rotation speed of a fan positioned close to (highly related to) a noise-cancellation effect detecting microphone having a high coherence value may be increased, and so that the rotation speed of a fan positioned close to (highly related to) a noise-cancellation effect detecting microphone having a low coherence value may be decreased.

In this case, the fan-individual-control rotation speed determining means 134B may determine the rotation speeds of the individual fans 20A through 20C so that the amount of air obtained when fan individual control is performed will become the same as that when identical rotation speed control is performed.

[0370] In the indoor unit 100 according to Embodiment 36, for example, if the coherence value between the noise detecting microphone 161 and the noise-cancellation effect detecting microphone 191 is 0.8, if the coherence value between the noise detecting microphone 162 and the noise-cancellation effect detecting microphone 192 is 0.8, and if the coherence value between the noise detecting microphone 163 and the noise-cancellation effect detecting microphone 193 is 0.5, the fan-individual-control rotation speed determining means 134B determines the rotation speeds of the fans so that the rotation speeds of the fans 20A and 20C may be increased and so that the rotation speed of the fan 20B may be decreased.

The amount of air and the rotation speed are proportional to each other. Thus, in the configuration shown in FIG. 83, for example, if each of the rotation speeds of the fans 20A and 20C is increased by 10 %, the rotation speed of the fan 20B is decreased by 20 %. Then, the amount of air when fan individual control is performed becomes the same as that when identical rotation speed control is performed.

[0371] The above-described approach to determining the rotation speeds of the fans 20A through 20C is only an example. For example, if the coherence value between the noise detecting microphone 161 and the noise-cancellation effect detecting microphone 191 is 0.8, if the coherence value between the noise detecting microphone 162 and the noise-cancellation effect detecting microphone 192 is 0.7, and if the coherence value between the noise detecting microphone 163 and the noise-cancellation effect detecting microphone 193 is 0.5, the rotation speeds of the fans may be determined so that the rotation speed of the fan 20A will be increased, so that the rotation speed of the fan 20B will be decreased, and so that the rotation speed of the fan 20C will remain the same.

That is, the rotation speeds of the fans may be determined so that the rotation speed of the fan 20A positioned close to the noise-cancellation effect detecting microphone 191 having the highest coherence value will be increased, and so that the rotation speed of the fan 20B positioned close to the noise-cancellation effect detecting microphone 193 having the lowest coherence value will be decreased, and so that the rotation speed of the fan 20C positioned close to the noise-cancellation effect detecting microphone 192 having neither of the highest coherence value nor the lowest coherence value will remain the same.

[0372] If an operation information signal indicating that fan individual control will be performed (for example, a low-noise mode signal) is input from the remote controller 280, the SWs 135 are switched so that rotation control signals indicating that identical rotation speed control will be performed may be switched to rotation control signals indicating that fan individual control will be performed. These rotation control signals are output from the controller 281 to the fans 20A through 20C. The rotation control signals output from the controller 281 are input into the motor drivers 282A through 282C, and the fans 20A through 20C are controlled so that they may be operated at rotation speeds in accordance with the rotation control signals.

[0373] As stated above, when active noise cancellation is utilized, noise cancellation effects to be expected are different depending on the coherence values between the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193, respectively. That is, it can be assumed that a noise-cancellation effect detecting microphone having a high coherence value will exhibit high noise cancellation effects, and it can be assumed that a noise-cancellation effect detecting microphone having a low coherence value will exhibit low noise cancellation effects.

Accordingly, in the indoor unit 100 including the plurality of fans 20A through 20C according to Embodiment 36, the rotation speed of a fan positioned close to a noise-cancellation effect detecting microphone having a high coherence value is increased, and the rotation speed of a fan positioned close to a noise-cancellation effect detecting microphone having a low coherence value is decreased.

[0374] As a result, in the indoor unit 100 according to Embodiment 36, in an area where it is assumed that noise cancellation effects are high, noise cancellation effects become even higher, and in an area where it is assumed that noise cancellation effects are low, noise becomes smaller. It is thus possible to further reduce noise output from the air outlet 3, as a whole, compared with an indoor unit which uses a single fan or an indoor unit which does not perform fan individual control.

Additionally, in the indoor unit 100 according to Embodiment 36, the rotation speeds of the plurality of fans 20A through 20C are individually controlled so that the amount of air when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce degradation in aerodynamic performance.

[0375] Further, as shown in FIGs. 80 and 81 of Embodiment 35, the flow channel of the indoor unit 100 is divided into a plurality of regions, thereby making it possible to further improve noise cancellation effects. That is, noise components output from the fans 20A through 20C can be separated into the respective regions, and the noise cancellation mechanism A reduces noise only output from the fan 20A, the noise cancellation mechanism B reduces noise only output from the fan 20C, and the noise cancellation mechanism C reduces noise only output from the fan 20B. With this configuration, crosstalk noise components (noise output from a fan provided in an adjacent flow channel) detected by the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193 are decreased.

[0376] Moreover, since the flow channel becomes closer to a duct structure, noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby increasing noise cancellation effects. Thus, by dividing the flow channel of the indoor unit 100 into a plurality of regions, noise can be further reduced compared with the configuration shown in FIG. 83.

Additionally, as in FIG. 82 of Embodiment 35, even if there is a fan which is not provided with a noise cancellation mechanism, the rotation speed of such a fan 20 is decreased, thereby reducing noise in an area where a noise cancellation mechanism is not provided. As a result, effects similar to those described above can be obtained.

[0377] The noise detecting microphones 161 through 163 according to Embodiment 36 may be mounted at any positions as long as they are mounted on the upstream side of the control speakers 181 through 183, respectively. The control speakers 181 through 183 may be respectively mounted at any positions as long as they are mounted on the downstream side of the noise detecting microphones 161 through 163 and on the upstream side of the noise-cancellation effect detecting microphones 191 through 193. In Embodiment 36, the noise-cancellation effect detecting microphones 191 through 193 are disposed substantially on lines extending from the rotational axes of the fans 20A, 20C, and 20B, respectively.
However, the noise-cancellation effect detecting microphones 191 through 193 may be mounted at any positions as long as they are on the downstream side of the control speakers 181 through 183, respectively. In Embodiment 36, three noise detecting microphones, three control speakers, three noise-cancellation effect detecting microphones, and three signal processors are provided. However, Embodiment 36 is not restricted to this configuration.
[0378] In Embodiment 36, the air-sending fan control means 173 is constituted by the CPU 131 within the controller 281. However, the air-sending fan control means 173 may be constituted by hardware, such as a LSI (Large Scale Integration) or a FPGA (Field Programmable Gate Array). Moreover, the configuration of the air-sending fan control means 173 is not restricted to the configuration shown in FIG. 84.
[0379] In Embodiment 36, the air-sending fan control means 173 is configured so that the rotation speeds of the fans 20A and 20C positioned close to the noise-cancellation effect detecting microphones 191 and 192, respectively, having higher coherence values may be increased and so that the rotation speed of the fan 20B positioned close to the noise-cancellation effect detecting microphone 193 having a lower coherence value may be decreased. However, the air-sending fan control means 173 may be configured so that the rotation speeds of the fans 20A and 20C will be increased or so that the rotation speed of the fan 20B will be decreased.
[0380] As described above, in the indoor unit 100 according to Embodiment 36, the plurality of fans 20A through 20C are provided, and the controller 281 (more specifically, the air-sending fan control means 173) which individually controls the rotation speeds of the fans 20A through 20C is provided. The air-sending fan control means 173 calculates coherence values between the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193, respectively, and controls the rotation speeds so that the rotation speed of a fan positioned close to a noise-cancellation effect detecting microphone which has a higher coherence value with the associated noise detecting microphone may be increased, and so that the rotation speed of a fan positioned close to a noise-cancellation effect detecting microphone which has a lower coherence value with the associated noise detecting microphone may be decreased.
As a result, in an area where high noise cancellation effects can be expected, noise cancellation effects become even higher, and in an area where noise cancellation effects cannot be expected, noise becomes smaller. It is thus possible to further reduce noise compared with an indoor unit which has a noise cancellation mechanism having the same configuration as that of Embodiment 36 but uses only a single fan or an indoor unit which does not perform fan individual control.
[0381] Additionally, the air-sending fan control means 173 controls the rotation speeds of the fans 20A through 20C so that the amount of air output from the air outlet 3 when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce noise without causing degradation in aerodynamic performance.
[0382] Moreover, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated, and the noise cancellation mechanism A reduces noise only output from the fan 20A, the noise cancellation mechanism B reduces noise only output from the fan 20C, and the noise cancellation mechanism C reduces noise only output from the fan 20B. With this configuration, in each region, crosstalk noise components caused by noise output to an adjacent region can be decreased.
[0383] Further, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, the flow channel becomes closer to a duct structure, and noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby making it possible to obtain even higher noise reduction effects than the configuration shown in FIG. 83. Additionally, even if there is a fan 20 which is not provided with a noise cancellation mechanism, the rotation speed of such a fan 20 is decreased, thereby reducing noise in an area where a noise cancellation mechanism is not provided. As a result, noise cancellation effects similar to those described above can be obtained.
[0384] Further, in the indoor unit 100 according to Embodiment 36, the rotation speeds are controlled on the basis of coherence values between the noise detecting microphones and the noise-cancellation effect detecting microphones. Since theoretical noise cancellation effects can be estimated from the coherence values, optimal and finer control of rotation speeds of the fans is implemented on the basis of the coherence values of the noise-cancellation effect detecting microphones. Thus, the indoor unit 100 according to Embodiment 36 can obtain even higher noise cancellation effects than the configurations of Embodiment 34 and Embodiment 35.

Embodiment 37

[0385] A noise cancellation mechanism for carrying out the present invention is not restricted to the noise cancellation mechanisms discussed in Embodiment 34 through Embodiment 36. For example, by using a noise cancellation mechanism different from the above-described noise cancellation mechanisms, an air-conditioning apparatus exhibiting advantages similar to those discussed in Embodiment 34 through Embodiment 36 can be obtained. In Embodiment 37, an example in which a different noise cancellation mechanism is used in the air-conditioning apparatus according to Embodiment 34 will be discussed. In Embodiment 37, points different from Embodiment 34 through Embodiment 36 will be mainly discussed, and the same portions as those of Embodiment 34 through Embodiment 36 are designated by like reference numerals.

[0386] FIG. 85 is a front view illustrating an indoor unit according to Embodiment 37 of the present invention.
The indoor unit 100 according to Embodiment 37 is different from that of Embodiment 34 in the configuration of a noise cancellation mechanism. More specifically, in the noise cancellation mechanism A of the indoor unit 100 according to Embodiment 34, two microphones (the noise detecting microphone 161 and the noise-cancellation effect detecting microphone 191) are used for performing active noise cancellation. In contrast, in a noise cancellation mechanism D used in the indoor unit 100 according to Embodiment 37 as a noise cancellation mechanism corresponding to the noise cancellation mechanism A, the two microphones (the noise detecting microphone 161 and the noise-cancellation effect detecting microphone 191) of the noise cancellation mechanism A are replaced by one microphone (a noise/noise-cancellation effect detecting microphone 211).
Similarly, in the noise cancellation mechanism B of the indoor unit 100 according to Embodiment 34, two microphones (the noise detecting microphone 162 and the noise-cancellation effect detecting microphone 192) are used for performing active noise cancellation. In contrast, in a noise cancellation mechanism E used in the indoor unit 100 according to Embodiment 37 as a noise cancellation mechanism corresponding to the noise cancellation mechanism B, the two microphones (the noise detecting microphone 162 and the noise-cancellation effect detecting microphone 192) of the noise cancellation mechanism B are replaced by one microphone (a noise/noise-cancellation effect detecting microphone 212).
In accordance with this replacement, a signal processing method becomes different. Thus, in the indoor unit 100 according to Embodiment 37, instead of the signal processors 201 and 202, signal processors 204 and 205 are provided. The configurations of the signal processors 204 and 205 are exactly the same as that of the signal processor discussed in Embodiment 33.

[0387] The operation of the indoor unit 100 will now be described below.
As in Embodiment 34, when the indoor unit 100 starts, the impellers of the fans 20A through 20C rotate, and indoor air is sucked through the upper sides of the fans 20A through 20C and is supplied to the lower sides of the fans 20A through 20C, thereby generating airflow. Accordingly, operating sound (noise) is produced near the air outlets of the fans 20A through 20C and propagates toward the downstream side.
Air supplied from the fans 20A through 20C passes through the flow channel and is supplied to the heat exchanger 50. In the case of a cooling operation, for example, a low-temperature refrigerant is supplied from a pipe connected to an outdoor unit (not shown) to the heat exchanger 50. Air supplied to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 and is transformed into cool air, which is directly output to the indoor room through the air outlet 3.

[0388] A method for reducing operating sound in the indoor unit 100 is also exactly the same as that discussed in Embodiment 33. The indoor unit 100 is operated as follows. The indoor unit 100 outputs control sound so that noise detected by the noise/noise-cancellation effect detecting microphones 211 and 212 may approximate to zero. As a result, noise detected by the noise/noise-cancellation effect detecting microphones 211 and 212 can be reduced.

[0389] As discussed in Embodiment 34, in the active noise cancellation method, control sound is output from the control speakers 181 and 182 such that the phase thereof is opposite to the phase of noise at the positions (control points) at which the noise/noise-cancellation effect detecting microphones 211 and 212, respectively, are disposed. Accordingly, noise cancellation effects are high around the noise/noise-cancellation effect detecting microphones 211 and 212, but the phase of control sound changes as the position is farther away from the control points. Thus, at positions farther away from the noise/noise-cancellation effect detecting microphones 211 and 212, the phase shift between noise and control sound becomes larger, thereby decreasing the noise cancellation effects.

[0390] Fan individual control to be performed on the fans 20A through 20C according to Embodiment 37 is the same as that performed by the air-sending fan control means 171 discussed in Embodiment 34.

[0391] In this manner, in the indoor unit 100 including the plurality of fans 20A through 20C, the rotation speeds of the fans 20A and 20C positioned closer to the noise/noise-cancellation effect detecting microphones 211 and 212, respectively, are increased, and the rotation speed of the fan 20B positioned farther away from the noise/noise-cancellation effect detecting microphones 211 and 212 is decreased.
Thus, noise around the noise/noise-cancellation effect detecting microphones 211 and 212 where noise cancelation

effects obtained by performing active noise cancellation are high is increased, and noise in an area farther away from the noise/noise-cancellation effect detecting microphones 211 and 212 where noise cancellation effects obtained by performing active noise cancellation become low can be decreased.

[0392] That is, when active noise cancellation is utilized, as stated above, noise cancellation effects become high at and around the noise/noise-cancellation effect detecting microphones 211 and 212, which serve as control points of noise control, but at positions farther away from the control points, the phase shift between control sound and noise output from the control speakers 181 and 182 becomes larger, thereby decreasing noise cancellation effects.
However, in Embodiment 37, since the indoor unit 100 includes the plurality of fans 20A through 20C, the rotation speeds of the fans 20A and 20C (fans that output noise which is likely to be cancelled) positioned closer to the noise/noise-cancellation effect detecting microphones 211 and 212, respectively, can be increased, and the rotation speed of the fan 20B (fan that outputs noise which is not likely to be canceled) positioned farther away from the noise/noise-cancellation effect detecting microphones 211 and 212 can be decreased.

[0393] As a result, in the indoor unit 100 according to Embodiment 37, in an area where noise cancellation effects are high, noise cancellation effects become even higher, and in an area where noise cancellation effects are low, noise becomes smaller. It is thus possible to further reduce noise output from the air outlet 3, as a whole, compared with an indoor unit which uses a single fan or an indoor unit which does not perform fan individual control. Moreover, in the indoor unit 100 according to Embodiment 37, the rotation speeds of the plurality of fans 20A through 20C are individually controlled so that the amount of air may become the same as that when identical rotation speed control is performed. It is thus possible to reduce degradation in aerodynamic performance.

[0394] Further, as shown in FIGs. 86 and 87, the flow channel of the indoor unit 100 is divided into a plurality of regions, thereby making it possible to further improve noise cancellation effects.

[0395] FIG. 86 is a front view illustrating another example of an indoor unit according to Embodiment 37 of the present invention. FIG. 87 is a left side view illustrating the indoor unit shown in FIG. 86. In FIG. 87, the side wall of the casing 1 of the indoor unit 100 is transparent. In the indoor unit 100 shown in FIGs. 86 and 87, the flow channel is divided by partition boards 90 and 90a so that it may be separated into a region through which air blown out of the fan 20A passes, a region through which air blown out of the fan 20B passes, and a region through which air blown out of the fan 20C passes. Then, the control speaker 181 and the noise/noise-cancellation effect detecting microphone 211 of the noise cancellation mechanism D are positioned in the region through which air blown out of the fan 20A passes. The control speaker 182 and the noise/noise-cancellation effect detecting microphone 212 of the noise cancellation mechanism E are positioned in the region through which air blown out of the fan 20C passes.

[0396] By forming the indoor unit 100 as described above, noise components output from the fans 20A through 20C can be separated into the respective regions, and the noise cancellation mechanism D reduces noise only output from the fan 20A, and the noise cancellation mechanism E reduces noise only output from the fan 20C. This prevents noise output from the fan 20B from being detected by the noise/noise-cancellation effect detecting microphones 211 and 212, thereby decreasing crosstalk noise components of the noise/noise-cancellation effect detecting microphones 211 and 212.

[0397] Moreover, since the flow channel becomes closer to a duct structure, noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby increasing noise cancellation effects. Thus, by forming the indoor unit 100 as shown in FIGs. 86 and 87, noise can be further reduced compared with the configuration shown in FIG. 85. In FIGs. 86 and 87, partition boards are inserted in the entire flow channel. However, only part of the flow channel, for example, only the upstream side or the downstream side of the heat exchanger 50, may be divided by using partition boards.

[0398] In Embodiment 37, the noise/noise-cancellation effect detecting microphones 211 and 212 are mounted on the downstream side of the control speakers 181 and 182, respectively. However, the noise/noise-cancellation effect detecting microphones 211 and 212 may be mounted on the upstream side of the control speakers 181 and 182, respectively. In Embodiment 37, two control speakers, two noise/noise-cancellation effect detecting microphones, and two signal processors are provided. However, Embodiment 37 is not restricted to this configuration.

[0399] In Embodiment 37, the air-sending fan control means 171 is constituted by the CPU 131 within the controller 281. However, the air-sending fan control means 171 may be constituted by hardware, such as a LSI (Large Scale Integration) or a FPGA (Field Programmable Gate Array). Moreover, as in Embodiment 34, the configuration of the air-sending fan control means 171 is not restricted to the configuration shown in FIG. 75.

[0400] In Embodiment 37, the air-sending fan control means 171 is configured so that the rotation speeds of the fans 20A and 20C positioned close to the noise/noise-cancellation effect detecting microphones 211 and 212, respectively, may be increased and so that the rotation speed of the fan 20B positioned farther away from the noise/noise-cancellation effect detecting microphones 211 and 212 may be decreased. However, the air-sending fan control means 171 may be configured so that the rotation speeds of the fans 20A and 20C will be increased or so that the rotation speed of the fan 20B will be decreased.

[0401] As described above, in the indoor unit 100 according to Embodiment 37, the plurality of fans 20A through 20C are provided, and the controller 281 (more specifically, the air-sending fan control means 171) which individually controls the rotation speeds of the fans 20A through 20C is provided. The air-sending fan control means 171 controls the rotation speeds so that the rotation speeds of the fans 20A and 20C that send air to an area near the noise/noise-cancellation effect detecting microphones 211 and 212, respectively, where noise cancellation effects are high may be increased, and so that the rotation speed of the fan 20B that sends air to an area farther away from the noise/noise-cancellation effect detecting microphones 211 and 212 where noise cancellation effects are low may be decreased.
Accordingly, in an area where noise cancellation effects are high, noise cancellation effects become even higher, and in an area where the noise cancellation effects are low, noise becomes smaller. It is thus possible to further reduce noise compared with an indoor unit which has a noise cancellation mechanism having the same configuration as that of Embodiment 37 but uses only a single fan or an indoor unit which does not perform fan individual control.
[0402] Additionally, the air-sending fan control means 171 controls the rotation speeds of the fans 20A through 20C so that the amount of air output from the air outlet 3 when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce noise without causing degradation in aerodynamic performance.
[0403] Moreover, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated, and the noise cancellation mechanism D reduces noise only output from the fan 20A, and the noise cancellation mechanism E reduces noise only output from the fan 20C. With this configuration, crosstalk noise components caused by noise output from the fan 20B can be decreased.
[0404] Further, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, the flow channel becomes closer to a duct structure, and noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller.
Additionally, by decreasing the rotation speed of the fan 20B, which is not provided with a noise cancellation mechanism, noise in an area where a noise cancellation mechanism is not provided can be reduced. It is thus possible to obtain higher noise reduction effects than the configuration shown in FIG. 85.
[0405] Further, in Embodiment 37, the noise detecting microphones 161 and 162 and the noise-cancellation effect detecting microphones 191 and 192 are integrated into the noise/noise-cancellation effect detecting microphones 211 and 212, respectively. Accordingly, the number of microphones can be reduced, and thus, the number of parts can be reduced, thereby making it possible to further decrease the cost.

Embodiment 38

[0406] The noise cancellation mechanism discussed in Embodiment 37 can be used in the indoor unit discussed in Embodiment 35. In Embodiment 38, points different from Embodiment 34 through Embodiment 37 will be mainly discussed, and the same portions as those of Embodiment 34 through Embodiment 37 are designated by like reference numerals.
[0407] FIG. 88 is a front view illustrating an indoor unit according to Embodiment 38 of the present invention.
The indoor unit 100 according to Embodiment 38 is different from that of Embodiment 37 in that a noise cancellation mechanism F (a control speaker 183, a noise/noise-cancellation effect detecting microphone 213, and a signal processor 206) is provided. The configuration of the signal processor 206 is exactly the same as that of the signal processor 204 or 205.
[0408] As in Embodiment 35, the indoor unit 100 of Embodiment 38 is also different from that of Embodiment 37 in that signal lines (signal lines through which signals S1, S2, and S3 are supplied) connected from the signal processors 204, 206, and 205, respectively, to air-sending fan control means 172 are provided. The signals S1, S2, and S3 sent from the signal processors 204, 206, and 205, respectively, to the air-sending fan control means 172 are digital signals converted by the A/D converters 152 from signals input from the noise/noise-cancellation effect detecting microphone 211, 213, and 212, respectively, via the microphone amplifiers 151. That is, the signals S1, S2, and S3 are digital values indicating sound pressure levels detected by the noise/noise-cancellation effect detecting microphone 211, 213, and 212, respectively.
[0409] The configuration of the air-sending fan control means 172 is the same as that discussed in Embodiment 35, and is shown in FIG. 79. The air-sending fan control means 172 includes identical-rotation-speed determining means 133, a plurality of averaging means 136 (the same number as that of noise-cancellation effect detecting microphones), fan-individual-control rotation speed determining means 134A, and a plurality of SWs 135 (the same number as that of the fans 20). The identical-rotation-speed determining means 133 determines the rotation speed used for rotating all of the fans 20A through 20C at the same rotation speed, on the basis of operation information input from the remote controller 280.

The operation information input from the remote controller 280 includes, for example, operation mode information indicating a cooling operation mode, a heating operation mode, or a dehumidifying operation mode, and also includes air amount information indicating the amount of air represented by the level, such as high, middle, or low. The averaging means 136 receive digital values S 1, S2, and S3 indicating sound pressure levels detected by the noise-cancellation effect detecting microphones 191, 193, and 192, respectively, and perform an averaging operation on these signals S1, S2, and S3 for a certain period of time.

[0410] The fan-individual-control rotation speed determining means 134A determines the rotation speed of each of the fans 20A through 20C when the rotation speeds of the fans 20A through 20C are individually controlled, on the basis of the signals S1, S2, and S3 averaged by the averaging means 136 and the rotation speed information input from the identical-rotation-speed determining means 133. The SWs 135 switch rotation control signals for the fans 20A through 20C to be supplied to the motor drivers 282A through 282C, respectively, on the basis of a signal input from, for example, the remote controller 280.

That is, the SWs 135 determine whether the fans 20A through 20C are all operated at the same rotation speed (whether identical rotation speed control is performed) or whether the fans 20A through 20C are individually operated at different rotation speeds (whether fan individual control is performed).

[0411] The operation of the indoor unit 100 will now be described below.

The operation of the indoor unit 100 is different from that discussed in Embodiment 37 only in the operation performed by the air-sending fan control means 172. The operation of the air-sending fan control means 172 is the same as that discussed in Embodiment 35. That is, digital values S1 through S3 indicating sound pressure levels detected by the noise/noise-cancellation effect detecting microphones 211, 213, and 212, respectively, are averaged for a certain period of time by the respective averaging means 136. The fan-individual-control rotation speed determining means 134A determines the rotation speeds of the fans used for performing fan individual control, on the basis of these averaged sound pressure level values and the rotation speed determined by the identical rotation speed determining means 133.

More specifically, the fan-individual-control rotation speed determining means 134A determines the rotation speeds of the fans so that the rotation speed of a fan positioned close to (highly related to) a noise-cancellation effect detecting microphone corresponding to an averaged smaller sound pressure level value may be increased, and so that the rotation speed of a fan positioned close to (highly related to) a noise-cancellation effect detecting microphone corresponding to an averaged larger sound pressure level may be decreased.

In this case, the fan-individual-control rotation speed determining means 134A may determine the rotation speeds of the individual fans 20A through 20C so that the amount of air obtained when fan individual control is performed will become the same as that when identical rotation speed control is performed.

[0412] In the indoor unit 100 according to Embodiment 38, for example, if the average value of the noise levels detected by the noise/noise-cancellation effect detecting microphone 211 is 45 dB, if the average value of the noise levels detected by the noise/noise-cancellation effect detecting microphone 212 is 45 dB, and if the average value of the noise levels detected by the noise/noise-cancellation effect detecting microphone 213 is 50 dB, the fan-individual-control rotation speed determining means 134A determines the rotation speeds of the fans so that the rotation speeds of the fans 20A and 20C may be increased and so that the rotation speed of the fan 20B may be decreased.

The amount of air and the rotation speed are proportional to each other. Thus, in the configuration shown in FIG. 88, for example, if each of the rotation speeds of the fans 20A and 20C is increased by 10 %, the rotation speed of the fan 20B is decreased by 20 %. Then, the amount of air when fan individual control is performed becomes the same as that when identical rotation speed control is performed.

[0413] The above-described approach to determining the rotation speeds of the fans 20A through 20C is only an example. For example, if the average value of the noise levels detected by the noise/noise-cancellation effect detecting microphone 211 is 45 dB, if the average value of the noise levels detected by the noise/noise-cancellation effect detecting microphone 212 is 47 dB, and if the average value of the noise levels detected by the noise/noise-cancellation effect detecting microphone 213 is 50 dB, the rotation speeds of the fans may be determined so that the rotation speed of the fan 20A will be increased, so that the rotation speed of the fan 20B will be decreased, and so that the rotation speed of the fan 20C will remain the same.

That is, the rotation speeds of the fans may be determined so that the rotation speed of the fan 20A positioned close to the noise/noise-cancellation effect detecting microphone 211 which has detected the smallest noise level will be increased, and so that the rotation speed of the fan 20B positioned close to the noise/noise-cancellation effect detecting microphone 213 which has detected the largest noise level will be decreased, and so that the rotation speed of the fan 20C positioned close to the noise/noise-cancellation effect detecting microphone 212 which has detected neither of the smallest noise level nor the largest noise level will remain the same.

[0414] If an operation information signal indicating that fan individual control will be performed (for example, a low-noise mode signal) is input from the remote controller 280, the rotation speeds of the fans are individually controlled. That is, if an operation information signal indicating that fan individual control will be performed (for example, a low-noise mode signal) is input from the remote controller 280, the SWs 135 are switched so that rotation control signals indicating that

identical rotation speed control will be performed may be switched to rotation control signals indicating that fan individual control will be performed.
These rotation control signals are output from the controller 281 to the fans 20A through 20C. The rotation control signals output from the controller 281 are input into the motor drivers 282A through 282C, and the fans 20A through 20C are controlled so that they may be operated at rotation speeds in accordance with the rotation control signals.
[0415] As stated above, in the indoor unit 100 according to Embodiment 38, as in Embodiment 35, because of the difference in the amount of crosstalk noise components from adjacent fans, noise cancellation effects in areas around the noise/noise-cancellation effect detecting microphones 211 and 212 become higher than those in an area around the noise/noise-cancellation effect detecting microphone 213.
That is, the noise levels detected in the areas around the noise/noise-cancellation effect detecting microphones 211 and 212 become smaller than those detected in the area around the noise/noise-cancellation effect detecting microphone 213. In contrast, the noise cancellation effects in the area around the noise/noise-cancellation effect detecting microphone 213 are low.
Accordingly, in the indoor unit 100 including the plurality of fans 20A through 20C according to Embodiment 38, among the averaged noise level values detected by the noise/noise-cancellation effect detecting microphones 211 through 213, the rotation speeds of the fans 20A and 20C positioned close to the noise/noise-cancellation effect detecting microphones 211 and 212, respectively, corresponding to smaller averaged noise levels are increased, and the rotation speed of the fan 20B positioned close to the noise/noise-cancellation effect detecting microphone 213 corresponding to a larger averaged noise level is decreased.
[0416] As a result, in the indoor unit 100 according to Embodiment 38, in an area where noise cancellation effects are high, noise cancellation effects become even higher, and in an area where noise cancellation effects are low, noise becomes smaller. It is thus possible to further reduce noise output from the air outlet 3, as a whole, compared with an indoor unit which uses a single fan or an indoor unit which does not perform fan individual control.
Additionally, in the indoor unit 100 according to Embodiment 38, the rotation speeds of the fans 20A through 20C are individually controlled so that the amount of air output from the air outlet 3 when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce noise without causing degradation in aerodynamic performance.
[0417] Further, as shown in FIGs. 89 and 90, the flow channel of the indoor unit 100 is divided into a plurality of regions, thereby making it possible to further improve noise cancellation effects.
[0418] FIG. 89 is a front view illustrating another example of an indoor unit according to Embodiment 38 of the present invention. FIG. 90 is a left side view illustrating the indoor unit shown in FIG. 89. In FIG. 90, the side wall of the casing 1 of the indoor unit 100 is transparent. In the indoor unit 100 shown in FIGs. 89 and 90, the flow channel is divided by partition boards 90 and 90a so that it may be separated into a region through which air blown out of the fan 20A passes, a region through which air blown out of the fan 20B passes, and a region through which air blown out of the fan 20C passes.
Then, the control speaker 181 and the noise/noise-cancellation effect detecting microphone 211 of the noise cancellation mechanism D are positioned in the region through which air blown out of the fan 20A passes. The control speaker 182 and noise/noise-cancellation effect detecting microphones 212 of the noise cancellation mechanism E are positioned in the region through which air blown out of the fan 20C passes. The control speaker 183 and the noise/noise-cancellation effect detecting microphone 213 of the noise cancellation mechanism F are positioned in the region through which air blown out of the fan 20B passes.
[0419] By forming the indoor unit 100 as described above, noise components output from the fans 20A through 20C can be separated into the respective regions, and the noise cancellation mechanism D reduces noise only output from the fan 20A, the noise cancellation mechanism E reduces noise only output from the fan 20C, and the noise cancellation mechanism F reduces noise only output from the fan 20B. With this configuration, crosstalk noise components (noise output from a fan provided in an adjacent flow channel) detected by the noise/noise-cancellation effect detecting microphones 211 through 213 are decreased.
[0420] Moreover, since the flow channel becomes closer to a duct structure, noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby increasing noise cancellation effects.
Thus, by forming the indoor unit 100 as shown in FIGs. 89 and 90, noise can be further reduced compared with the configuration shown in FIG. 88. In FIGs. 89 and 90, partition boards are inserted in the entire flow channel.
However, only part of the flow channel, for example, only the upstream side or the downstream side of the heat exchanger 50, may be divided by using partition boards. Additionally, as in Embodiment 37, even if there is a fan 20 which is not provided with a noise cancellation mechanism, as shown in FIG. 91, the rotation speed of such a fan 20 is decreased, thereby reducing noise in an area where a noise cancellation mechanism is not provided. As a result, noise cancellation effects similar to those described above can be obtained.
[0421] In Embodiment 38, the noise/noise-cancellation effect detecting microphones 211 through 213 are mounted on the downstream side of the control speakers 181 through 183, respectively. However, the noise/noise-cancellation

effect detecting microphones 211 through 213 may be mounted on the upstream side of the control speakers 181 through 183, respectively. In Embodiment 38, two or three control speakers, two or three noise/noise-cancellation effect detecting microphones, and two or three signal processors are provided. However, Embodiment 38 is not restricted to this configuration.

[0422] In Embodiment 38, the air-sending fan control means 172 is constituted by the CPU 131 within the controller 281. However, the air-sending fan control means 172 may be constituted by hardware, such as a LSI (Large Scale Integration) or a FPGA (Field Programmable Gate Array). Moreover, as in Embodiment 35, the configuration of the air-sending fan control means 172 is not restricted to the configuration shown in FIG. 79.

[0423] In Embodiment 38, the air-sending fan control means 172 is configured so that the rotation speed of a fan positioned close to a noise/noise-cancellation effect detecting microphone which has detected smaller noise levels may be increased and so that the rotation speed of a fan positioned close to a noise/noise-cancellation effect detecting microphone which has detected larger noise levels may be decreased.

However, the air-sending fan control means 172 may be configured so that the rotation speed of a fan positioned close to a noise/noise-cancellation effect detecting microphone which has detected smaller noise levels will be increased or so that the rotation speed of a fan positioned close to a noise/noise-cancellation effect detecting microphone which has detected larger noise levels will be decreased.

[0424] As described above, in the indoor unit 100 according to Embodiment 38, the plurality of fans 20A through 20C are provided, and the controller 281 (more specifically, the air-sending fan control means 172) which individually controls the rotation speeds of the fans 20A through 20C is provided. The air-sending fan control means 172 controls the rotation speeds so that, among averaged noise levels detected by the noise/noise-cancellation effect detecting microphones 211 through 213, the rotation speed of a fan positioned close to a noise/noise-cancellation effect detecting microphone which has detected an averaged smaller noise level may be increased, and so that the rotation speed of a fan positioned close to a noise/noise-cancellation effect detecting microphone which has detected an averaged larger noise level may be decreased.

Accordingly, in an area where noise cancellation effects are high (that is, noise levels are small), noise cancellation effects become even higher, and in an area where noise cancellation effects are low (that is, noise levels are large), noise becomes smaller. It is thus possible to further reduce noise compared with an indoor unit which has a noise cancellation mechanism having the same configuration as that of Embodiment 38 but uses only a single fan or an indoor unit which does not perform fan individual control.

[0425] Additionally, the air-sending fan control means 172 controls the rotation speeds of the fans 20A through 20C so that the amount of air output from the air outlet 3 when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce noise without causing degradation in aerodynamic performance.

[0426] Moreover, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated, and the noise cancellation mechanism D reduces noise only output from the fan 20A, the noise cancellation mechanism E reduces noise only output from the fan 20C, and the noise cancellation mechanism F reduces noise only output from the fan 20B. With this configuration, in each region, crosstalk noise components caused by noise output to an adjacent region can be decreased.

[0427] Further, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, the flow channel becomes closer to a duct structure, and noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller.

Accordingly, noise cancellation effects obtained by the noise/noise-cancellation effect detecting microphones 211 through 213 are enhanced, thereby making it possible to further reduce noise compared with the configuration shown in FIG. 89. Additionally, even if there is a fan 20 which is not provided with a noise cancellation mechanism, the rotation speed of such a fan 20 is decreased, thereby reducing noise in an area where a noise cancellation mechanism is not provided. As a result, noise cancellation effects similar to those described above can be obtained.

[0428] Further, in Embodiment 38, the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193 are integrated into the noise/noise-cancellation effect detecting microphones 211 through 213, respectively. Accordingly, the number of microphones can be reduced, and thus, the number of parts can be reduced, thereby making it possible to further decrease the cost.

Embodiment 39

[0429] In Embodiment 34 through Embodiment 38, a fan positioned close to the noise-cancellation effect detecting microphone or the noise/noise-cancellation effect detecting microphone is set as a fan which outputs noise highly related to a noise-cancellation effect detecting microphone or a noise/noise-cancellation effect detecting microphone (that is, a fan which outputs noise which is highly likely to be canceled by the noise-cancellation effect detecting microphone or

the noise/noise-cancellation effect detecting microphone).
However, the following fan may be set as a fan which outputs noise highly related to a noise-cancellation effect detecting microphone or a noise/noise-cancellation effect detecting microphone (that is, a fan which outputs noise which is highly likely to be canceled by the noise-cancellation effect detecting microphone or the noise/noise-cancellation effect detecting microphone).
In Embodiment 39, the air-conditioning apparatus according to Embodiment 34 is used by way of example. In Embodiment 39, points different from Embodiment 34 through Embodiment 38 will be mainly discussed, and the same portions as those of Embodiment 34 through Embodiment 38 are designated by like reference numerals.

[0430] As stated above, the basic configuration of the indoor unit 100 according to Embodiment 39 is similar to that of Embodiment 34 shown in FIG. 73. The indoor unit 100 according to Embodiment 39 is different from that of Embodiment 34 in that air-sending fan information input into the memory 132 of the controller 281 is different. That is, the indoor unit 100 according to Embodiment 39 is different from that of Embodiment 34 in that air-sending fan information input into the fan-individual-control rotation speed determining means 134 from the memory 132 is different.

[0431] In Embodiment 34, a detailed configuration in which the control speakers 181 and 182 are mounted on the side surfaces of the indoor unit 100 has not been given. In Embodiment 39, the control speakers 181 and 182 are mounted on the side surfaces of the indoor unit 100 as follows.
The control speakers 181 and 182 have a certain thickness, and thus, if they are mounted on the front surface or the back surface of the indoor unit 100, they block the flow channel, which may cause degradation in aerodynamic performance. Accordingly, in Embodiment 39, the control speakers 181 and 182 are stored in machine boxes (a box (not shown) in which a control substrate, etc. are stored) each provided on either side surface of the casing 1. By arranging the control speakers 181 and 182 in this manner, it is possible to prevent the control speakers 181 and 182 from protruding into the flow channel.

[0432] More specifically, in Embodiment 34, the identification numbers of fans 20 positioned close to the noise-cancellation effect detecting microphones 191 and 192 are used as air-sending fan information. In Embodiment 39, however, the identification numbers of the fans 20 disposed at both ends of the casing 1 of the indoor unit 100 are used as air-sending fan information. That is, as is seen from FIG. 73, the air-sending fan information used in Embodiment 39 indicates the identification numbers of the fans 20A and 20C.

[0433] The operation of the indoor unit 100 is similar to that discussed in Embodiment 34. Accordingly, individual control to be performed on the fans 20A through 20C will be discussed below.

[0434] As in Embodiment 34, the fan-individual-control rotation speed determining means 134 of the air-sending fan control means 171 determines rotation speeds of the fans 20 used when performing fan individual control, on the basis of the rotation speed information determined by the identical-rotation-speed determining means 133 and the air-sending fan information read from the memory 132. More specifically, the fan-individual-control rotation speed determining means 134 increases the rotation speeds of the fans 20A and 20C whose identification numbers are stored in the memory 132, and decreases the rotation speed of the fan 20B whose identification number is not stored in the memory 132.
As a result, the fan-individual-control rotation speed determining means 134 increases the rotation speeds of the fans 20A and 20C fixed at both ends of the casing 1 of the indoor unit 100, and decreases the rotation speed of the fan 20B fixed at a portion other than both ends of the casing 1 of the indoor unit 100. In this case, the fan-individual-control rotation speed determining means 134 may determine the rotation speeds of the fans 20A through 20C so that the amount of air when fan individual control is performed will become the same as that when identical rotation speed control is performed.

[0435] If an operation information signal indicating that fan individual control will be performed (for example, a low-noise mode signal) is input from the remote controller 280, the SWs 135 are switched so that rotation control signals indicating that identical rotation speed control will be performed may be switched to rotation control signals indicating that fan individual control will be performed.
These rotation control signals are output from the controller 281 to the fans 20A through 20C. The rotation control signals output from the controller 281 are input into the motor drivers 282A through 282C, and the fans 20A through 20C are controlled so that they may be operated at rotation speeds in accordance with the rotation control signals.

[0436] When detecting noise from the fans 20A through 20C, crosstalk noise components to be considered are different between when noise output from the fans 20A and 20C fixed at both ends is actively canceled and when noise output from the fan 20B fixed at a portion other than both ends is actively canceled. This is because, when detecting noise output from the fan 20B, noise output from the adjacent fans 20A and 20C is also input as crosstalk noise components.
Accordingly, in Embodiment 39, the indoor unit 100 includes the plurality of fans 20A through 20C, and the rotation speeds of the fans 20A and 20C, which are fixed at both ends, receiving small crosstalk noise components when detecting noise are increased, and the rotation speed of the fan 20B, which is fixed at a portion other than both ends, receiving large crosstalk noise components when detecting noise is decreased.

[0437] As a result, in the indoor unit 100 according to Embodiment 39, in an area where noise cancellation effects are high, noise cancellation effects become even higher, and in an area where noise cancellation effects are low, noise

becomes smaller. It is thus possible to further reduce noise output from the air outlet 3, as a whole, compared with an indoor unit which uses a single fan or an indoor unit which does not perform fan individual control.
Moreover, in the indoor unit 100 according to Embodiment 39, the rotation speeds of the plurality of fans 20A through 20C are individually controlled so that the amount of air when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce degradation in aerodynamic performance.

[0438] In Embodiment 39, the control speakers 181 and 182 are mounted on both side surfaces of the indoor unit 100 so as not to protrude into the flow channel. This can avoid the occurrence of pressure loss which would be caused if the control speakers 181 and 182 protrude into the flow channel, thereby preventing degradation in aerodynamic performance.

[0439] Further, as in the indoor unit 100 discussed in Embodiment 34 shown in FIGs. 76 and 77, in the indoor unit 100 according to Embodiment 39, the flow channel of the indoor unit 100 is divided into a plurality of regions, thereby making it possible to further improve noise cancellation effects.

[0440] That is, the flow channel of the indoor unit 100 is divided into a plurality of regions by using partition boards 90 and 90a so that noise components output from the fans 20A through 20C may be separated into the respective regions, and the noise cancellation mechanism A reduces noise only output from the fan 20A, while the noise cancellation mechanism B reduces noise only output from the fan 20C. This prevents noise output from the fan 20B from being detected by the noise detecting microphones 161 and 162 and the noise-cancellation effect detecting microphones 191 and 192, thereby decreasing crosstalk noise components of the noise detecting microphones 161 and 162 and the noise-cancellation effect detecting microphones 191 and 192.

[0441] Moreover, since the flow channel becomes closer to a duct structure, noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby increasing noise cancellation effects. Additionally, by reducing the rotation speed of the fan 20B, which is not provided with a noise cancellation mechanism, noise in an area where a noise cancellation mechanism is not provided can be reduced.
Thus, in the indoor unit 100 according to Embodiment 39, too, by dividing the flow channel of the indoor unit 100 into a plurality of regions, noise can be further reduced compared with the configuration shown in FIG. 73. It is not necessary to provide partition boards in the entire flow channel. Only part of the flow channel, for example, only the upstream side or the downstream side of the heat exchanger 50, may be divided by using partition boards.

[0442] In Embodiment 39, the noise detecting microphones 161 and 162 are each mounted on either side surface of the indoor unit 100. However, the noise detecting microphones 161 and 162 may be mounted at any positions as long as they are mounted on the upstream side of the control speakers 181 and 182, respectively. In Embodiment 39, the noise-cancellation effect detecting microphones 191 and 192 are disposed substantially on lines extending from the rotational axes of the fans 20A and 20C, respectively.
However, the noise-cancellation effect detecting microphones 191 and 192 may be mounted at any positions as long as they are on the downstream side of the control speakers 181 and 182, respectively. In Embodiment 39, two noise detecting microphones, two control speakers, two noise-cancellation effect detecting microphones, and two signal processors are provided. However, Embodiment 39 is not restricted to this configuration.

[0443] In Embodiment 39, the air-sending fan control means 171 is constituted by the CPU 131 within the controller 281. However, the air-sending fan control means 171 may be constituted by hardware, such as a LSI (Large Scale Integration) or a FPGA (Field Programmable Gate Array). Moreover, the configuration of the air-sending fan control means 171 is not restricted to the configuration shown in FIG. 75.

[0444] In Embodiment 39, the air-sending fan control means 171 is configured so that the rotation speeds of the fans 20A and 20C fixed at both ends of the indoor unit 100 may be increased and so that the rotation speed of the fan 20B fixed at a portion other than both ends of the indoor unit 100 may be decreased. However, the air-sending fan control means 171 may be configured so that the rotation speeds of the fans 20A and 20C will be increased or so that the rotation speed of the fan 20B will be decreased.

[0445] As described above, in the indoor unit 100 according to Embodiment 39, the plurality of fans 20A through 20C are provided, and the air-sending fan control means 171 which individually controls the rotation speeds of the fans 20A through 20C is provided. The air-sending fan control means 171 controls the rotation speeds so that the rotation speeds of the fans 20A and 20C fixed at both ends of the indoor unit 100 may be increased and so that the rotation speed of the fan 20B fixed at a portion other than both ends of the indoor unit 100 may be decreased.
Accordingly, in an area where crosstalk noise components from an adjacent fan are small and noise cancellation effects are high, noise cancellation effects become even higher, and in an area where crosstalk noise components from an adjacent fan are large and noise cancellation effects are low, noise becomes smaller. It is thus possible to obtain higher noise reduction effects than an indoor unit which has a noise cancellation mechanism having the same configuration as that of Embodiment 39 but uses only a single fan or an indoor unit which does not perform fan individual control.

[0446] Additionally, the air-sending fan control means 171 controls the rotation speeds of the fans 20A through 20C so that the amount of air output from the air outlet 3 when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce noise without causing degradation in aerodynamic performance.

[0447] Further, the control speakers 181 and 182 are mounted on both side surfaces of the indoor unit 100 so as not to protrude into the flow channel. This can prevent the occurrence of pressure loss which would be caused if the control speakers 181 and 182 protrude into the flow channel, thereby preventing degradation in aerodynamic performance.

[0448] Moreover, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated, and the noise cancellation mechanism A reduces noise only output from the fan 20A, while the noise cancellation mechanism B reduces noise only output from the fan 20C. This decreases crosstalk noise components caused by noise output from the fan 20B.

[0449] Further, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, the flow channel becomes closer to a duct structure, and noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller. Additionally, by decreasing the rotation speed of the fan 20B, which is not provided with a noise cancellation mechanism, noise in an area where a noise cancellation mechanism is not provided can be reduced. Thus, even higher noise reduction effects can be obtained compared with the configuration shown in FIG. 73.

Embodiment 40

[0450] The air-sending fan information discussed in Embodiment 39 can be used in the indoor unit according to Embodiment 37. In Embodiment 40, points different from Embodiment 34 through Embodiment 39 will be mainly discussed, and the same portions as those of Embodiment 34 through Embodiment 39 are designated by like reference numerals.

[0451] The basic configuration of the indoor unit 100 according to Embodiment 40 is similar to that of Embodiment 37 shown in FIG. 85. The indoor unit 100 according to Embodiment 40 is different from that of Embodiment 37 in that air-sending fan information input into the memory 132 of the controller 281 is different. More specifically, in Embodiment 40, identification numbers of the fans 20 fixed at both ends of the casing 1 of the indoor unit 100 are used as air-sending fan information. That is, as is seen from FIG. 85, the air-sending fan information used in Embodiment 40 indicates the identification numbers of the fans 20A and 20C.

[0452] In Embodiment 37, a detailed configuration in which the control speakers 181 and 182 are mounted on the side surfaces of the indoor unit 100 has not been given. In Embodiment 40, the control speakers 181 and 182 are mounted on the side surfaces of the indoor unit 100 in the following manner.

The control speakers 181 and 182 have a certain thickness, and thus, if they are mounted on the front surface or the back surface of the indoor unit 100, they block the flow channel, which may cause degradation in aerodynamic performance. Accordingly, in Embodiment 40, the control speakers 181 and 182 are stored in machine boxes (a box (not shown) in which a control substrate, etc. are stored) each provided on either side surface of the casing 1. By arranging the control speakers 181 and 182 in this manner, it is possible to prevent the control speakers 181 and 182 from protruding into the flow channel.

[0453] The operation of the indoor unit 100 is similar to that discussed in Embodiment 37. Accordingly, individual control to be performed on the fans 20A through 20C will be discussed below.

[0454] As in Embodiment 37, the fan-individual-control rotation speed determining means 134 of the air-sending fan control means 171 determines rotation speeds of the fans 20 used when performing fan individual control, on the basis of the rotation speed information determined by the identical-rotation-speed determining means 133 and the air-sending fan information read from the memory 132. More specifically, the fan-individual-control rotation speed determining means 134 increases the rotation speeds of the fans 20A and 20C whose identification numbers are stored in the memory 132, and decreases the rotation speed of the fan 20B whose identification number is not stored in the memory 132.

As a result, the fan-individual-control rotation speed determining means 134 increases the rotation speeds of the fans 20A and 20C fixed at both ends of the casing 1 of the indoor unit 100, and decreases the rotation speed of the fan 20B fixed at a portion other than both ends of the casing 1 of the indoor unit 100. In this case, the fan-individual-control rotation speed determining means 134 may determine the rotation speeds of the fans 20A through 20C so that the amount of air when fan individual control is performed will become the same as that when identical rotation speed control is performed.

[0455] If an operation information signal indicating that fan individual control will be performed (for example, a low-noise mode signal) is input from the remote controller 280, the SWs 135 are switched so that rotation control signals indicating that identical rotation speed control will be performed may be switched to rotation control signals indicating that fan individual control will be performed. These rotation control signals are output from the controller 281 to the fans 20A through 20C. The rotation control signals output from the controller 281 are input into the motor drivers 282A through

282C, and the fans 20A through 20C are controlled so that they may be operated at rotation speeds in accordance with the rotation control signals.

[0456] When detecting noise from the fans 20A through 20C, crosstalk noise components to be considered are different between when noise output from the fans 20A and 20C fixed at both ends is actively canceled and when noise output from the fan 20B fixed at a portion other than both ends is actively canceled. This is because, when detecting noise output from the fan 20B, noise output from the adjacent fans 20A and 20C is also input as crosstalk noise components. Accordingly, in Embodiment 40, the indoor unit 100 includes the plurality of fans 20A through 20C, and the rotation speeds of the fans 20A and 20C, which are fixed at both ends, receiving small crosstalk noise components when detecting noise are increased, and the rotation speed of the fan 20B, which is fixed at a portion other than both ends, receiving large crosstalk noise components when detecting noise is decreased.

[0457] As a result, in the indoor unit 100 according to Embodiment 40, in an area where noise cancellation effects are high, noise cancellation effects become even higher, and in an area where noise cancellation effects are low, noise becomes smaller. It is thus possible to further reduce noise output from the air outlet 3, as a whole, compared with an indoor unit which uses a single fan or an indoor unit which does not perform fan individual control.

Moreover, in the indoor unit 100 according to Embodiment 40, the rotation speeds of the plurality of fans 20A through 20C are individually controlled so that the amount of air when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce degradation in aerodynamic performance.

[0458] In Embodiment 40, the control speakers 181 and 182 are mounted on both side surfaces of the indoor unit 100 so as not to protrude into the flow channel. This can avoid the occurrence of pressure loss which would be caused if the control speakers 181 and 182 protrude into the flow channel, thereby preventing degradation in aerodynamic performance.

[0459] Further, as in the indoor unit 100 discussed in Embodiment 37 shown in FIGs. 86 and 87, in the indoor unit 100 according to Embodiment 40, the flow channel of the indoor unit 100 is divided into a plurality of regions, thereby making it possible to further improve noise cancellation effects.

[0460] That is, the flow channel of the indoor unit 100 is divided into a plurality of regions by using partition boards 90 and 90a so that noise components output from the fans 20A through 20C may be separated into the respective regions, and the noise cancellation mechanism D reduces noise only output from the fan 20A, while the noise cancellation mechanism E reduces noise only output from the fan 20C. This prevents noise output from the fan 20B from being detected by the noise/noise-cancellation effect detecting microphones 211 and 212, thereby decreasing crosstalk noise components of the noise/noise-cancellation effect detecting microphones 211 and 212.

[0461] Moreover, since the flow channel becomes closer to a duct structure, noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby increasing noise cancellation effects. Additionally, by reducing the rotation speed of the fan 20B, which is not provided with a noise cancellation mechanism, noise in an area where a noise cancellation mechanism is not provided can be reduced.

Thus, in the indoor unit 100 according to Embodiment 40, too, by dividing the flow channel of the indoor unit 100 into a plurality of regions, noise can be further reduced compared with the configuration shown in FIG. 85. It is not necessary to provide partition boards in the entire flow channel. Only part of the flow channel, for example, only the upstream side or the downstream side of the heat exchanger 50, may be divided by using partition boards.

[0462] In Embodiment 40, the noise/noise-cancellation effect detecting microphones 211 and 212 are mounted on the downstream side of the control speakers 181 and 182, respectively. However, the noise/noise-cancellation effect detecting microphones 211 and 212 may be mounted on the upstream side of the control speakers 181 and 182, respectively.

In Embodiment 40, two control speakers, two noise/noise-cancellation effect detecting microphones, and two signal processors are provided. However, Embodiment 40 is not restricted to this configuration.

[0463] In Embodiment 40, the air-sending fan control means 171 is constituted by the CPU 131 within the controller 281. However, the air-sending fan control means 171 may be constituted by hardware, such as a LSI (Large Scale Integration) or a FPGA (Field Programmable Gate Array). Moreover, the configuration of the air-sending fan control means 171 is not restricted.

[0464] In Embodiment 40, the air-sending fan control means 171 is configured so that the rotation speeds of the fans 20A and 20C fixed at both ends of the indoor unit 100 may be increased and so that the rotation speed of the fan 20B fixed at a portion other than both ends of the indoor unit 100 may be decreased. However, the air-sending fan control means 171 may be configured so that the rotation speeds of the fans 20A and 20C will be increased or so that the rotation speed of the fan 20B will be decreased.

[0465] As described above, in the indoor unit 100 according to Embodiment 40, the plurality of fans 20A through 20C are provided, and the air-sending fan control means 171 which individually controls the rotation speeds of the fans 20A through 20C is provided. The air-sending fan control means 171 controls the rotation speeds so that the rotation speeds of the fans 20A and 20C fixed at both ends of the indoor unit 100 may be increased and so that the rotation speed of the fan 20B fixed at a portion other than both ends of the indoor unit 100 may be decreased.

Accordingly, in an area where crosstalk noise components output from an adjacent fan are small and noise cancellation effects are high, noise cancellation effects become even higher, and in an area where crosstalk noise components output from an adjacent fan are large and noise cancellation effects are low, noise becomes smaller. It is thus possible to further reduce noise compared with an indoor unit which has a noise cancellation mechanism having the same configuration as that of Embodiment 40 but uses only a single fan or an indoor unit which does not perform fan individual control.

[0466] Additionally, the air-sending fan control means 171 controls the rotation speeds of the fans 20A through 20C so that the amount of air output from the air outlet 3 when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce noise without causing degradation in aerodynamic performance.

[0467] Further, the control speakers 181 and 182 are mounted on both side surfaces of the indoor unit 100 so as not to protrude into the flow channel. This can prevent the occurrence of pressure loss which would be caused if the control speakers 181 and 182 protrude into the flow channel, thereby preventing degradation in aerodynamic performance.

[0468] Moreover, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated, and the noise cancellation mechanism D reduces noise only output from the fan 20A, while the noise cancellation mechanism E reduces noise only output from the fan 20C. This decreases crosstalk noise components caused by noise output from the fan 20B.

[0469] Further, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, the flow channel becomes closer to a duct structure, and noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller. Additionally, by decreasing the rotation speed of the fan 20B, which is not provided with a noise cancellation mechanism, noise in an area where a noise cancellation mechanism is not provided can be reduced. Thus, even higher noise reduction effects can be obtained compared with the configuration shown in FIG. 85.

[0470] Further, in Embodiment 40, the noise detecting microphones 161 and 162 and the noise-cancellation effect detecting microphones 191 and 192 are integrated into the noise/noise-cancellation effect detecting microphones 211 and 212, respectively. Accordingly, the number of microphones can be reduced, and thus, the number of parts can be reduced, thereby making it possible to further decrease the cost.

<u>Embodiment 41</u>

[0471] When performing fan individual control in accordance with noise cancellation effects of noise-cancellation effect detecting microphones or noise/noise-cancellation effect detecting microphones, fan individual control may be performed, for example, in the following manner. In Embodiment 41, points different from Embodiment 34 through Embodiment 40 will be mainly discussed, and the same portions as those of Embodiment 34 through Embodiment 40 are designated by like reference numerals.

[0472] FIG. 92 is a front view illustrating an indoor unit according to Embodiment 41 of the present invention.

The indoor unit 100 according to Embodiment 41 is different from that of Embodiment 35 only in the configuration of air-sending fan control means 174.

[0473] The configuration of the air-sending fan control means 174 according to Embodiment 41 will be discussed below. FIG. 93 is a block diagram illustrating the controller according to Embodiment 41 of the present invention. Various operations and means described below are implemented by executing a program stored in the controller 281 included in the indoor unit 100. As in the configuration discussed in Embodiment 34 through Embodiment 40, the controller 281 includes, as major parts, an input section 130 into which a signal from an external input device, such as the remote controller 280, is input, a CPU 131 that executes operations in accordance with a built-in program, and a memory 132 in which data and programs are stored. The CPU 131 according to Embodiment 41 includes the air-sending fan control means 174.

[0474] The air-sending fan control means 174 includes identical-rotation-speed determining means 133, a plurality of noise-cancellation-amount calculating means 138 (the same number as that of noise-cancellation effect detecting microphones), fan-individual-control rotation speed determining means 134C, and a plurality of SWs 135 (the same number as that of the fans 20). The identical-rotation-speed determining means 133 determines the rotation speed used for rotating all of the fans 20A through 20C at the same rotation speed, on the basis of operation information input from the remote controller 280.

The operation information input from the remote controller 280 includes, for example, operation mode information indicating a cooling operation mode, a heating operation mode, or a dehumidifying operation mode, and also includes air amount information indicating the amount of air represented by the level, such as high, middle, or low. The noise-cancellation-amount calculating means 138 receive digital values S1, S2, and S3 indicating sound pressure levels detected by the noise-cancellation effect detecting microphones 191, 193, and 192, respectively, and calculate the noise cancellation amounts from these signals S1, S2, and S3.

[0475] The fan-individual-control rotation speed determining means 134C determines the rotation speeds of the fans 20A through 20C when the rotation speeds of the fans 20A through 20C are individually controlled, on the basis of the noise cancelation amounts calculated by the noise-cancellation-amount calculating means 138 and air-sending fan information stored in the memory 132. The air-sending fan information is information concerning the fans 20 highly related to the noise-cancellation effect detecting microphones 191 through 193.

The SWs 135 switch rotation control signals for the fans 20A through 20C to be supplied to the motor drivers 282A through 282C, respectively, on the basis of a signal input from, for example, the remote controller 280. That is, the SWs 135 determine whether the fans 20A through 20C are all operated at the same rotation speed (whether identical rotation speed control is performed) or whether the fans 20A through 20C are individually operated at different rotation speeds (whether fan individual control is performed).

[0476] FIG. 94 is a block diagram illustrating the noise-cancellation-amount calculating means according to Embodiment 41 of the present invention.

The noise-cancellation-amount calculating means 138 includes averaging means 136 which performs an averaging operation on an input signal (S1, S2, or S3), pre-control sound pressure level storage means 139 in which sound pressure levels before active noise cancellation control is started are stored, and a differentiator 140.

[0477] The operation of the indoor unit 100 will now be described below.

As in Embodiment 35, when the indoor unit 100 starts, the impellers of the fans 20A through 20C rotate, and indoor air is sucked through the upper sides of the fans 20A through 20C and is supplied to the lower sides of the fans 20A through 20C, thereby generating airflow. Accordingly, operating sound (noise) is produced near the air outlets of the fans 20A through 20C and propagates toward the downstream side. Air supplied from the fans 20A through 20C passes through the flow channel and is supplied to the heat exchanger 50.

In the case of a cooling operation, for example, a low-temperature refrigerant is supplied from a pipe connected to an outdoor unit (not shown) to the heat exchanger 50. Air supplied to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 and is transformed into cool air, which is directly output to the indoor room through the air outlet 3.

[0478] The operation of the noise cancellation mechanisms A through C are exactly the same as that discussed in Embodiment 35. The noise cancellation mechanisms A through C are operated as follows. The noise cancellation mechanisms A through C respectively output control sound so that noise detected by the noise-cancellation effect detecting microphones 191 through 193 may approximate to zero, thereby reducing noise detected by the noise-cancellation effect detecting microphones 191 through 193.

[0479] In the indoor unit 100 according to Embodiment 41, not only noise output from the fan 20B, but also noise (crosstalk noise components) output from the adjacent fans 20A and 20C, is input into the noise-cancellation effect detecting microphone 193. In contrast, crosstalk noise components detected by the noise-cancellation effect detecting microphones 191 and 192 are smaller than those detected by the noise-cancellation effect detecting microphone 193. This is because the noise-cancellation effect detecting microphones 191 and 192 have only one adjacent fan (fan 20B). Thus, noise cancellation effects of the noise cancellation mechanisms A and B become higher than those of the noise cancellation mechanism C.

[0480] Fan individual control to be performed on the fans 20A through 20C according to Embodiment 41 will now be described below.

Operation information selected by using the remote controller 280 is input into the controller 281. As described above, the operation information is operation mode information indicating a cooling operation mode, a heating operation mode, or a dehumidifying operation mode. Additionally, as the operation information, air amount information indicating the amount of air represented by the level, such as high, middle, or low, is also input into the controller 281 from the remote controller 280.

The operation information input into the controller 281 is input into the identical-rotation-speed determining means 133 through the input section 130. Upon receiving the operation information, the identical-rotation-speed determining means 133 determines, on the basis of the received operation information, the rotation speed used when performing identical rotation speed control on the fans 20A through 20C. If fan individual control is not performed, the fans 20A through 20C are all operated at the same rotation speed.

[0481] Meanwhile, in the noise-cancellation-amount calculating means 138, S1 through S3 (digital values indicating sound pressure levels detected by the noise-cancellation effect detecting microphones 191, 193, and 192, respectively) are input from the signal processors 201, 203, and 202 respectively, into the averaging means 136. By using the averaging means 136, the noise-cancellation-amount calculating means 138 average, for a certain period of time, sound pressure levels detected by the respective noise-cancellation effect detecting microphones 191 through 193 before active noise cancellation control was performed, and store the averaged sound pressure levels in the pre-control sound pressure level storage means 139.

Then, by using the averaging means 136, the noise-cancellation-amount calculating means 138 average, for a certain period of time, sound pressure levels detected by the respective noise-cancellation effect detecting microphones 191 through 193 when active noise cancellation control is performed.

[0482] Then, the noise-cancellation-amount calculating means 138 calculate noise cancellation amounts from the differences between "sound pressure levels obtained as a result of the averaging means 136 averaging, for a certain period of time, sound pressure levels detected by the respective noise-cancellation effect detecting microphones 191 through 193 when active noise cancellation control is performed" and "sound pressure levels obtained as a result of the averaging means 136 averaging, for a certain period of time, sound pressure levels detected by the respective noise-cancellation effect detecting microphones 191 through 193 before active noise cancellation control was performed" (the averaged sound pressure levels stored in the pre-control sound pressure level storage means 139). The noise cancellation amounts detected by the noise-cancellation-amount calculating means 138 are input into the fan-individual-control rotation speed determining means 134C.

[0483] In the memory 132, air-sending fan information is stored. The air-sending fan information is information concerning the fans 20 that output noise which is highly related to sound detected by the noise-cancellation effect detecting microphones 191 through 193. The identification numbers of such fans are associated with the noise-cancellation effect detecting microphones in a one-to-one correspondence. In Embodiment 41, identification numbers which can be used as air-sending fan information are determined as follows. For example, it is checked to which one of the noise components output from the fans 20A through 20C the sound detected by the noise-cancellation effect detecting microphone 191 is most highly related.

If the sound detected by the noise-cancellation effect detecting microphone 191 is most highly related to the noise output from the fan 20A, air-sending fan information associated with the noise-cancellation effect detecting microphone 191 is the identification number of the fan 20A. Similarly, air-sending fan information associated with each of the noise-cancellation effect detecting microphones 192 and 193 is determined, and is stored in the memory 132 in advance.

[0484] The air-sending fan information may be determined, for example, as follows. Before shipping the product, for example, in the state in which the fans 20A through 20C are being operated, by using a microphone which can precisely detect noise output from the fans 20A through 20C, noise output from each of the fans 20A through 20C is detected. Then, a coherence value between sound detected by each of these microphones and sound detected by the noise-cancellation effect detecting microphone 191 is measured.

Thereafter, the microphone having the highest coherence value with the sound detected by the noise-cancellation effect detecting microphone 191 is determined. Then, the identification number of the fan 20 which outputs noise detected by this microphone is used as air-sending fan information for the noise-cancellation effect detecting microphone 191. Air-sending fan information for each of the noise-cancellation effect detecting microphones 192 and 193 may be similarly determined.

[0485] Alternatively, the air-sending fan information may be determined as follows. Coherence calculating means 137, such as that discussed in Embodiment 36, may be loaded into the air-sending fan control means 174 of the indoor unit 100. Then, during the operation after the product was shipped, the coherence values between the values of noise detected by the noise detecting microphones 161 through 163 and the values of sound detected by the noise-cancellation effect detecting microphones 191 through 193, respectively, may be measured.

Then, the identification numbers of the fans 20 positioned closest to the noise detecting microphones having the highest coherence values with the respective noise-cancellation effect detecting microphones 191 through 193, may be used as air-sending fan information.

[0486] An approach to determining the air-sending fan information is not restricted to the above-described methods. Any approach may be taken as long as the fan which outputs noise most highly related to sound detected by each of the noise-cancellation effect detecting microphones 191 through 193 can be specified.

[0487] Information concerning the noise cancellation amounts calculated by the noise-cancellation-amount calculating means 138 and the air-sending fan information stored in the memory 132 are input into the fan-individual-control rotation speed determining means 134C. The fan-individual-control rotation speed determining means 134C determines the rotation speeds of the fans used for performing fan individual control, on the basis of these items of information.

More specifically, the fan-individual-control rotation speed determining means 134C determines the rotation speeds of the fans so that the rotation speed of a fan highly related to sound detected by a noise-cancellation effect detecting microphone having a larger noise cancellation amount may be increased, and so that the rotation speed of a fan highly related to sound detected by a noise-cancellation effect detecting microphone having a smaller noise cancellation amount may be decreased.

In this case, the fan-individual-control rotation speed determining means 134C may determine the rotation speeds of the individual fans 20A through 20C so that the amount of air obtained when fan individual control is performed will become the same as that when identical rotation speed control is performed.

[0488] In the indoor unit 100 according to Embodiment 41, it is assumed, for example, that the fan which outputs noise most highly related to sound detected by the noise-cancellation effect detecting microphone 191 is the fan 20A, the fan which outputs noise most highly related to sound detected by the noise-cancellation effect detecting microphone 192 is

the fan 20C, and the fan which outputs noise most highly related to sound detected by the noise-cancellation effect detecting microphone 193 is the fan 20B. Then, if the noise cancellation amount of the noise-cancellation effect detecting microphone 191 is -5 dB, if the noise cancellation amount of the noise-cancellation effect detecting microphone 192 is -5 dB, and if the noise cancellation amount of the noise-cancellation effect detecting microphone 193 is -2 dB, the fan-individual-control rotation speed determining means 134C determines the rotation speeds of the fans so that the rotation speeds of the fans 20A and 20C may be increased and so that the rotation speed of the fan 20B may be decreased.
The amount of air and the rotation speed are proportional to each other. Thus, in the configuration shown in FIG. 92, for example, if each of the rotation speeds of the fans 20A and 20C is increased by 10 %, the rotation speed of the fan 20B is decreased by 20 %. Then, the amount of air when fan individual control is performed becomes the same as that when identical rotation speed control is performed.

[0489] The above-described approach to determining the rotation speeds of the fans 20A through 20C is only an example. In the indoor unit 100 according to Embodiment 41, it is assumed, for example, that the fan which outputs noise most highly related to sound detected by the noise-cancellation effect detecting microphone 191 is the fan 20A, the fan which outputs noise most highly related to sound detected by the noise-cancellation effect detecting microphone 192 is the fan 20C, and the fan which outputs noise most highly related to sound detected by the noise-cancellation effect detecting microphone 193 is the fan 20B.
Then, if the noise cancellation amount of the noise-cancellation effect detecting microphone 191 is -5 dB, if the noise cancellation amount of the noise-cancellation effect detecting microphone 192 is -3 dB, and if the noise cancellation amount of the noise-cancellation effect detecting microphone 193 is -2 dB, the rotation speeds of the fans may be determined so that the rotation speed of the fan 20A will be increased, so that the rotation speed of the fan 20B will be decreased, and so that the rotation speed of the fan 20C will remain the same.
That is, the rotation speeds of the fans may be determined so that the rotation speed of the fan 20A most highly related to the noise-cancellation effect detecting microphone 191 having the largest noise cancellation amount will be increased, and so that the rotation speed of the fan 20B most highly related to the noise-cancellation effect detecting microphone 193 having the smallest noise cancellation amount will be decreased, and so that the rotation speed of the fan 20C most highly related to the noise-cancellation effect detecting microphone 192 having neither of the largest noise cancellation amount nor the smallest noise cancellation amount will remain the same.

[0490] If an operation information signal indicating that fan individual control will be performed (for example, a low-noise mode signal) is input from the remote controller 280, the SWs 135 are switched so that rotation control signals indicating that identical rotation speed control will be performed may be switched to rotation control signals indicating that fan individual control will be performed. These rotation control signals are output from the controller 281 to the fans 20A through 20C. The rotation control signals output from the controller 281 are input into the motor drivers 282A through 282C, and the fans 20A through 20C are controlled so that they may be operated at rotation speeds in accordance with the rotation control signals.

[0491] As stated above, in the indoor unit 100 according to Embodiment 41, because of the difference in the amount of crosstalk noise components from adjacent fans, the amounts in areas around the noise-cancellation effect detecting microphones 191 and 192 become larger than the amount in an area around the noise-cancellation effect detecting microphone 193. In contrast, the noise cancellation amount in the area around the noise-cancellation effect detecting microphone 193 becomes small.
Accordingly, in the indoor unit 100 including the plurality of fans 20A through 20C according to Embodiment 41, the rotation speeds of the fans 20A and 20C which output noise highly related to the noise-cancellation effect detecting microphones 191 and 192, respectively, having larger noise cancellation amounts are increased, and the rotation speed of the fan 20B which outputs noise highly related to the noise-cancellation effect detecting microphone 193 having a smaller noise cancellation amount is decreased.

[0492] As a result, in the indoor unit 100 according to Embodiment 41, in an area where noise cancellation effects are high, noise cancellation effects become even higher, and in an area where noise cancellation effects are low, noise becomes smaller. It is thus possible to further reduce noise output from the air outlet 3, as a whole, compared with an indoor unit which uses a single fan or an indoor unit which does not perform fan individual control.
Additionally, in the indoor unit 100 according to Embodiment 41, the rotation speeds of the plurality of fans 20A through 20C are individually controlled so that the amount of air when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce degradation in aerodynamic performance.

[0493] Further, in the indoor unit 100 according to Embodiment 41, as in the indoor unit 100 discussed in Embodiment 35 shown in FIGs. 80 and 81, the flow channel of the indoor unit 100 is divided into a plurality of regions, thereby making it possible to further improve noise cancellation effects.

[0494] That is, by dividing the flow channel of the indoor unit 100 by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated into the respective regions, and the noise cancellation mechanism A reduces noise only output from the fan 20A, the noise cancellation mechanism B reduces noise only

output from the fan 20C, and the noise cancellation mechanism C reduces noise only output from the fan 20B.
With this configuration, crosstalk noise components (noise output from a fan provided in an adjacent flow channel) detected by the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193 are decreased.

[0495] Moreover, since the flow channel becomes closer to a duct structure, noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby increasing noise cancellation effects.
Thus, in the indoor unit 100 according to Embodiment 41, too, by dividing the flow channel of the indoor unit 100 into a plurality of regions, noise can be further reduced compared with the configuration shown in FIG. 92. Even if there is a fan which is not provided with a noise cancellation mechanism, the rotation speed of such a fan 20 is decreased, thereby reducing noise in an area where a noise cancellation mechanism is not provided.
As a result, noise cancellation effects similar to those described above can be obtained. In FIGs. 80 and 81, partition boards are inserted in the entire flow channel. However, only part of the flow channel, for example, only the upstream side or the downstream side of the heat exchanger 50, may be divided by using partition boards.

[0496] In Embodiment 41, the noise-cancellation effect detecting microphones 191 through 193 are disposed substantially on lines extending from the rotational axes of the fans 20A, 20C, and 20B, respectively. However, the noise-cancellation effect detecting microphones 191 through 193 may be mounted at any positions as long as they are on the downstream side of the control speakers 181 through 183, respectively. In Embodiment 41, three noise detecting microphones, three control speakers, three noise-cancellation effect detecting microphones, and three signal processors are provided. However, Embodiment 41 is not restricted to this configuration.

[0497] In Embodiment 41, the air-sending fan control means 174 is constituted by the CPU 131 within the controller 281. However, the air-sending fan control means 174 may be constituted by hardware, such as a LSI (Large Scale Integration) or a FPGA (Field Programmable Gate Array). Moreover, the configuration of the air-sending fan control means 174 is not restricted to the configuration shown in FIG. 93 or 94.

[0498] In Embodiment 41, the air-sending fan control means 174 is configured so that the rotation speed of a fan which outputs noise highly related to sound detected by a noise-cancellation effect detecting microphone having a larger noise cancellation amount may be increased and so that the rotation speed of a fan which outputs noise highly related to sound detected by a noise-cancellation effect detecting microphone having a smaller noise cancellation amount may be decreased.
However, the air-sending fan control means 174 may be configured so that the rotation speed of a fan which outputs noise highly related to sound detected by a noise-cancellation effect detecting microphone having a larger noise cancellation amount will be increased or so that the rotation speed of a fan which outputs noise highly related to sound detected by a noise-cancellation effect detecting microphone having a smaller noise cancellation amount will be decreased.

[0499] In Embodiment 41, as the parameter for controlling the rotation speeds of fans, the noise cancellation amounts of the noise-cancellation effect detecting microphones 191 through 193 are used. However, as the parameter for controlling the rotation speeds of fans, another factor may be used. For example, the average value of sound pressure levels detected by each of the noise-cancellation effect detecting microphones 191 through 193 may be calculated, and the rotation speed of a fan which outputs noise most highly related to sound detected by a noise-cancellation effect detecting microphone having the largest averaged sound pressure level may be decreased.
Alternatively, for example, the average value of sound pressure levels detected by each of the noise-cancellation effect detecting microphones 191 through 193 may be calculated, and the rotation speed of a fan which outputs noise most highly related to sound detected by a noise-cancellation effect detecting microphone having the smallest averaged sound pressure level may be increased.
Alternatively, the rotation speed of a fan which outputs noise most highly related to sound detected by a noise-cancellation effect detecting microphone having the largest averaged sound pressure level may be decreased, and also, the rotation speed of a fan which outputs noise most highly related to sound detected by a noise-cancellation effect detecting microphone having the smallest averaged sound pressure level may be increased.

[0500] Alternatively, as the parameter for controlling the rotation speeds of fans, coherence values between the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193, respectively, may be used. For example, the rotation speed of a fan which outputs noise most highly related to sound detected by a noise-cancellation effect detecting microphone having the smallest coherence value may be decreased.
Alternatively, for example, the rotation speed of a fan which outputs noise most highly related to sound detected by a noise-cancellation effect detecting microphone having the largest coherence value may be increased.
Alternatively, the rotation speed of a fan which outputs noise most highly related to sound detected by a noise-cancellation effect detecting microphone having the smallest coherence value may be decreased, and the rotation speed of a fan which outputs noise most highly related to sound detected by a noise-cancellation effect detecting microphone having the largest coherence value may be increased.

[0501] As described above, in the indoor unit 100 according to Embodiment 41, the plurality of fans 20A through 20C are provided, and the controller 281 (more specifically, the air-sending fan control means 174) which individually controls the rotation speeds of the fans 20A through 20C is provided. The air-sending fan control means 174 controls the rotation speeds so that, among noise cancellation amounts of the noise-cancellation effect detecting microphones 191 through 193, the rotation speed of a fan which outputs noise highly related to sound detected by a noise-cancellation effect detecting microphone having the largest noise cancellation amount may be increased, and so that the rotation speed of a fan which outputs noise highly related to sound detected by a noise-cancellation effect detecting microphone having the smallest noise cancellation amount may be decreased.
Accordingly, by increasing the rotation speed in an area where the noise cancellation amount is large, noise cancellation effects become even higher, and by decreasing the rotation speed in an area where the noise cancellation amount is small, noise of this area becomes smaller. It is thus possible to further reduce noise compared with an indoor unit which has a noise cancellation mechanism having the same configuration as that of Embodiment 41 but uses only a single fan or an indoor unit which does not perform fan individual control.
[0502] In the indoor unit 100 according to Embodiment 41, the fan which outputs noise highly related to sound detected by a noise-cancellation effect detecting microphone having the largest noise cancellation amount is specified. Accordingly, even if the plurality of fans 20A through 20C having different sound pressure levels to be output are used, rotation speed control can be precisely performed.
[0503] Additionally, the air-sending fan control means 174 controls the rotation speeds of the fans 20A through 20C so that the amount of air output from the air outlet 3 when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce noise without causing degradation in aerodynamic performance.
[0504] Moreover, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated, and the noise cancellation mechanism A reduces noise only output from the fan 20A, the noise cancellation mechanism B reduces noise only output from the fan 20C, and the noise cancellation mechanism C reduces noise only output from the fan 20B. With this configuration, in each region, crosstalk noise components caused by noise output to an adjacent region can be decreased.
[0505] Further, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, the flow channel becomes closer to a duct structure, and noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby making it possible to obtain even higher noise reduction effects than the configuration shown in FIG. 92. Additionally, even if there is an area where a noise cancellation mechanism is not provided, the rotation speed of a fan which is not provided with a noise cancellation mechanism is decreased, thereby reducing noise in this area. As a result, noise cancellation effects similar to those described above can be obtained.

Embodiment 42

[0506] Fan individual control discussed in Embodiment 41 (fan individual control using information concerning the fans 20 highly related to noise-cancellation effect detecting microphones) can be implemented in an air-conditioning apparatus including a noise cancellation mechanism different from that according to Embodiment 41. A description will be given below of a case in which fan individual control discussed in Embodiment 41 is used in the indoor unit according to Embodiment 38. In Embodiment 42, points different from Embodiment 34 through Embodiment 41 will be mainly discussed, and the same portions as those of Embodiment 34 through Embodiment 41 are designated by like reference numerals.
[0507] FIG. 95 is a front view illustrating an indoor unit according to Embodiment 42 of the present invention.
The indoor unit 100 according to Embodiment 42 is different from that of Embodiment 38 only in the configuration of air-sending fan control means 174. The configuration of the air-sending fan control means 174 is exactly the same as that of Embodiment 41 shown in FIG. 93.
[0508] The operation of the indoor unit 100 will now be described below.
As in Embodiment 38, when the indoor unit 100 starts, the impellers of the fans 20A through 20C rotate, and indoor air is sucked through the upper sides of the fans 20A through 20C and is supplied to the lower sides of the fans 20A through 20C, thereby generating airflow. Accordingly, operating sound (noise) is produced near the air outlets of the fans 20A through 20C and propagates toward the downstream side. Air supplied from the fans 20A through 20C passes through the flow channel and is supplied to the heat exchanger 50.
In the case of a cooling operation, for example, a low-temperature refrigerant is supplied from a pipe connected to an outdoor unit (not shown) to the heat exchanger 50. Air supplied to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 and is transformed into cool air, which is directly output to the indoor room through the air outlet 3.

[0509] The operation of the noise cancellation mechanisms D through F are exactly the same as that discussed in Embodiment 38. The noise cancellation mechanisms D through F are operated as follows. The noise cancellation mechanisms D through F respectively output control sound so that noise detected by the noise/noise-cancellation effect detecting microphones 211, 213, and 212 may approximate to zero, thereby reducing noise detected by the noise/noise-cancellation effect detecting microphones 211, 213, and 212.

[0510] In the indoor unit 100 according to Embodiment 42, not only noise output from the fan 20B, but also noise (crosstalk noise components) output from the adjacent fans 20A and 20C, is input into the noise/noise-cancellation effect detecting microphone 213. In contrast, crosstalk noise components detected by the noise/noise-cancellation effect detecting microphones 211 and 212 are smaller than those detected by the noise/noise-cancellation effect detecting microphone 213. This is because the noise/noise-cancellation effect detecting microphones 211 and 212 has only one adjacent fan (fan 20B). Thus, noise cancellation effects of the noise cancellation mechanisms D and E become higher than those of the noise cancellation mechanism F.

[0511] Fan individual control to be performed on the fans 20A through 20C is similar to that discussed in Embodiment 41. Fan individual control of Embodiment 42 is different from that of Embodiment 41 in that S1 through S3 input into the noise-cancellation-amount calculating means 138 are digital values indicating sound pressure levels detected by the noise/noise-cancellation effect detecting microphones 211, 213, and 212, respectively.

Fan individual control of Embodiment 42 is also different from that of Embodiment 41 in that air-sending fan information stored in the memory 132 is the identification numbers of the fans 20 which output noise most highly related to sound detected by the noise/noise-cancellation effect detecting microphones 211 through 213.

[0512] Thus, the fan-individual-control rotation speed determining means 134C of the air-sending fan control means 174 determines the rotation speeds of the fans, on the basis of the noise cancellation amounts calculated by the noise-cancellation-amount calculating means 138 and the air-sending fan information stored in the memory 132, so that the rotation speed of a fan highly related to sound detected by a noise/noise-cancellation effect detecting microphone having a larger noise cancellation amount may be increased, and so that the rotation speed of a fan highly related to sound detected by a noise/noise-cancellation effect detecting microphone having a smaller noise cancellation amount may be decreased. In this case, the fan-individual-control rotation speed determining means 134C may determine the rotation speeds of the individual fans 20A through 20C so that the amount of air obtained when fan individual control is performed will become the same as that when identical rotation speed control is performed.

[0513] For example, in the indoor unit 100 according to Embodiment 42, it is assumed, for example, that the fan which outputs noise most highly related to sound detected by the noise/noise-cancellation effect detecting microphone 211 is the fan 20A, the fan which outputs noise most highly related to sound detected by the noise/noise-cancellation effect detecting microphone 212 is the fan 20C, and the fan which outputs noise most highly related to sound detected by the noise/noise-cancellation effect detecting microphone 213 is the fan 20B.

Then, if the noise cancellation amount of the noise/noise-cancellation effect detecting microphone 211 is -5 dB, if the noise cancellation amount of the noise/noise-cancellation effect detecting microphone 212 is -5 dB, and if the noise cancellation amount of the noise/noise-cancellation effect detecting microphone 213 is -2 dB, the fan-individual-control rotation speed determining means 134C determines the rotation speeds of the fans so that the rotation speeds of the fans 20A and 20C may be increased and so that the rotation speed of the fan 20B may be decreased.

The amount of air and the rotation speed are proportional to each other. Thus, in the configuration shown in FIG. 95, for example, if each of the rotation speeds of the fans 20A and 20C is increased by 10 %, the rotation speed of the fan 20B is decreased by 20 %. Then, the amount of air when fan individual control is performed becomes the same as that when identical rotation speed control is performed.

[0514] The above-described approach to determining the rotation speeds of the fans 20A through 20C is only an example. In the indoor unit 100 according to Embodiment 42, it is assumed, for example, that the fan which outputs noise most highly related to sound detected by the noise/noise-cancellation effect detecting microphone 211 is the fan 20A, the fan which outputs noise most highly related to sound detected by the noise/noise-cancellation effect detecting microphone 212 is the fan 20C, and the fan which outputs noise most highly related to sound detected by the noise/noise-cancellation effect detecting microphone 213 is the fan 20B.

Then, if the noise cancellation amount of the noise/noise-cancellation effect detecting microphone 211 is -5 dB, if the noise cancellation amount of the noise/noise-cancellation effect detecting microphone 212 is -3 dB, and if the noise cancellation amount of the noise/noise-cancellation effect detecting microphone 213 is -2 dB, the rotation speeds of the fans may be determined so that the rotation speed of the fan 20A will be increased, and so that the rotation speed of the fan 20B will be decreased, and so that the rotation speed of the fan 20C will remain the same.

That is, the rotation speeds of the fans may be determined so that the rotation speed of the fan 20A most highly related to the noise-cancellation effect detecting microphone 191 having the largest noise cancellation amount will be increased, and so that the rotation speed of the fan 20B most highly related to the noise-cancellation effect detecting microphone 193 having the smallest noise cancellation amount will be decreased, and so that the rotation speed of the fan 20C most highly related to the noise-cancellation effect detecting microphone 192 having neither of the largest noise cancellation amount nor the smallest noise cancellation amount will remain the same.

[0515] If an operation information signal indicating that fan individual control will be performed (for example, a low-noise mode signal) is input from the remote controller 280, the SWs 135 are switched so that rotation control signals indicating that identical rotation speed control will be performed may be switched to rotation control signals indicating that fan individual control will be performed. These rotation control signals are output from the controller 281 to the fans 20A through 20C. The rotation control signals output from the controller 281 are input into the motor drivers 282A through 282C, and the fans 20A through 20C are controlled so that they may be operated at rotation speeds in accordance with the rotation control signals.

[0516] As stated above, in the indoor unit 100 according to Embodiment 42, because of the difference in the amount of crosstalk noise components from adjacent fans, the noise cancellation amounts in areas around the noise/noise-cancellation effect detecting microphones 211 and 212 become larger than the noise cancellation amount in an area around the noise/noise-cancellation effect detecting microphone 213. In contrast, the noise cancellation amount in the area around the noise/noise-cancellation effect detecting microphone 213 becomes small.

Accordingly, in the indoor unit 100 including the plurality of fans 20A through 20C according to Embodiment 42, the rotation speeds of the fans 20A and 20C which output noise highly related to the noise-cancellation effect detecting microphones 191 and 192, respectively, having larger noise cancellation amounts are increased, and the rotation speed of the fan 20B which outputs noise highly related to the noise-cancellation effect detecting microphone 193 having a smaller noise cancellation amount is decreased.

[0517] As a result, in the indoor unit 100 according to Embodiment 42, in an area where noise cancellation effects are high, noise cancellation effects become even higher, and in an area where noise cancellation effects are low, noise becomes smaller. It is thus possible to further reduce noise output from the air outlet 3, as a whole, compared with an indoor unit which uses a single fan or an indoor unit which does not perform fan individual control. Additionally, in the indoor unit 100 according to Embodiment 42, the rotation speeds of the plurality of fans 20A through 20C are individually controlled so that the amount of air when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce degradation in aerodynamic performance.

[0518] Further, in the indoor unit 100 according to Embodiment 42, as in the indoor unit 100 discussed in Embodiment 38 shown in FIGs. 89 and 90, the flow channel of the indoor unit 100 is divided into a plurality of regions, thereby making it possible to further improve noise cancellation effects.

[0519] That is, by dividing the flow channel of the indoor unit 100 by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated into the respective regions, and the noise cancellation mechanism D reduces noise only output from the fan 20A, the noise cancellation mechanism E reduces noise only output from the fan 20C, and the noise cancellation mechanism F reduces noise only output from the fan 20B. With this configuration, crosstalk noise components (noise output from a fan provided in an adjacent flow channel) detected by the noise/noise-cancellation effect detecting microphones 211 through 213 are decreased.

[0520] Moreover, since the flow channel becomes closer to a duct structure, noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby increasing noise cancellation effects. Thus, in the indoor unit 100 according to Embodiment 42, too, by dividing the flow channel of the indoor unit 100 into a plurality of regions, noise can be further reduced compared with the configuration shown in FIG. 95.

Even if there is a fan which is not provided with a noise cancellation mechanism, the rotation speed of such a fan 20 is decreased, thereby reducing noise in an area where a noise cancellation mechanism is not provided. As a result, effects similar to those described above can be obtained. In FIGs. 89 and 90, partition boards are inserted in the entire flow channel. However, only part of the flow channel, for example, only the upstream side or the downstream side of the heat exchanger 50, may be divided by using partition boards.

[0521] In Embodiment 42, the noise/noise-cancellation effect detecting microphones 211 through 213 are disposed on the downstream side of the control speakers 181 through 183, respectively. However, the noise/noise-cancellation effect detecting microphones 211 through 213 may be disposed on the upstream side of the control speakers 181 through 183, respectively. In Embodiment 42, three control speakers, three noise/noise-cancellation effect detecting microphones, and three signal processors are provided. However, Embodiment 42 is not restricted to this configuration.

[0522] In Embodiment 42, the air-sending fan control means 174 is constituted by the CPU 131 within the controller 281. However, the air-sending fan control means 174 may be constituted by hardware, such as a LSI (Large Scale Integration) or a FPGA (Field Programmable Gate Array). Moreover, the configuration of the air-sending fan control means 174 is not restricted to the configuration shown in FIG. 93.

[0523] In Embodiment 42, the air-sending fan control means 174 is configured so that the rotation speed of a fan which outputs noise highly related to sound detected by a noise-cancellation effect detecting microphone having a larger noise cancellation amount may be increased and so that the rotation speed of a fan which outputs noise highly related to sound detected by a noise/noise-cancellation effect detecting microphone having a smaller noise cancellation amount may be decreased.

However, the air-sending fan control means 174 may be configured so that the rotation speed of a fan which outputs noise highly related to sound detected by a noise-cancellation effect detecting microphone having a larger noise cancellation amount will be increased or so that the rotation speed of a fan which outputs noise highly related to sound detected by a noise/noise-cancellation effect detecting microphone having a smaller noise cancellation amount will be decreased.

[0524] In Embodiment 42, as the parameter for controlling the rotation speeds of fans, the noise cancellation amounts of the noise/noise-cancellation effect detecting microphones 211 through 213 are used. However, as the parameter for controlling the rotation speeds of fans, another factor may be used. For example, the average value of sound pressure levels detected by each of the noise/noise-cancellation effect detecting microphones 211 through 213 may be calculated, and the rotation speed of a fan which outputs noise most highly related to sound detected by a noise/noise-cancellation effect detecting microphone having the largest averaged sound pressure level may be decreased.

Alternatively, for example, the average value of sound pressure levels detected by each of the noise/noise-cancellation effect detecting microphones 211 through 213 may be calculated, and the rotation speed of a fan which outputs noise most highly related to sound detected by a noise/noise-cancellation effect detecting microphone having the smallest averaged sound pressure level may be increased. Alternatively, the rotation speed of a fan which outputs noise most highly related to sound detected by a noise/noise-cancellation effect detecting microphone having the largest averaged sound pressure level may be decreased, and also, the rotation speed of a fan which outputs noise most highly related to sound detected by a noise/noise-cancellation effect detecting microphone having the smallest averaged sound pressure level may be increased.

[0525] As described above, in the indoor unit 100 according to Embodiment 42, the plurality of fans 20A through 20C are provided, and the controller 281 (more specifically, the air-sending fan control means 174) which individually controls the rotation speeds of the fans 20A through 20C is provided. The air-sending fan control means 174 controls the rotation speeds so that, among noise cancellation amounts of the noise/noise-cancellation effect detecting microphones 211 through 213, the rotation speed of a fan which outputs noise highly related to sound detected by a noise/noise-cancellation effect detecting microphone having the largest noise cancellation amount may be increased, and so that the rotation speed of a fan which outputs noise highly related to sound detected by a noise/noise-cancellation effect detecting microphone having the smallest noise cancellation amount may be decreased.

Accordingly, by increasing the rotation speed in an area where the noise cancellation amount is large, noise cancellation effects become even higher, and by decreasing the rotation speed in an area where the noise cancellation amount is small, noise of this area becomes smaller. It is thus possible to further reduce noise compared with an indoor unit which has a noise cancellation mechanism having the same configuration as that of Embodiment 42 but uses only a single fan or an indoor unit which does not perform fan individual control.

[0526] In the indoor unit 100 according to Embodiment 42, the fan which outputs noise highly related to sound detected by a noise/noise-cancellation effect detecting microphone having the largest noise cancellation amount is specified. Accordingly, even if the plurality of fans 20A through 20C having different sound pressure levels to be output are used, rotation speed control can be precisely performed.

[0527] Additionally, the air-sending fan control means 174 controls the rotation speeds of the fans 20A through 20C so that the amount of air output from the air outlet 3 when fan individual control is performed may become the same as that when identical rotation speed control is performed. It is thus possible to reduce noise without causing degradation in aerodynamic performance.

[0528] Moreover, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, noise components output from the fans 20A through 20C can be separated, and the noise cancellation mechanism D reduces noise only output from the fan 20A, the noise cancellation mechanism E reduces noise only output from the fan 20C, and the noise cancellation mechanism F reduces noise only output from the fan 20B. With this configuration, in each region, crosstalk noise components caused by noise output to an adjacent region can be decreased.

[0529] Further, by dividing the flow channel of the indoor unit 100 into a plurality of regions by using the partition boards 90 and 90a, the flow channel becomes closer to a duct structure, and noise can be linearly handled. Accordingly, the phase of noise which conducts through the indoor unit 100 becomes uniform, and thus, the phase error occurring when control sound is caused to interfere with noise becomes smaller, thereby making it possible to obtain even higher noise reduction effects than the configuration shown in FIG. 95. Additionally, even if there is an area where a noise cancellation mechanism is not provided, the rotation speed of a fan which is not provided with a noise cancellation mechanism is decreased, thereby reducing noise in this area. As a result, effects similar to those described above can be obtained.

[0530] Further, in Embodiment 42, the noise detecting microphones 161 through 163 and the noise-cancellation effect detecting microphones 191 through 193 are integrated into the noise/noise-cancellation effect detecting microphones 211 through 213, respectively. Accordingly, the number of microphones can be reduced, and thus, the number of parts can be reduced, thereby making it possible to further decrease the cost.

List of Reference Signs

[0531]

1	casing
1b	back portion
2	air inlet
3	air outlet
5	bell mouth
5a	top portion
5b	middle portion
5c	bottom portion
5d	through-hole
6	nozzle
10	filter
15	finger guard
16	motor stay
17	fixing member
17a	through-hole
17b	fixing member
18	support member
20	fan
20A	fan
20B	fan
20C	fan
20a	rotational axis
21	boss
22	ring-like member
23	blade (main blade)
23a	projecting piece
23b	ring-like member
23c	projecting piece
24	sub blade
25	impeller
26	housing
26a	upper housing
26b	lower housing
26c	rib
30	fan motor
30a	circuit board
31	rotor
35s	upport structure
40	stator
50	heat exchanger
50a	symmetric line
51	front-side heat exchanger
51a	heat exchanger
51b	heat exchanger
55	back-side heat exchanger
55a	heat exchanger
55b	heat exchanger
56	fin

(continued)

57	heat exchanger pipe
70	upper and lower vanes
70a-70c	upper and lower vanes
80	right and left vanes
90	partition board
90a	partition board
100	indoor unit
110	front-side drain pan
111	drainage channel
111a	tongue portion
115	back-side drain pan
116	connecting portion
117	drain hose
130	input section
131	CPU
132	memory
133	identical-rotation-speed determining means
134	fan-individual-control rotation speed determining means
134A	fan-individual-control rotation speed determining means
134B	fan-individual-control rotation speed determining means
134C	fan-individual-control rotation speed determining means
135	SW
136	averaging means
137	coherence calculating means
138	noise-cancellation-amount calculating means
139	pre-control sound pressure level storage means
140	differentiator
151	microphone amplifier
152	A/D converter
154	D/A converter
155	amplifier
158, 160	FIR filter
159	LMS algorithm
161	noise detecting microphone
162	noise detecting microphone
163	noise detecting microphone
171	air-sending fan control means
172	air-sending fan control means
173	air-sending fan control means
174	air-sending fan control means
181	control speaker
182	control speaker
183	control speaker
184	box
184a	back chamber
191	noise-cancellation effect detecting microphone
192	noise-cancellation effect detecting microphone
193	noise-cancellation effect detecting microphone
201	signal processor
206	signal processor
211	noise/noise-cancellation effect detecting microphone

(continued)

213	noise/noise-cancellation effect detecting microphone
250	small wing
251	projection
252	recirculating flow
253	leakage flow
254	projection
255	suction guide
256	discharge guide
257	insulating layer
260	acoustic material
280	remote controller
281	controller
282A	through 282C motor driver
301	boss (related art)
302	ring-like member (related art)
303	blade (related art)
305	rotor (related art)
309	stator (related art)

Claims

1. An indoor unit of an air-conditioning apparatus, comprising:

- a casing including an air inlet formed at a top portion thereof and an air outlet formed at a bottom side of a front portion thereof;
- an axial-flow or diagonal-flow fan disposed on a downstream side of the air inlet within the casing;
- a heat exchanger disposed on a downstream side of the fan within the casing and on an upstream side of the air outlet, for exchanging heat between air blown out of the fan and a refrigerant;
- a filter that collects dust from air sucked into the casing; and
- a motor stay including a fixing member and a bar-like or plate-like support member, the fixing member fixing a fan motor on which an impeller of the fan is mounted or a support structure for rotatably supporting the impeller of the fan, the bar-like or plate-like support member securing the fixing member to the casing,

wherein the filter and the motor stay are disposed on the downstream side of the fan, and
wherein the motor stay is disposed on an upstream side of the filter or the downstream side of the filter so that a distance between the motor stay and the filter is smaller than a projection dimension, the projection dimension being the largest among projection dimensions in a cross section view perpendicular to a longitudinal direction of the support member.

2. The indoor unit of an air-conditioning apparatus of claim 1,
wherein, as viewed from a longitudinal cross section, a distance between the support member and a trailing edge of a blade of the fan increases toward a tip portion of the blade.

3. The indoor unit of an air-conditioning apparatus of claim 1 or 2,
wherein the heat exchanger is one of a plurality of heat exchangers, and the fixing member is disposed above a joint portion of the plurality of heat exchangers.

4. An indoor unit of an air-conditioning apparatus, comprising:

- a casing including an air inlet formed at a top portion thereof and an air outlet formed at a bottom side of a front portion thereof;
- an axial-flow or diagonal-flow fan disposed on a downstream side of the air inlet within the casing; and
- a heat exchanger disposed on a downstream side of the fan within the casing and on an upstream side of the

air outlet, for exchanging heat between air blown out of the fan and a refrigerant,

wherein the fan includes an impeller and a housing which surrounds an outer periphery of the impeller, and the housing has a noise cancellation structure.

5. The indoor unit of an air-conditioning apparatus of claim 4,
wherein the housing is formed in a hollow structure, and a communication channel which communicates with an internal space of the housing is formed.

6. The indoor unit of an air-conditioning apparatus of claim 5,
wherein the internal space of the housing is divided into a plurality of space areas.

7. The indoor unit of an air-conditioning apparatus of claim 6, wherein:

the fan is one of a plurality of fans;
the housing is integrally formed such that the housing surrounds outer peripheries of the plurality of fans;
an inside of the housing is formed in a hollow structure; and
an internal space of the housing is divided into a plurality of space areas.

8. The indoor unit of an air-conditioning apparatus of any of claims 5 to 7, wherein the internal space of the housing is also used as a storage space.

9. The indoor unit of an air-conditioning apparatus of any of claims 5 to 8, wherein an acoustic material is provided in the internal space of the housing.

10. The indoor unit of an air-conditioning apparatus of any of claims 5 to 9, wherein the communication channel is constituted by a plurality of through-holes.

11. The indoor unit of an air-conditioning apparatus of any of claims 5 to 9, wherein the communication channel is formed in a slit shape.

12. The indoor unit of an air-conditioning apparatus of claim 4,
further comprising:

- a noise detecting device that detects noise output from the fan;
- a control sound output device that outputs control sound for reducing the noise;
- a noise-cancellation effect detecting device that detects noise cancellation effects obtained by the control sound; and
- a control sound generating device that causes the control sound output device to output the control sound on the basis of detection results obtained by the noise detecting device and the noise-cancellation effect detecting device,

wherein the housing is formed in a hollow structure, and
the noise detecting device is disposed in an internal space of the housing.

13. The indoor unit of an air-conditioning apparatus of any of claims 1 to 12, wherein:

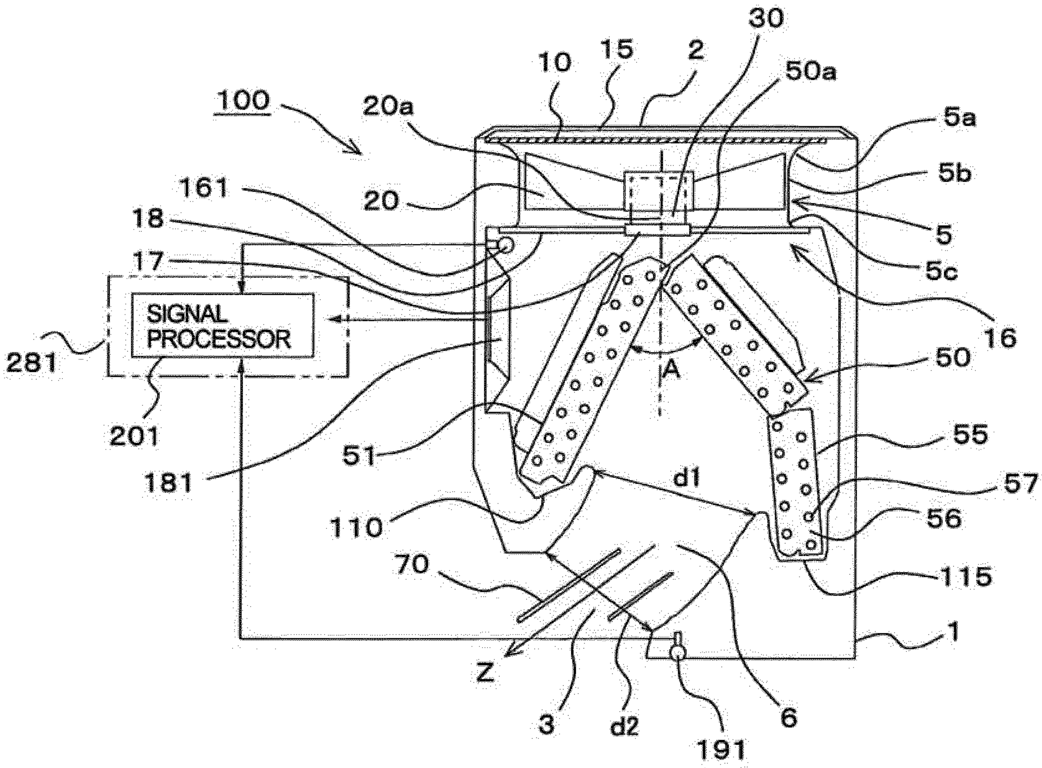
the heat exchanger includes a front-side heat exchanger disposed in a front side of the casing and a back-side heat exchanger disposed in a back side of the casing; and
as viewed from a side surface, a length of the front-side heat exchanger is shorter than a length of the back-side heat exchanger.

14. The indoor unit of an air-conditioning apparatus of any of claims 1 to 13, wherein:

the heat exchanger includes a front-side heat exchanger disposed in a front side of the casing and a back-side heat exchanger disposed in a back side of the casing; and
a pressure loss of the front-side heat exchanger is greater than a pressure loss of the back-side heat exchanger.

15. An air-conditioning apparatus comprising the indoor unit of any one of claims 1 to 14.

F I G. 1


30
10
15
2
50a
100
20a
5a
161
20
5b
5
18
5c
17
SIGNAL
PROCESSOR
16
281
A
50
201
55
51
d1
57
181
56
110
70
115
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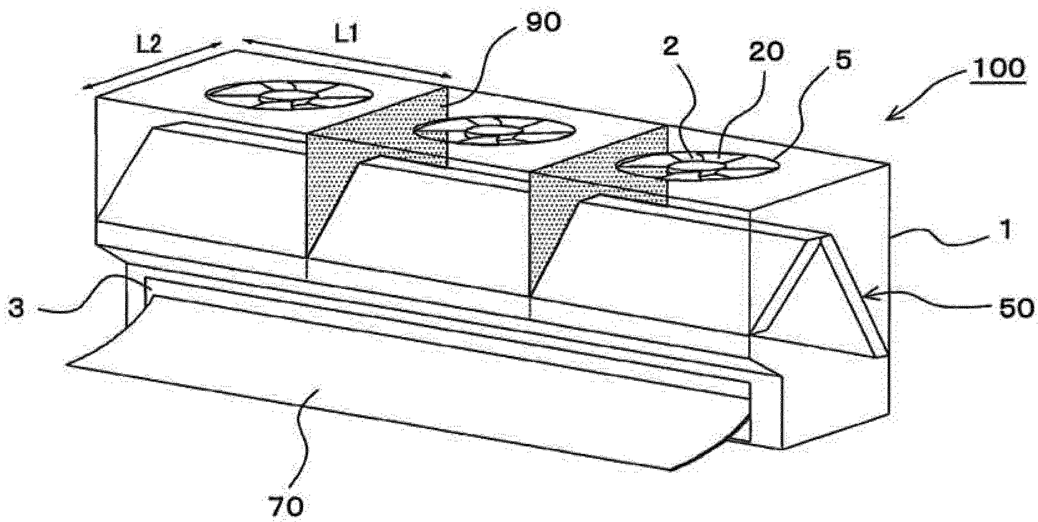
Z
3
d2
6
191

F I G. 2


L2
L1
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5
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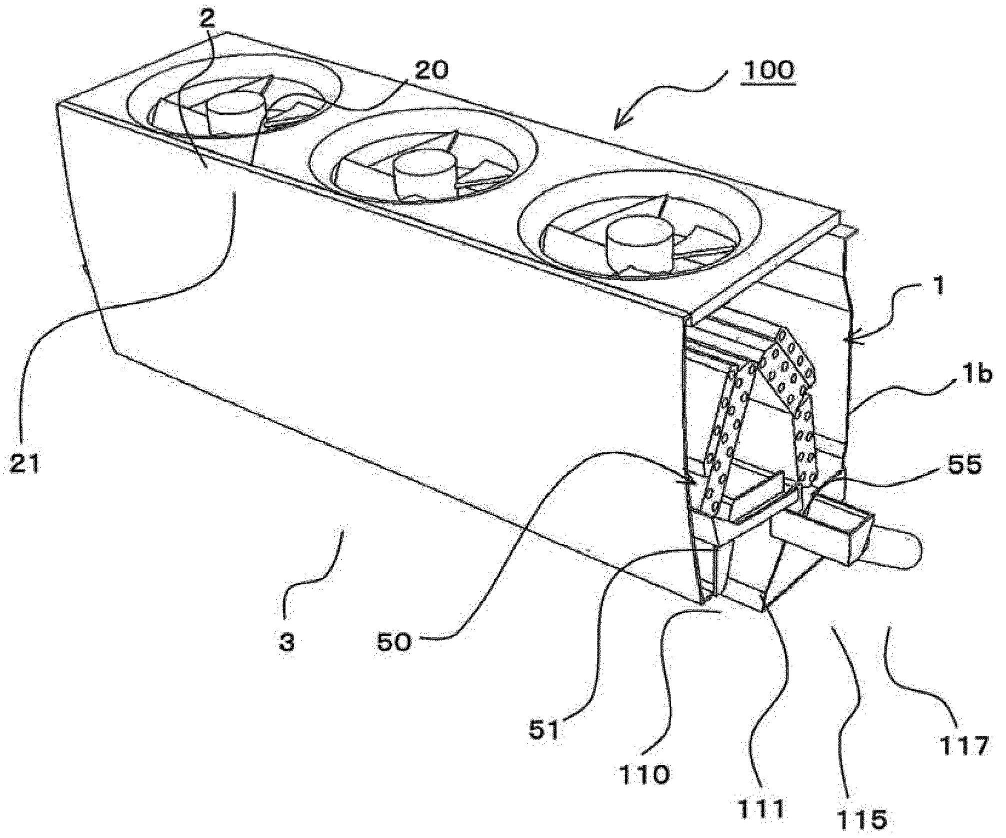
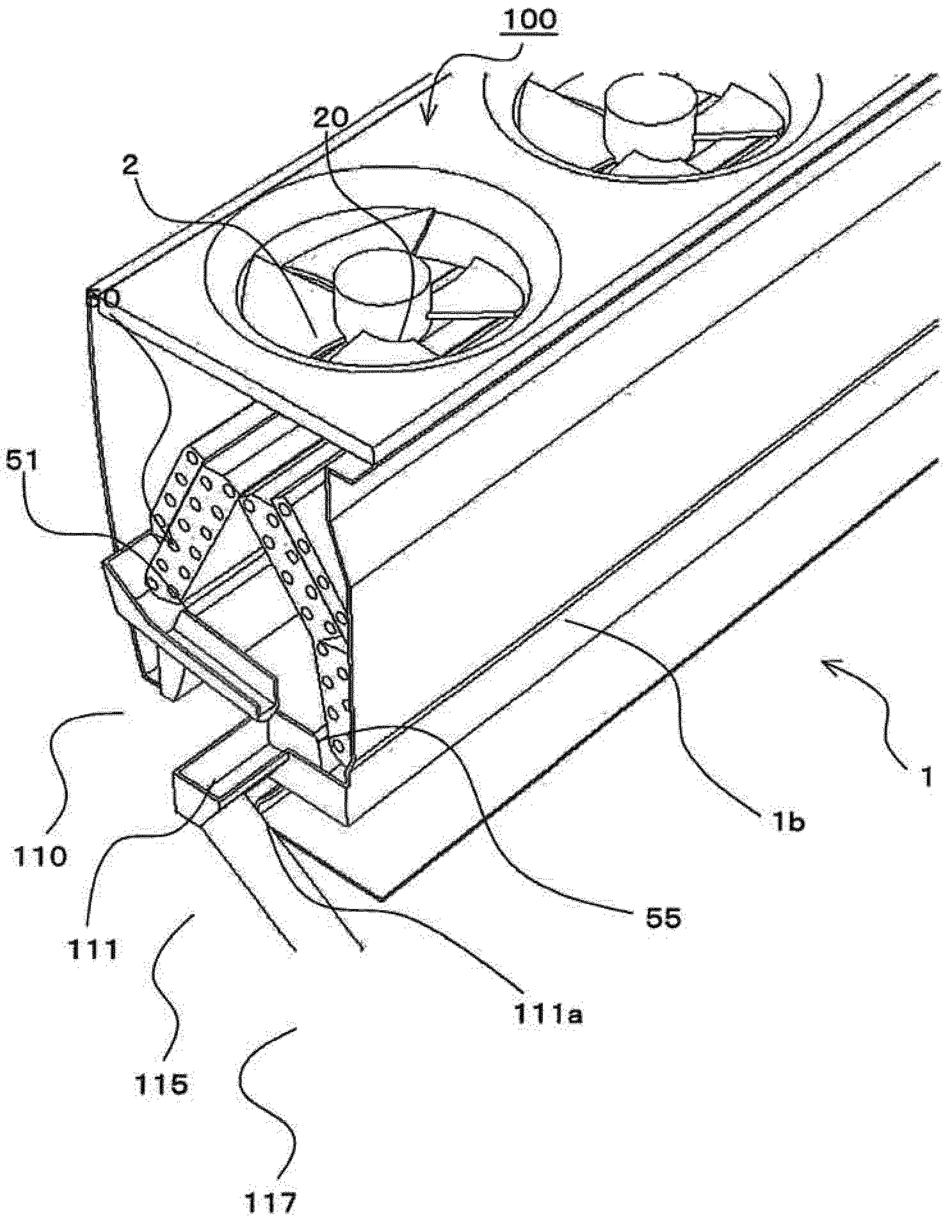
50
70

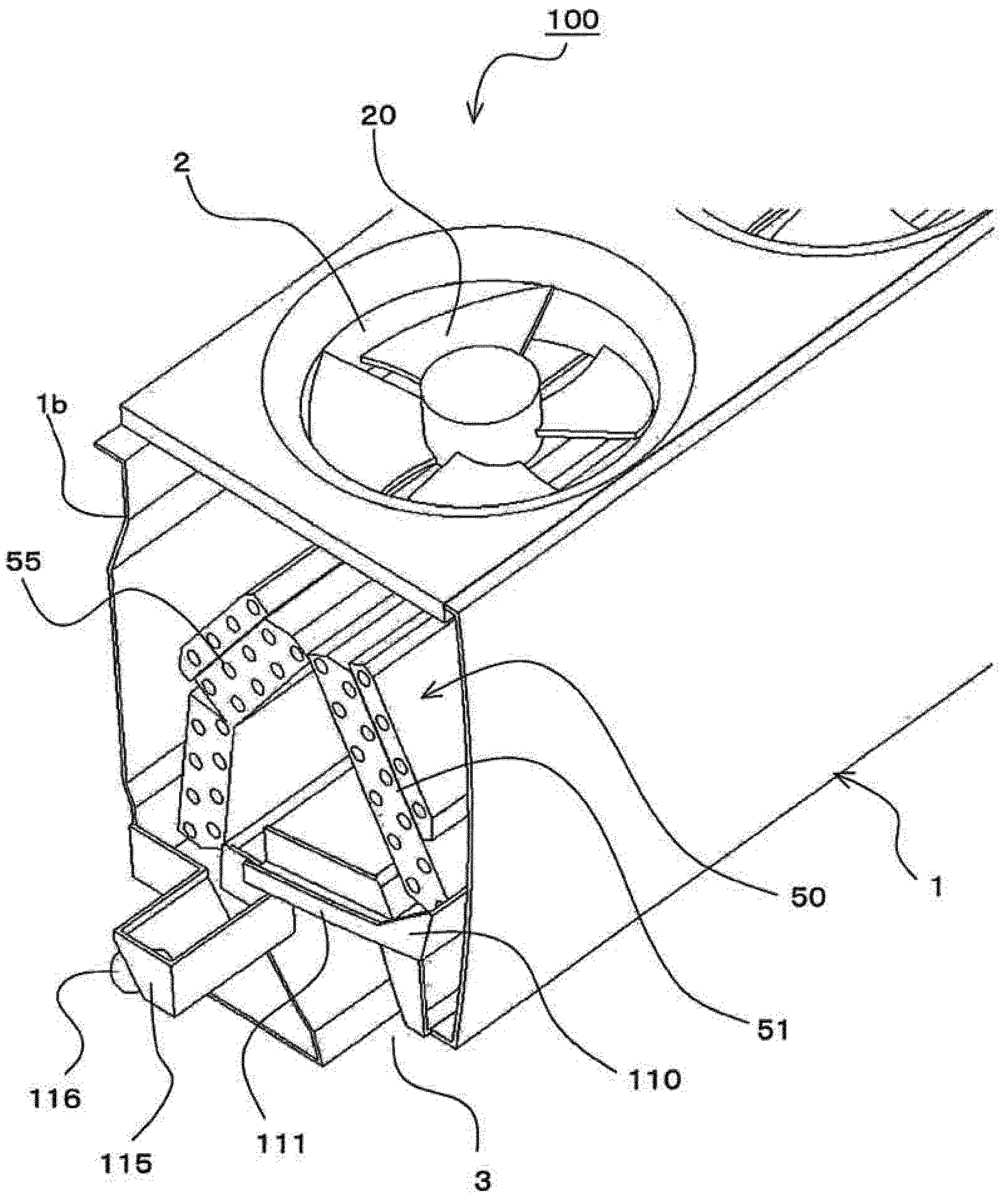
F I G. 3



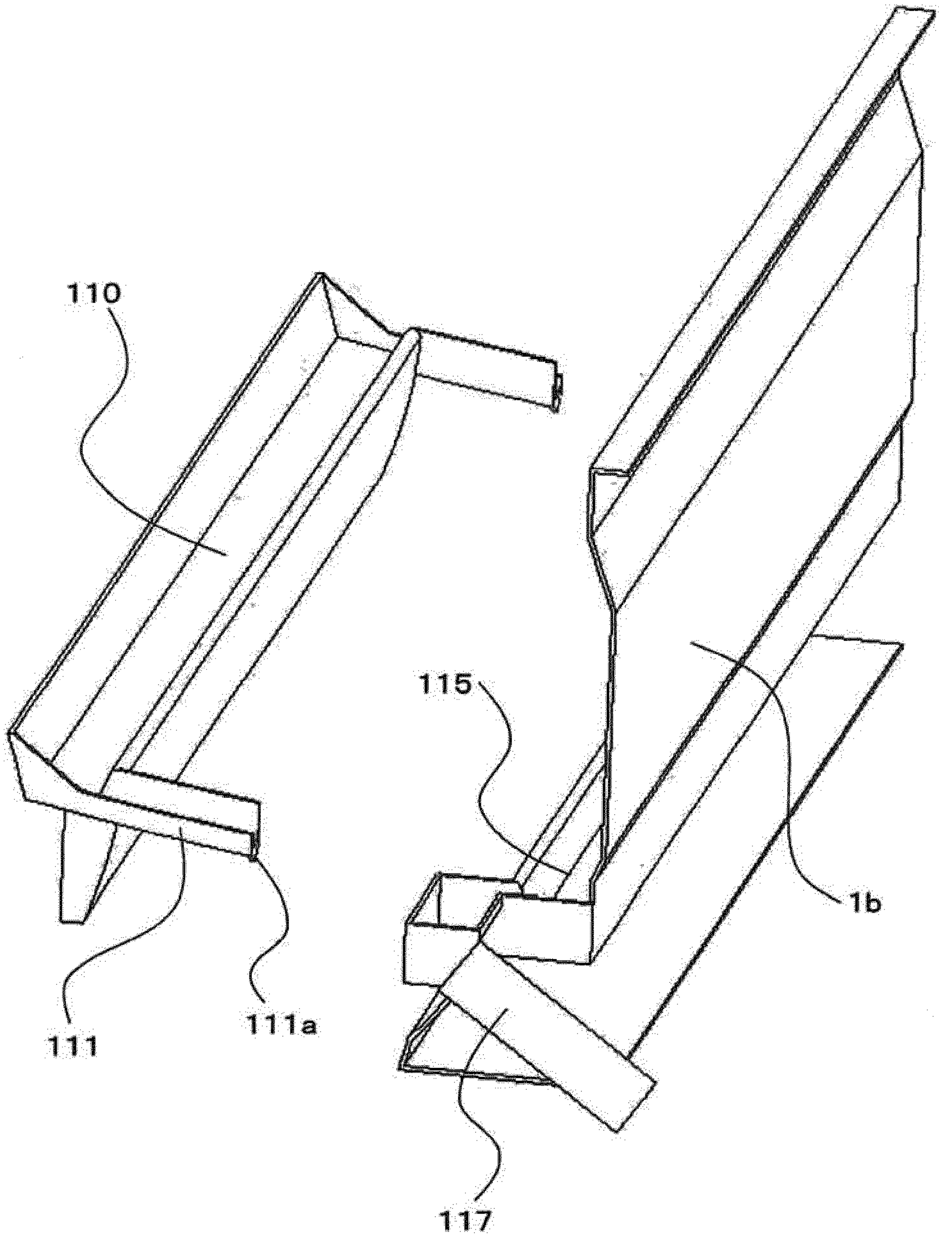
F I G. 4



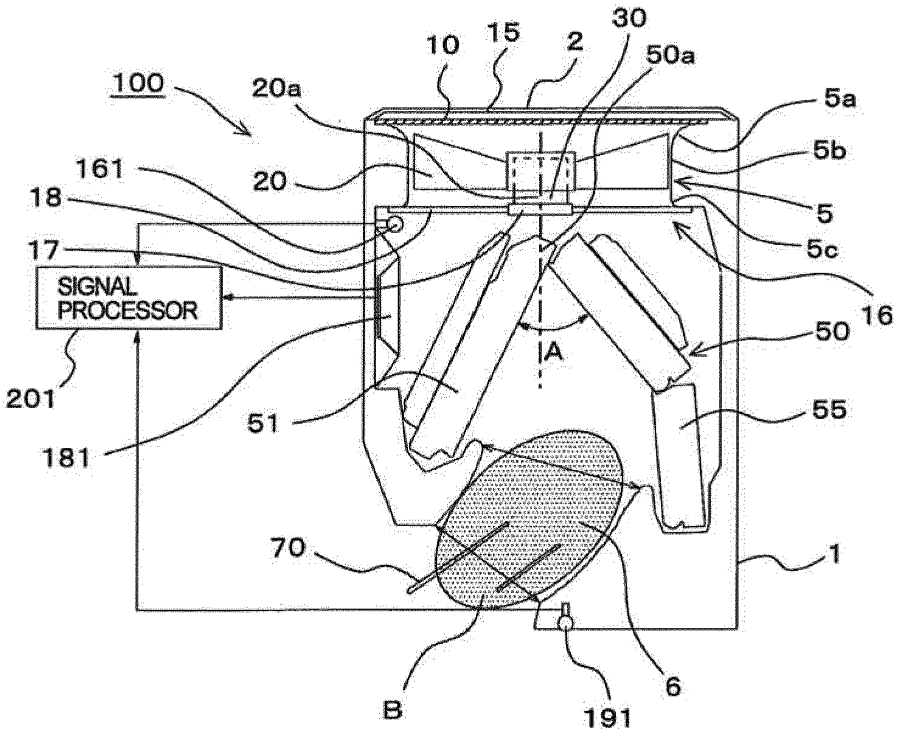
F I G. 5



F I G. 6



F I G. 7


100
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SIGNAL PROCESSOR
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A
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181
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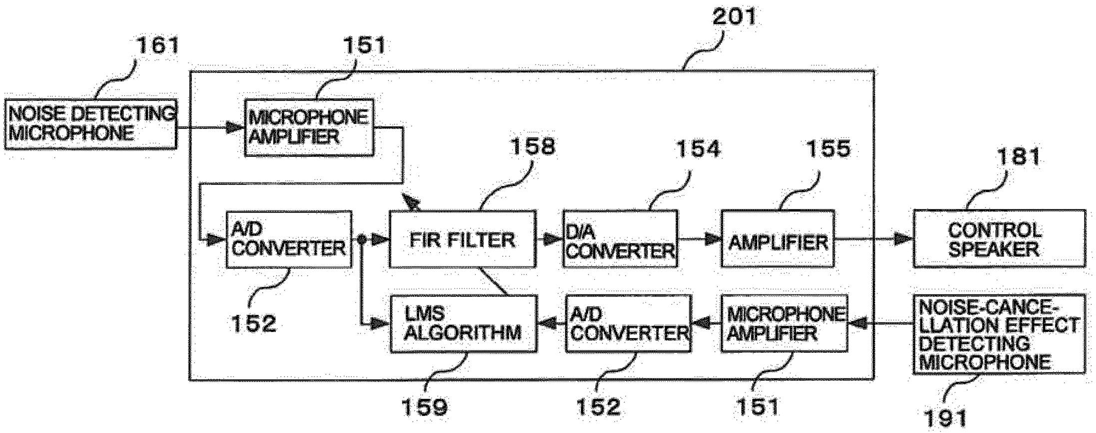
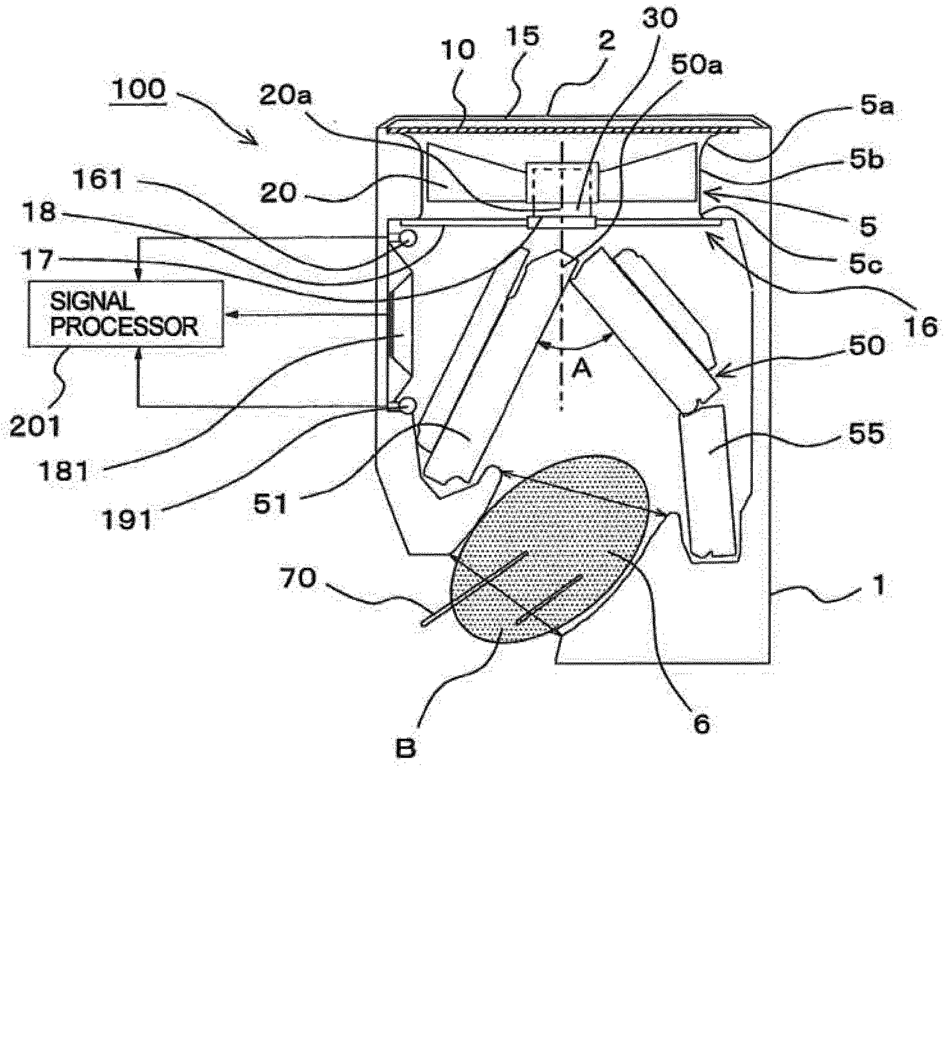
191
6

F I G. 8


201
161
151
NOISE DETECTING MICROPHONE
MICROPHONE AMPLIFIER
158
154
155
181
A/D CONVERTER
FIR FILTER
D/A CONVERTER
AMPLIFIER
CONTROL SPEAKER
152
LMS ALGORITHM
A/D CONVERTER
MICROPHONE AMPLIFIER
NOISE-CANCE-LLATION EFFECT DETECTING MICROPHONE
159
152
151
191

F I G. 9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SIGNAL PROCESSOR
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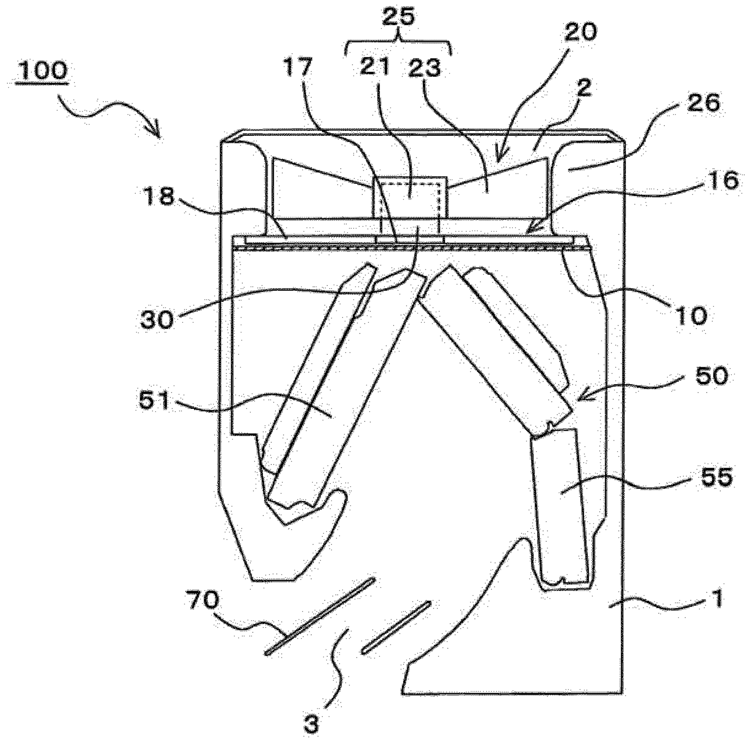
F I G. 1 0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F I G. 1 1

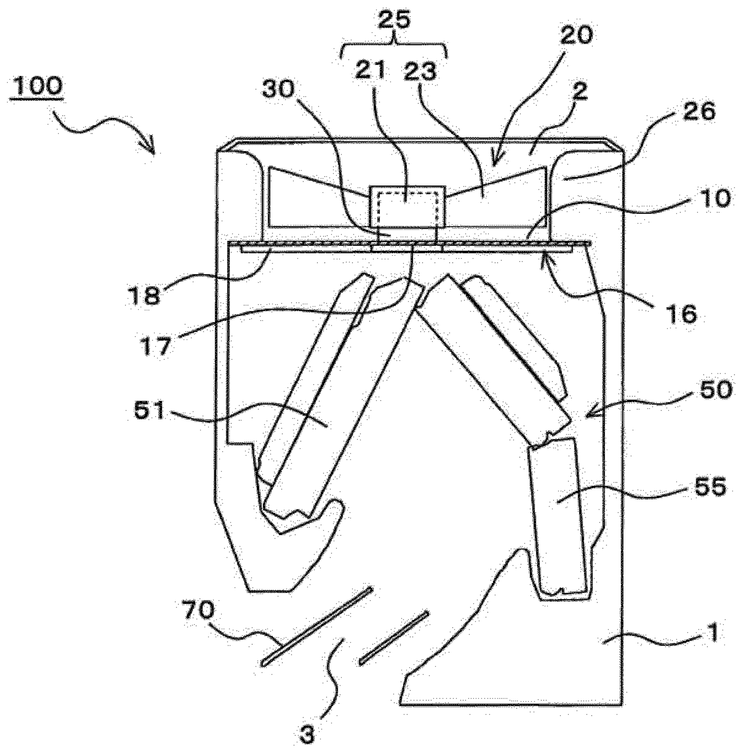
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FIG. 12

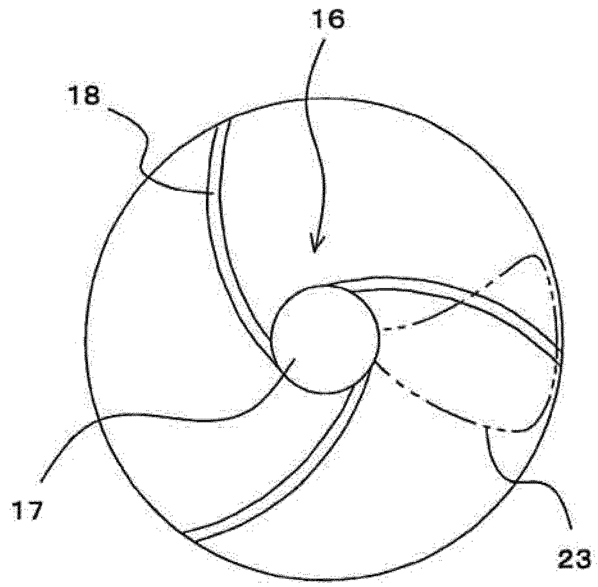


FIG. 13

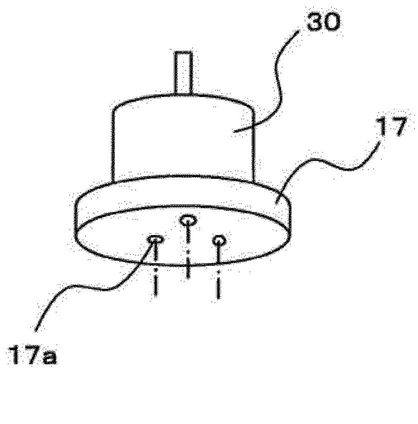


FIG. 14

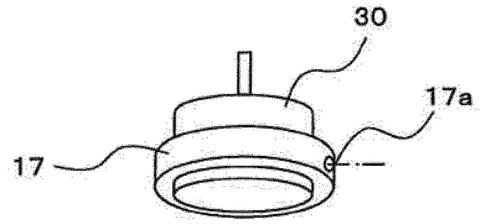


FIG. 15

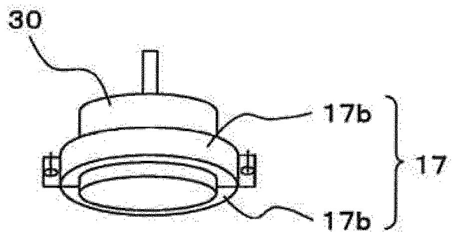


FIG. 16

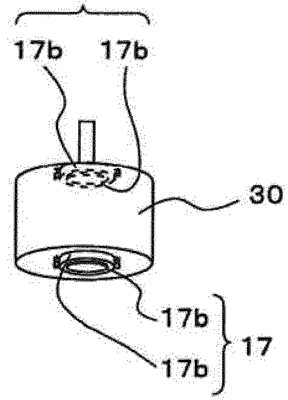
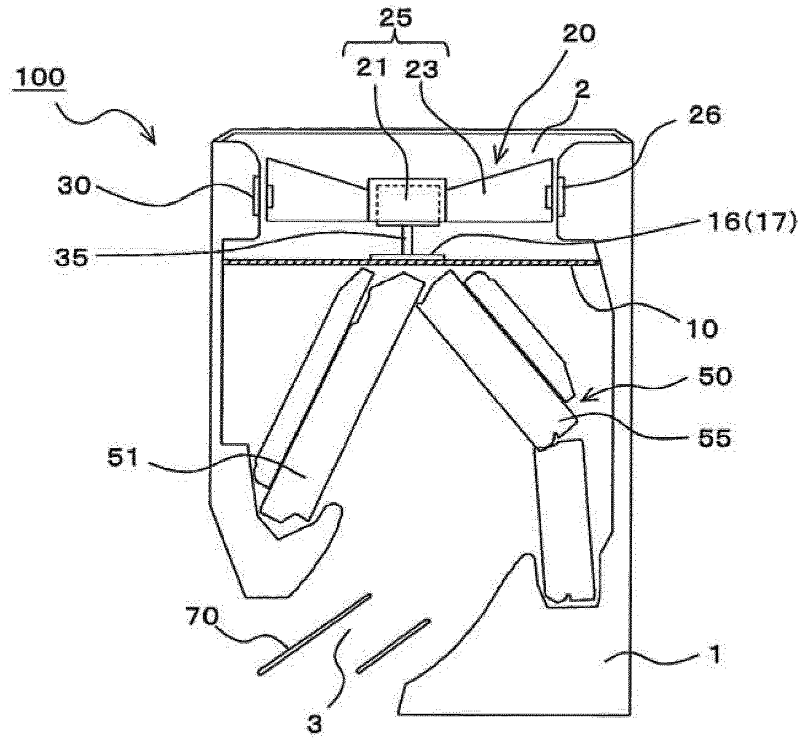


FIG. 17



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16(17)
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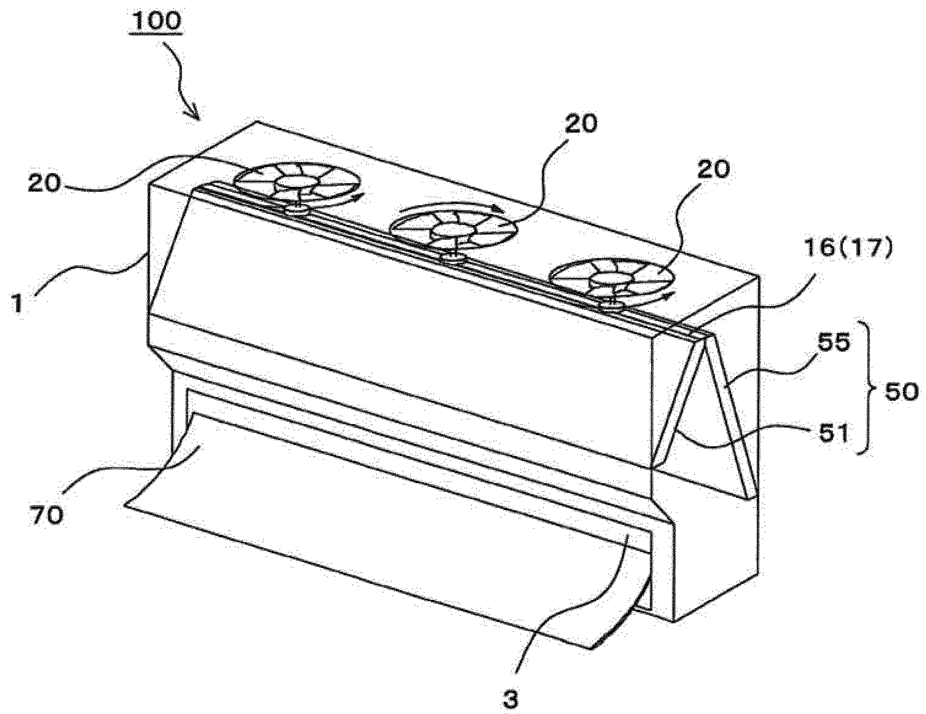
FIG. 18



100
20
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16(17)
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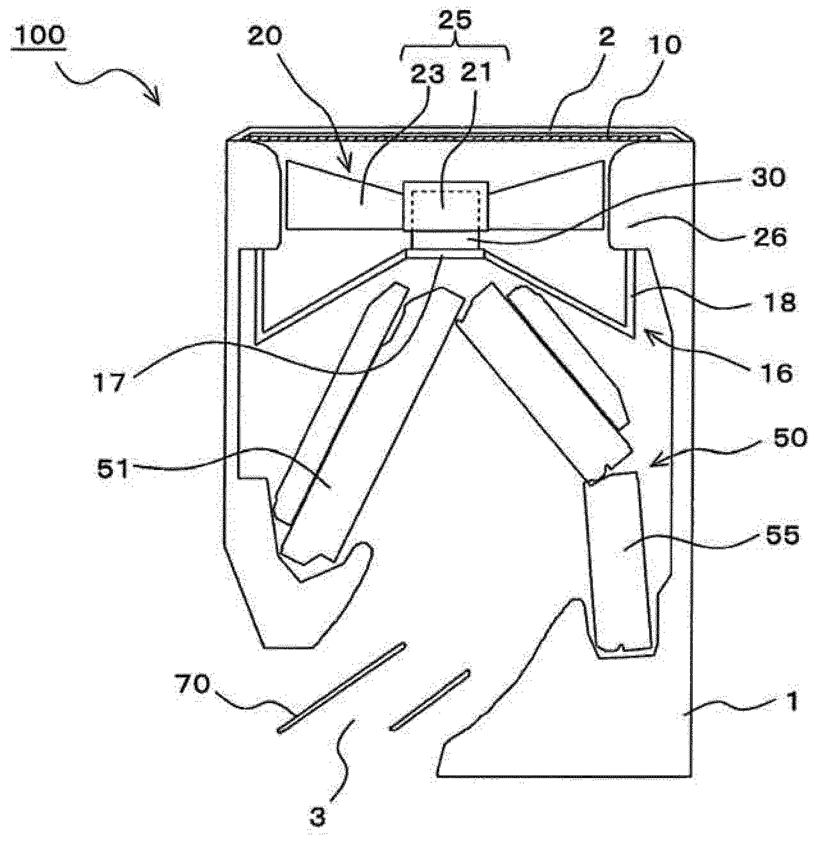
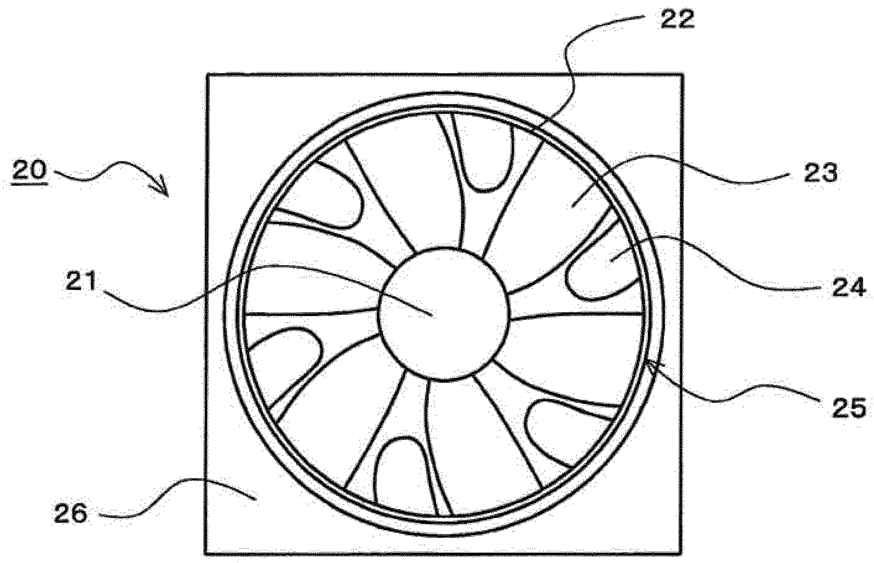
51
70
3

F I G. 1 9

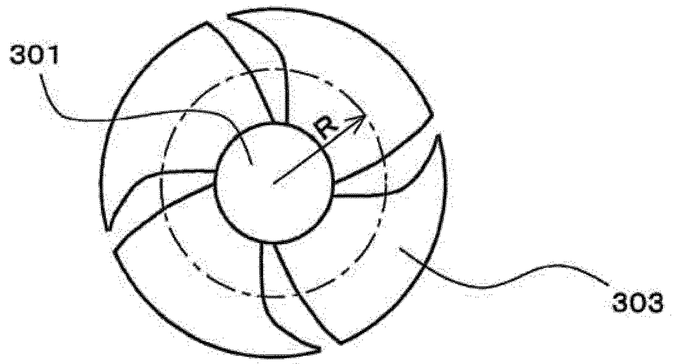


F I G. 2 0



F I G. 2 1

(a)



(b)

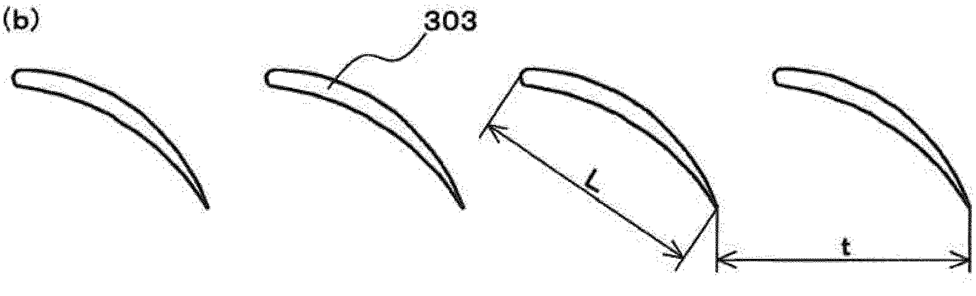


FIG. 22

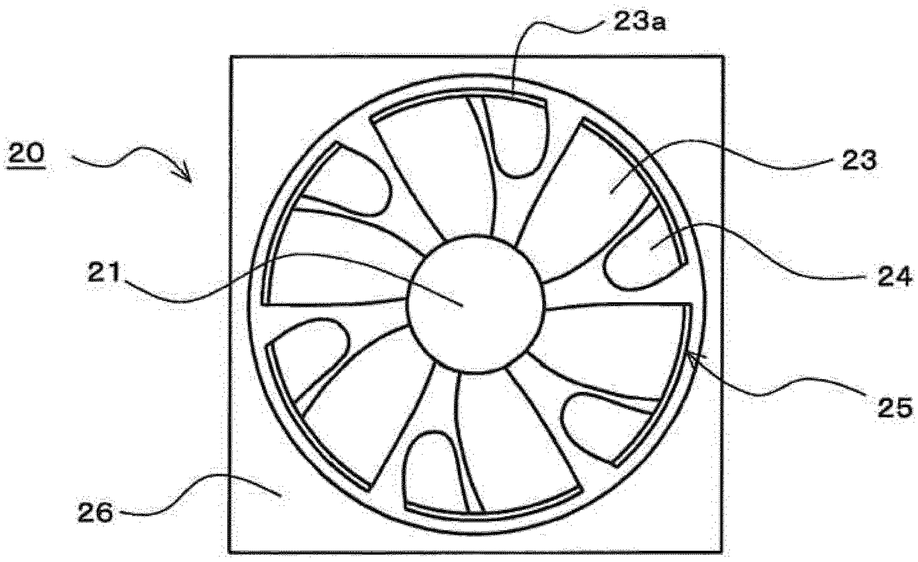


FIG. 23

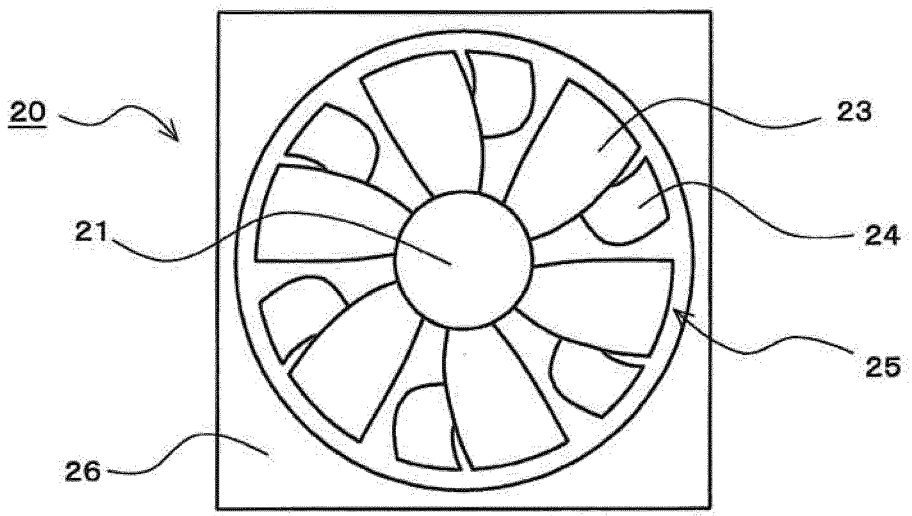


FIG. 24

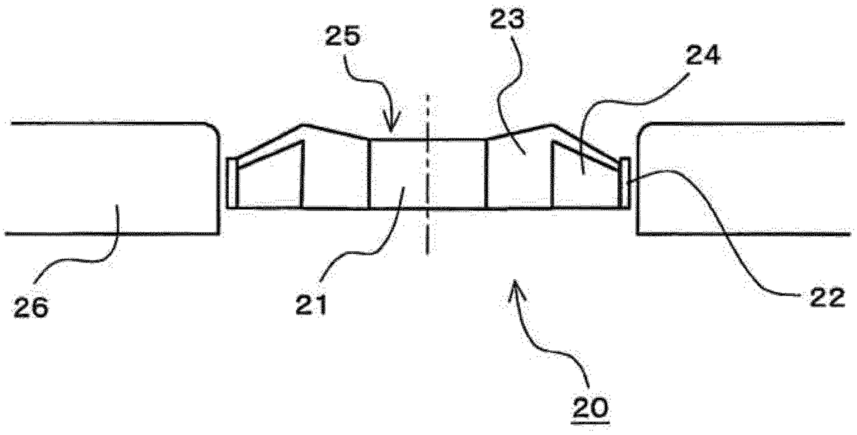
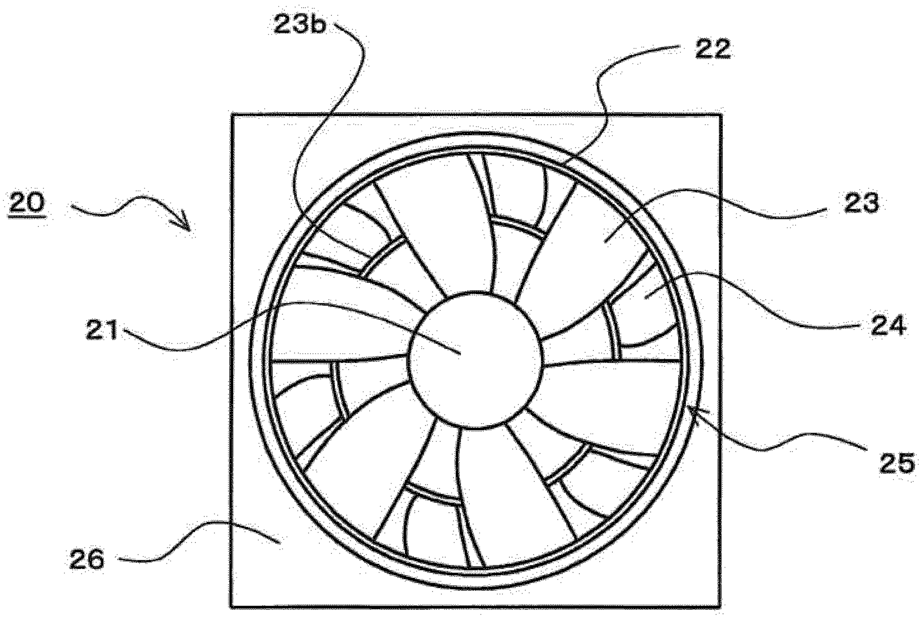
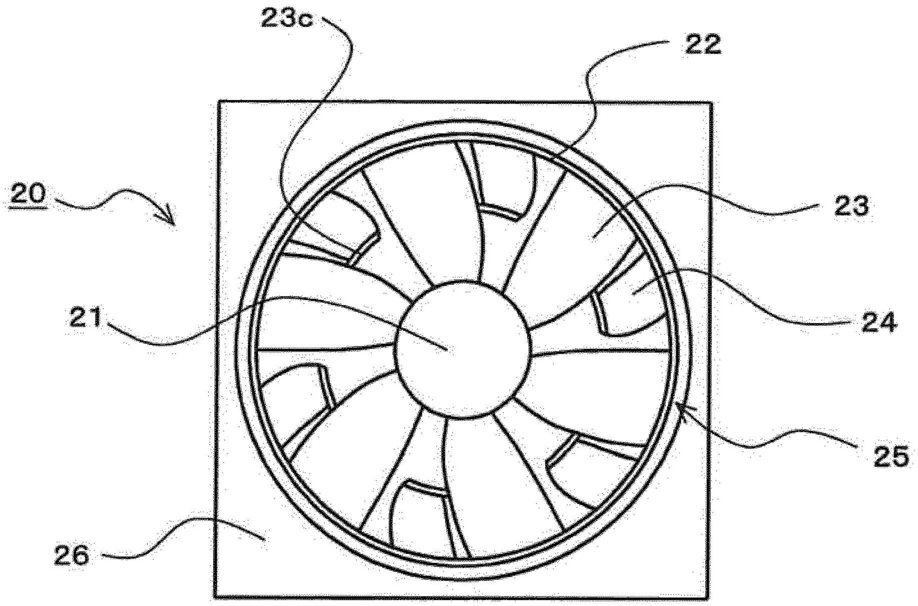


FIG. 25



F I G. 2 6



F I G. 2 7

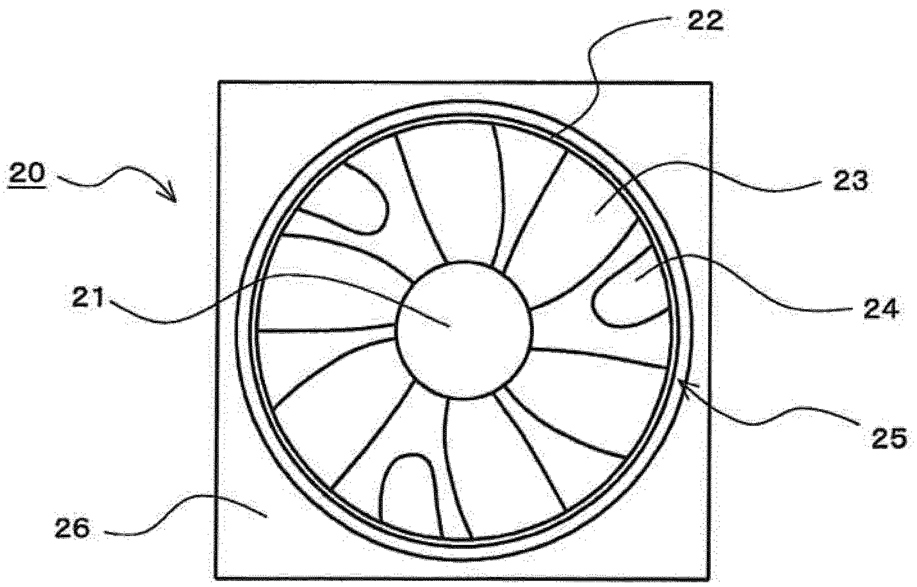


FIG. 28

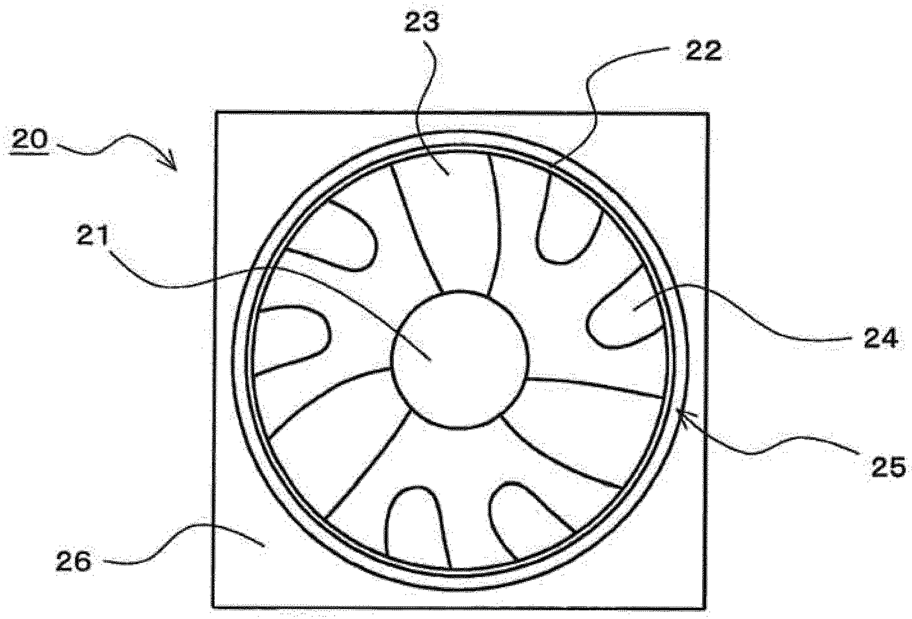
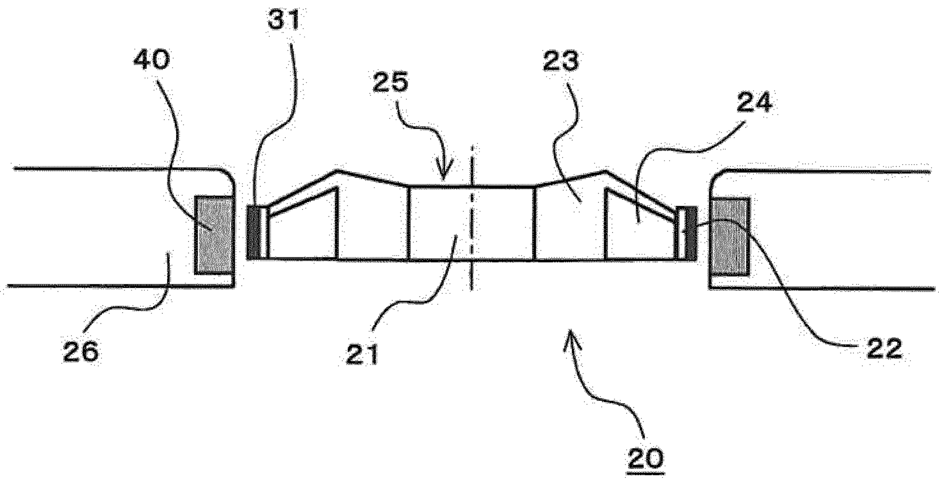
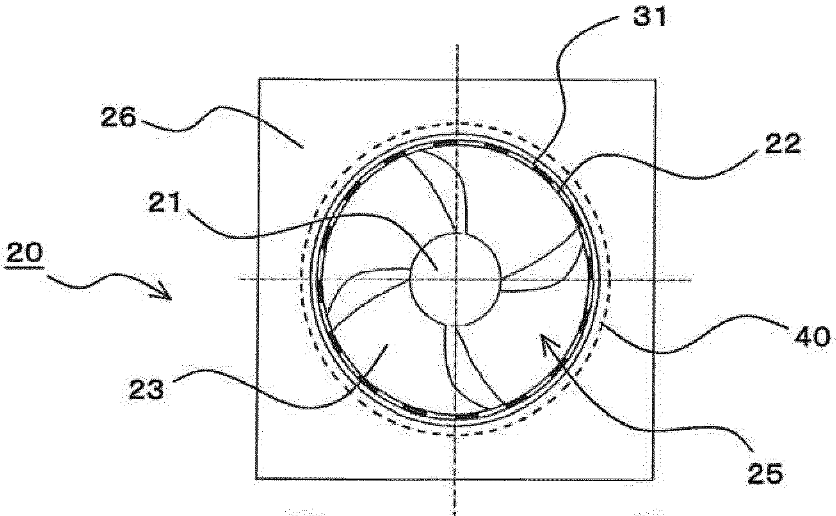


FIG. 29



F I G. 3 0

(a)



(b)

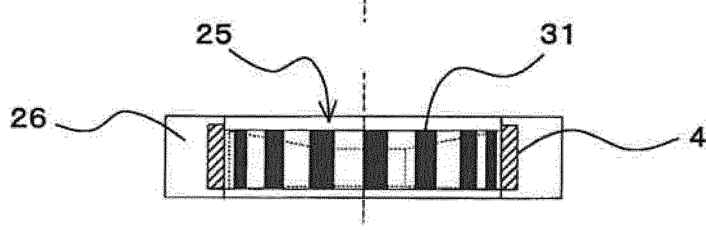


FIG. 31

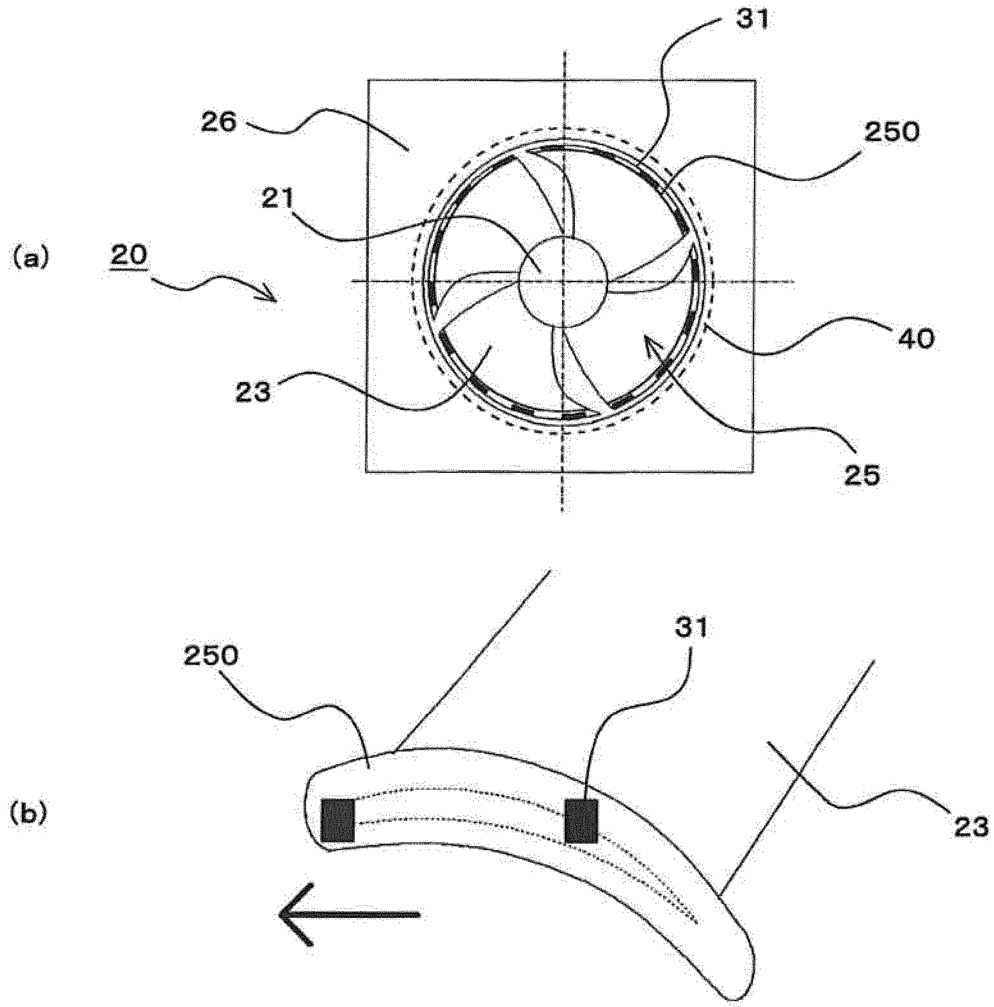
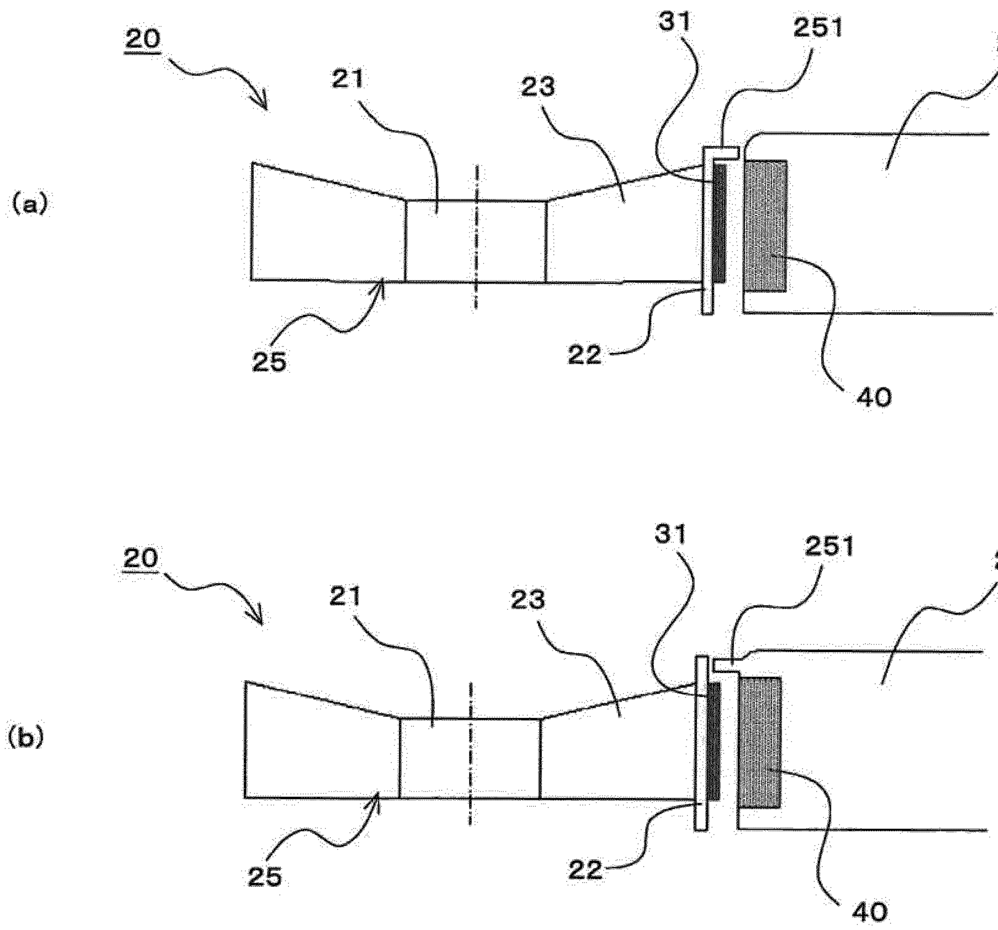


FIG. 32



F I G. 3 3

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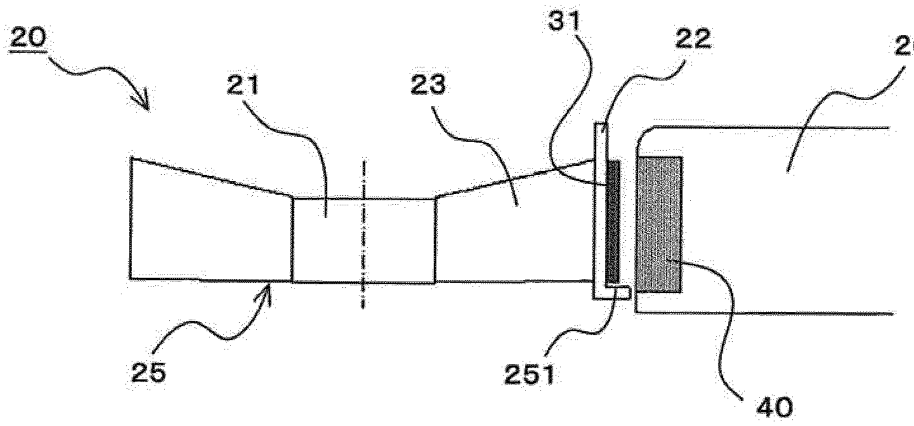
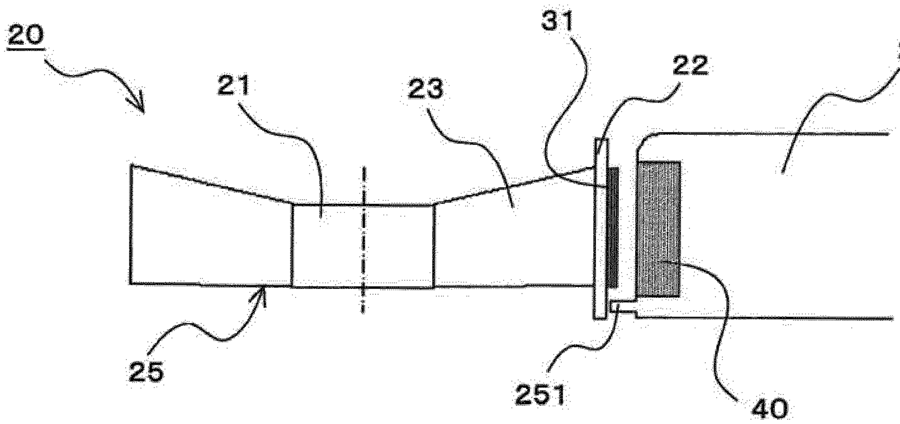


(b)



F I G. 3 4

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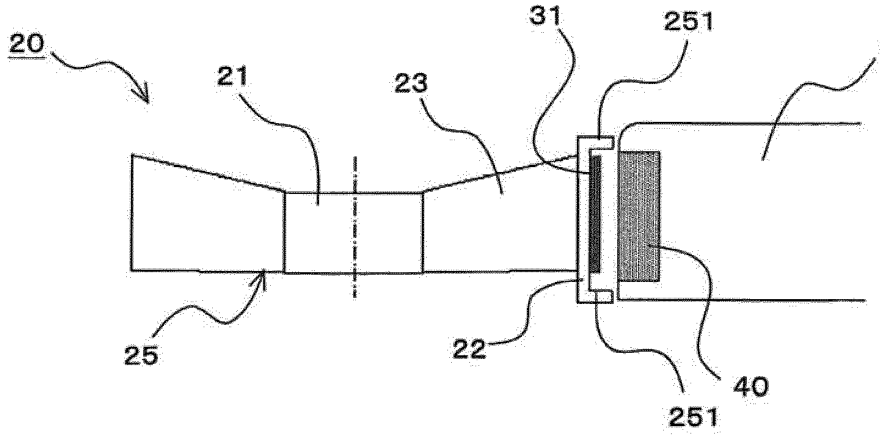

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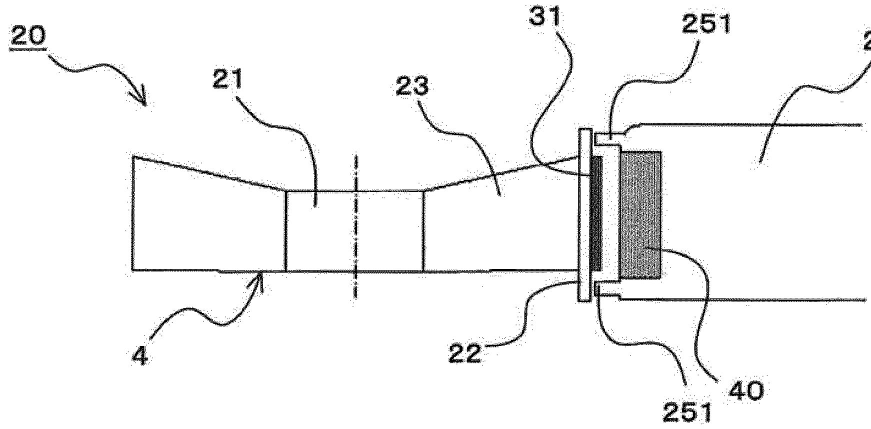
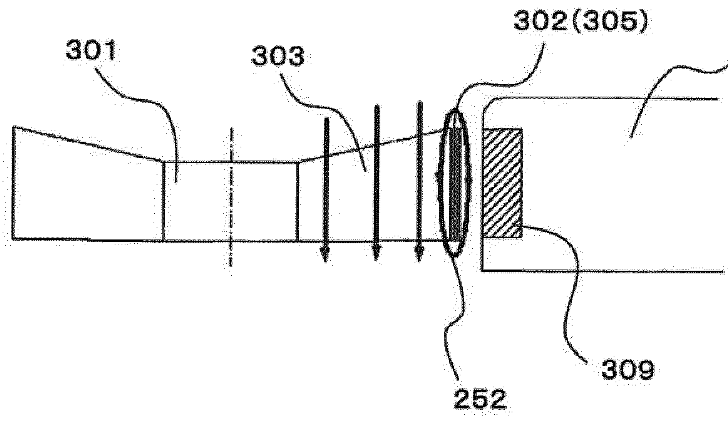


FIG. 35

(a)



(b)

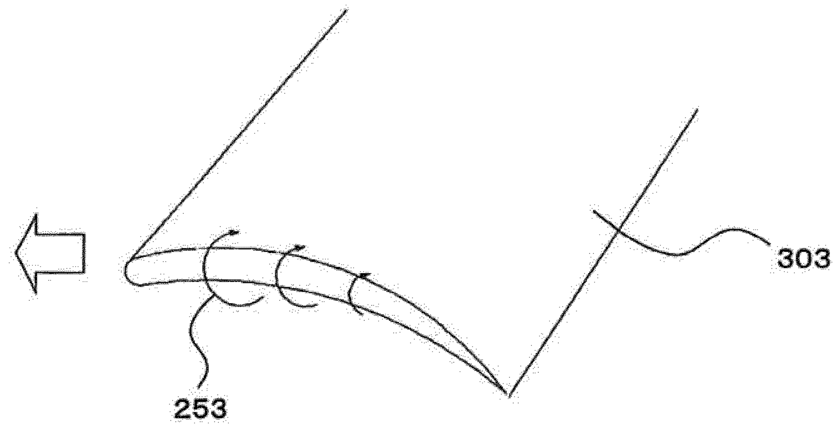
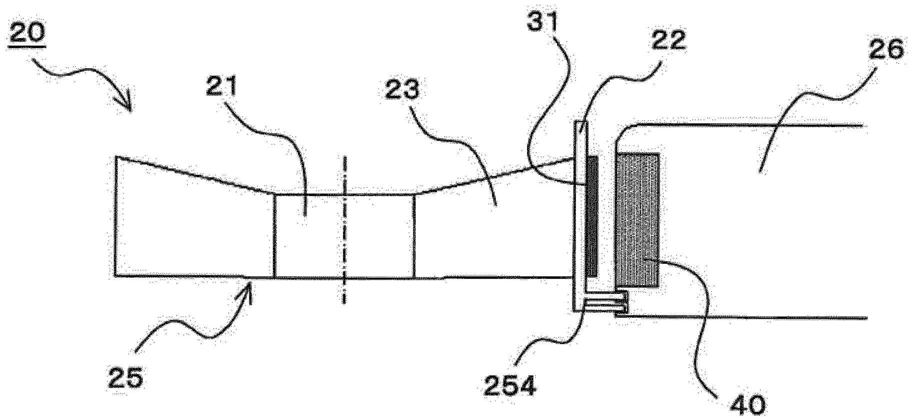
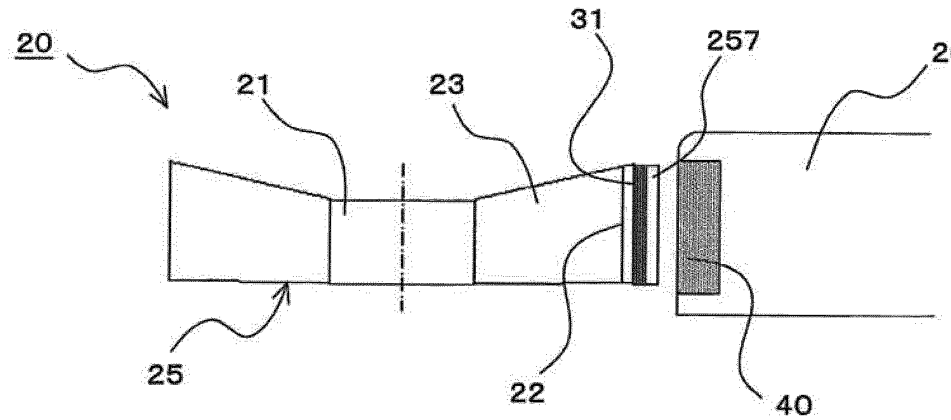


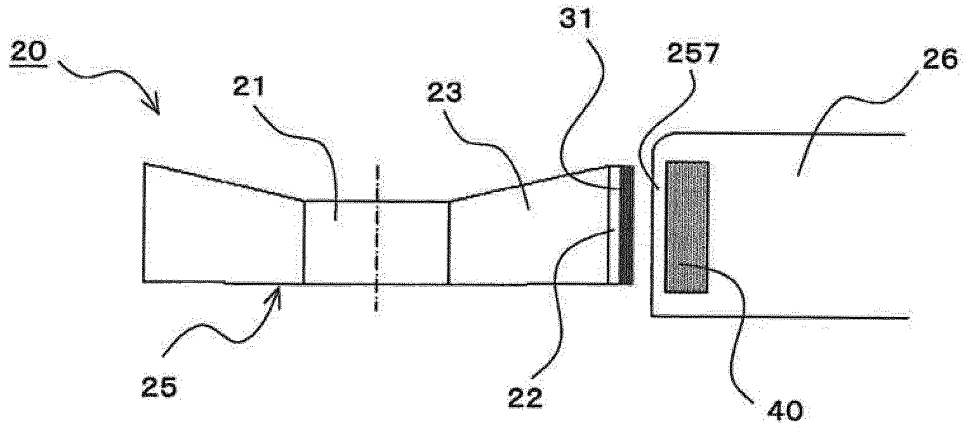
FIG. 36



F I G. 3 7



F I G. 3 8



F I G. 3 9

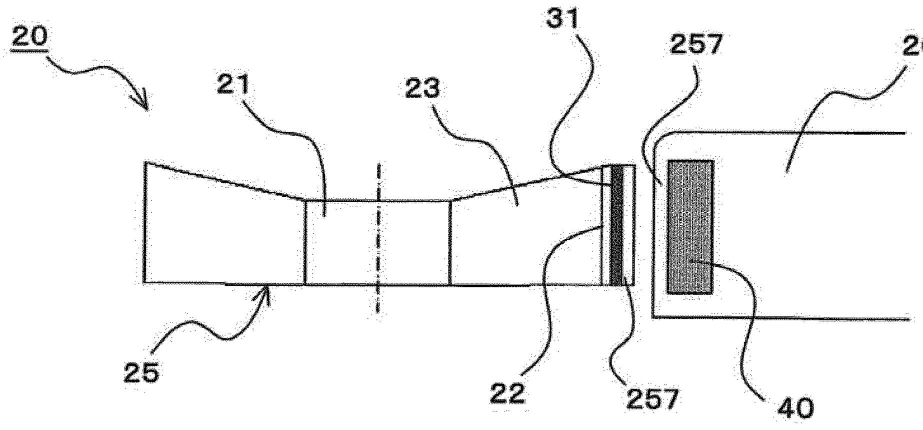


FIG. 40

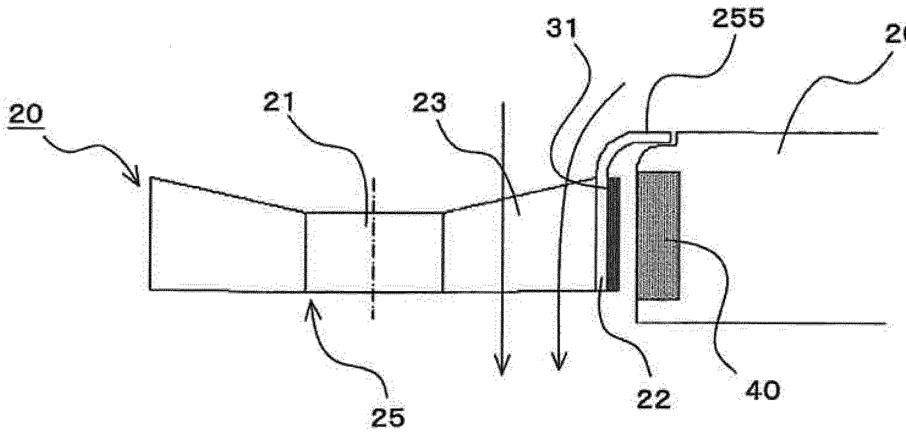
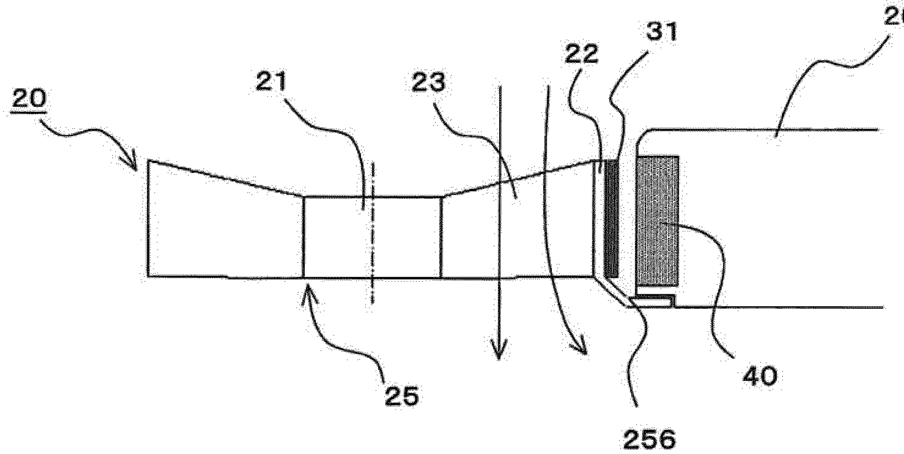
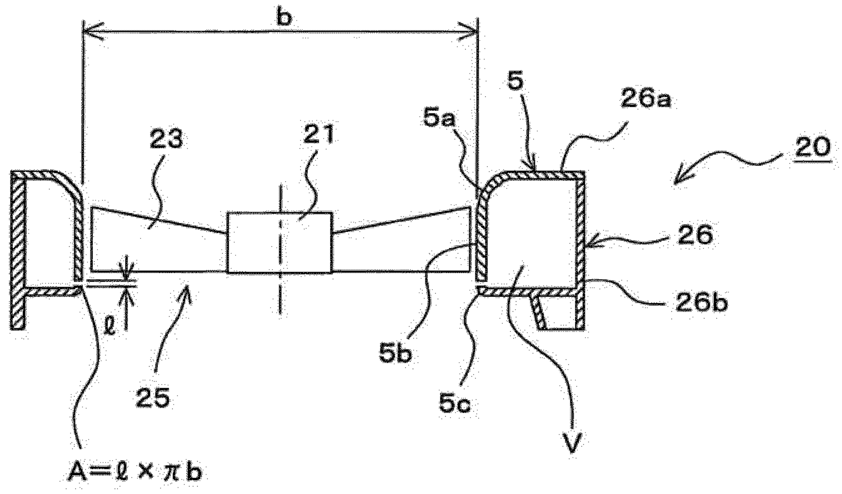


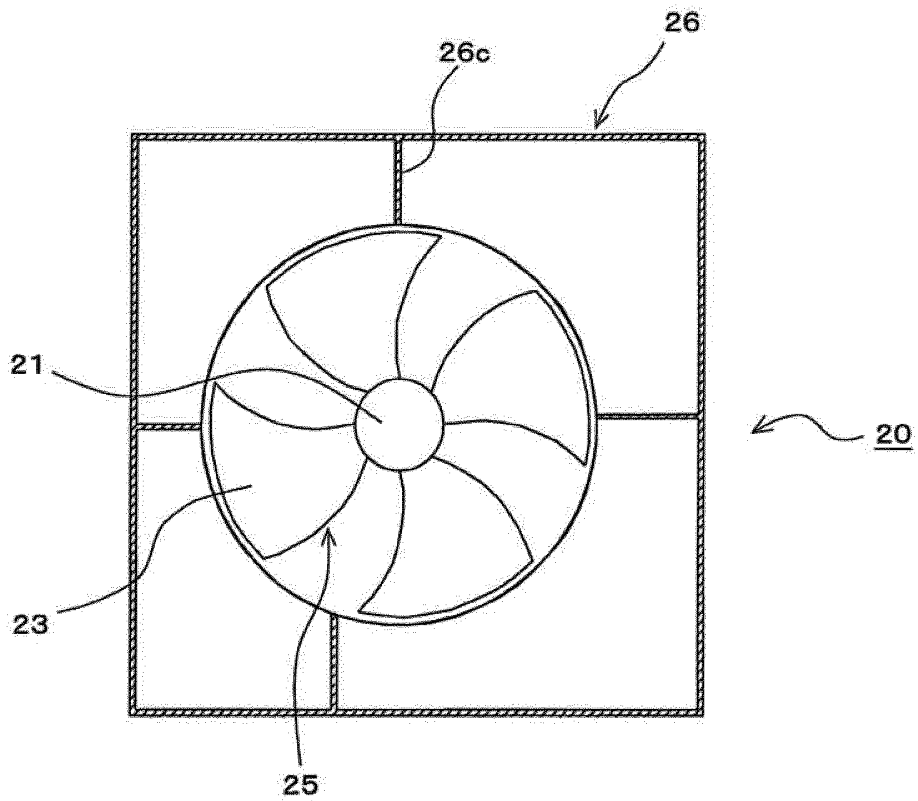
FIG. 41



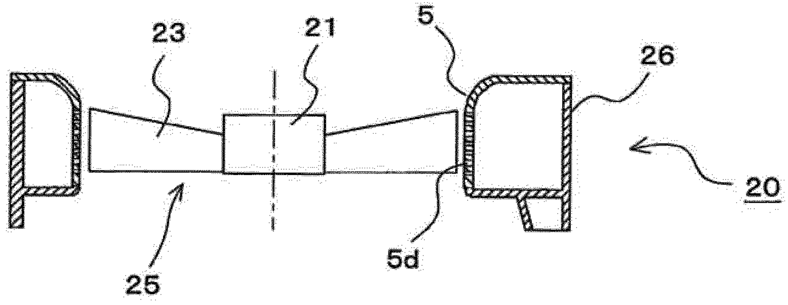
F I G. 4 2



F I G. 4 3



F I G. 4 4



F I G. 4 5

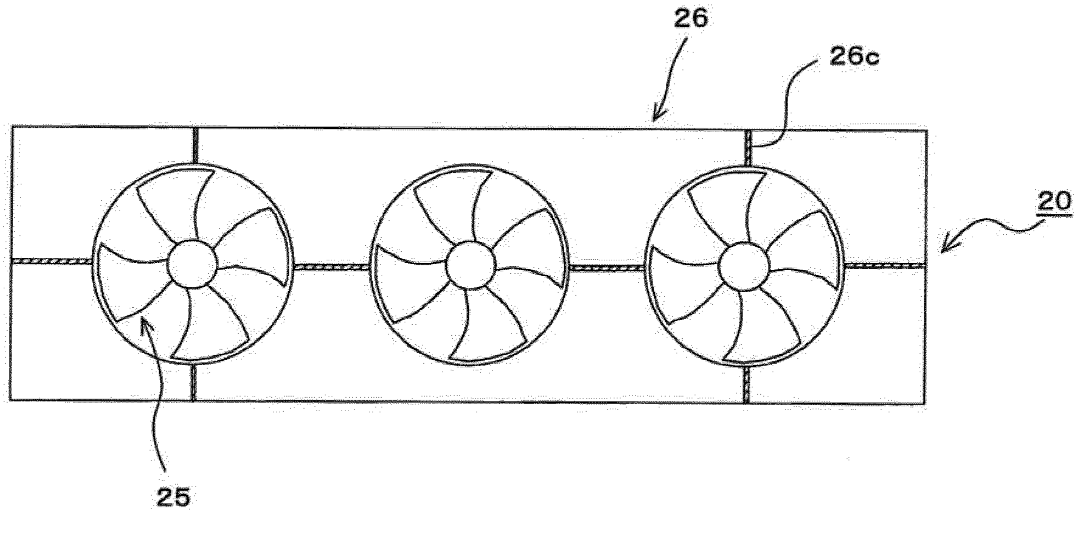
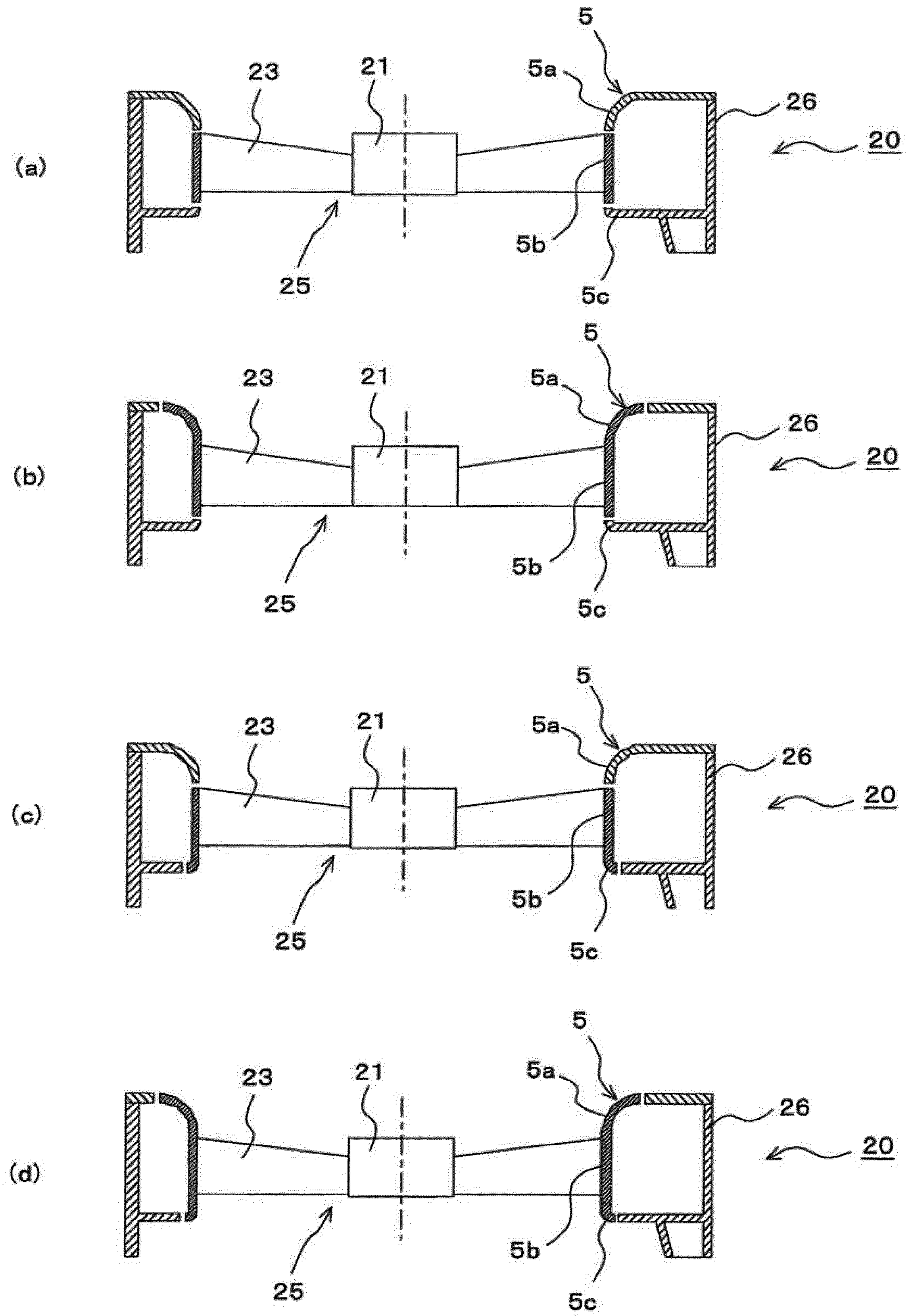


FIG. 46


(a)
23
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5c
(b)
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(c)
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(d)
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5b
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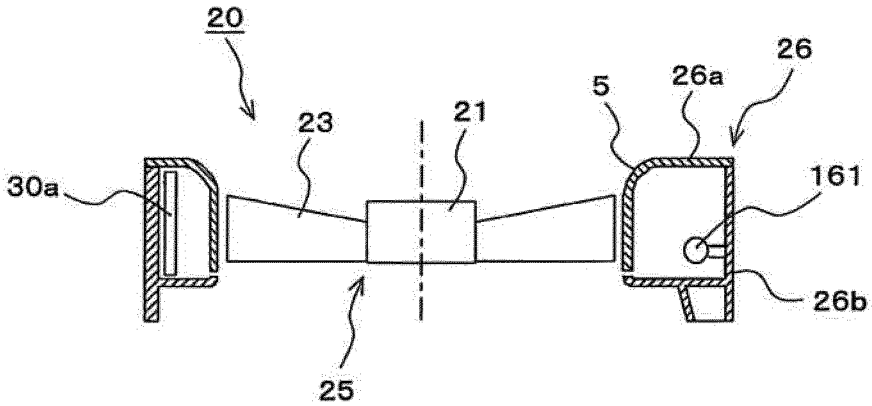
5c

F I G. 4 7



F I G. 4 8

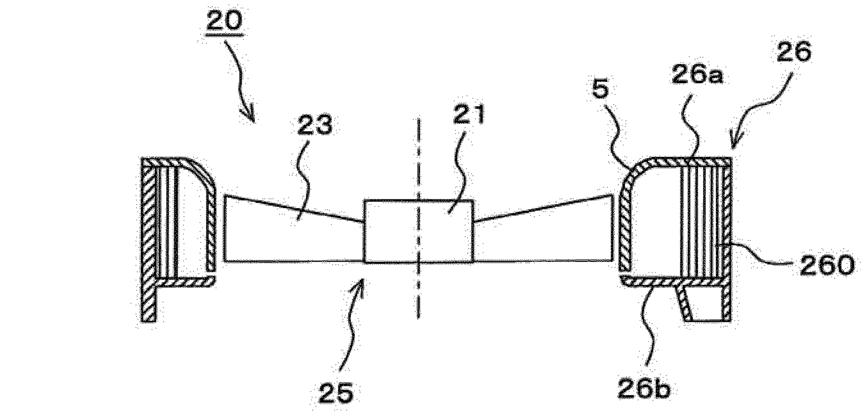


FIG. 49

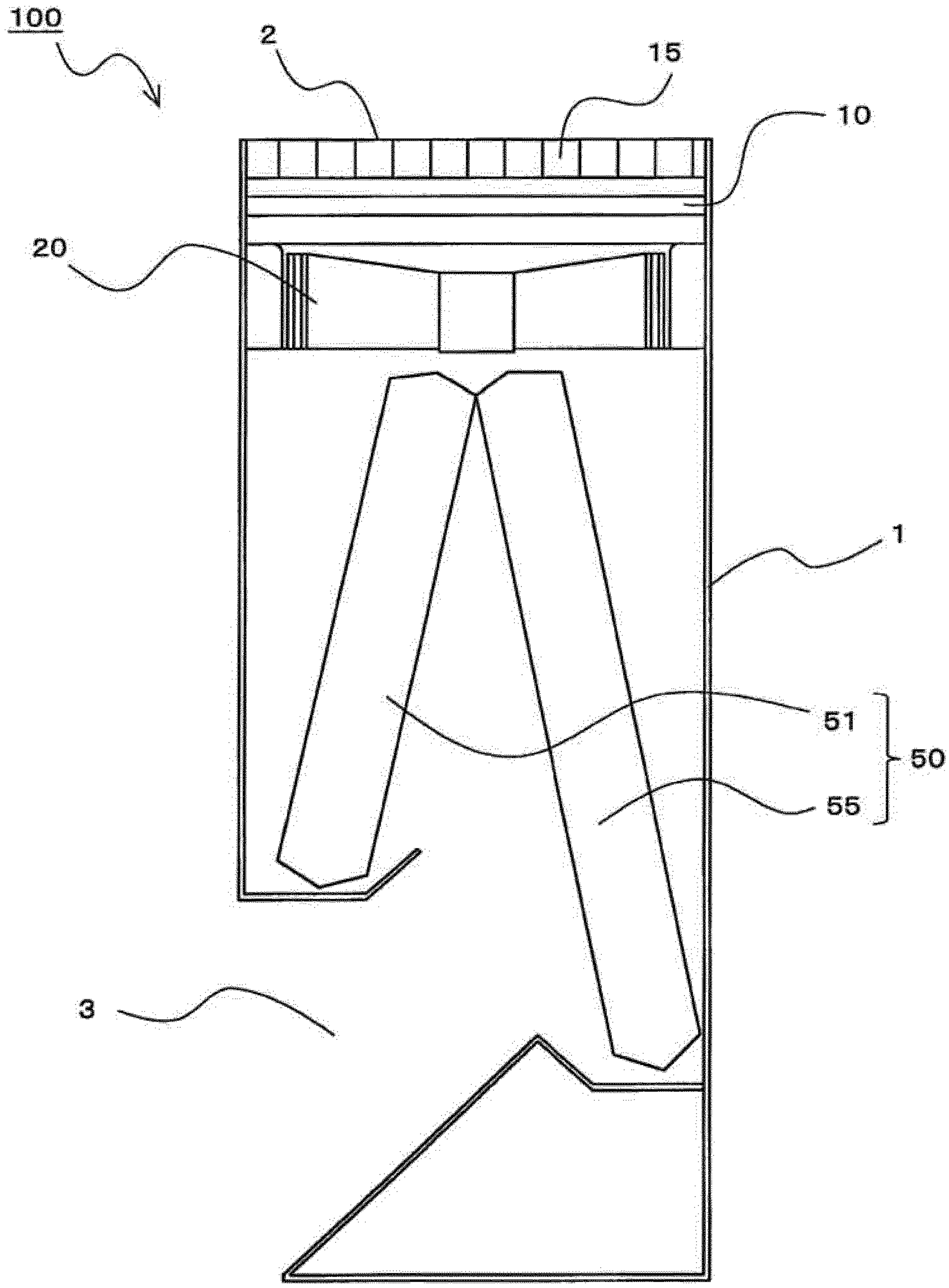


FIG. 50

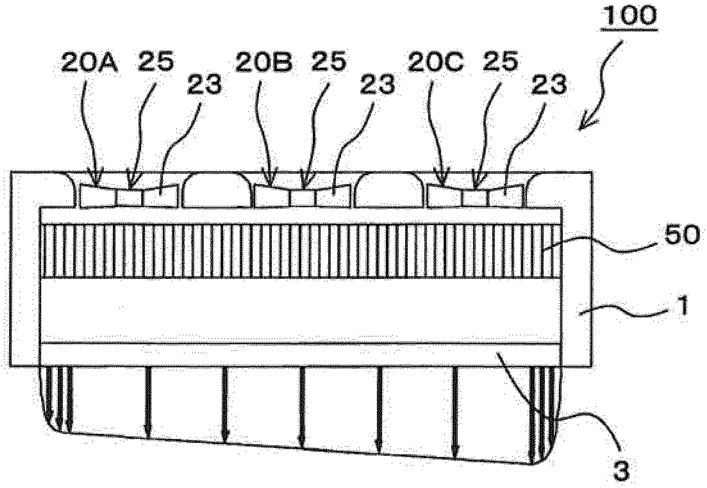

100
20A
25
23
20B
25
23
20C
25
23
50
1
3

FIG. 51

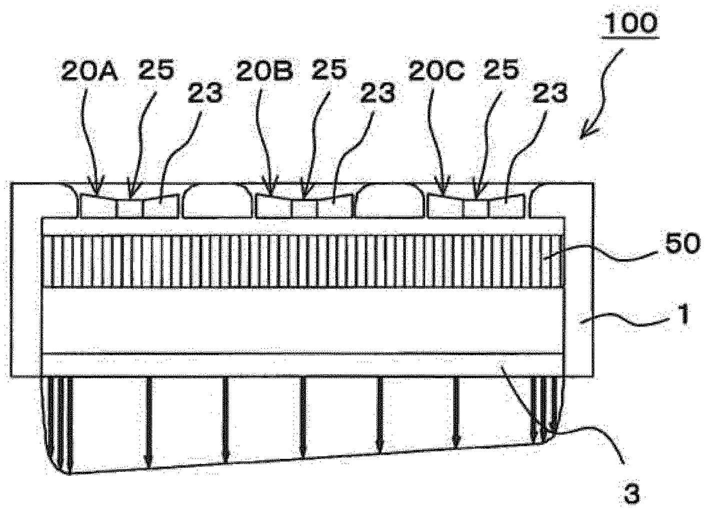

100
20A
25
23
20B
25
23
20C
25
23
50
1
3

FIG. 52

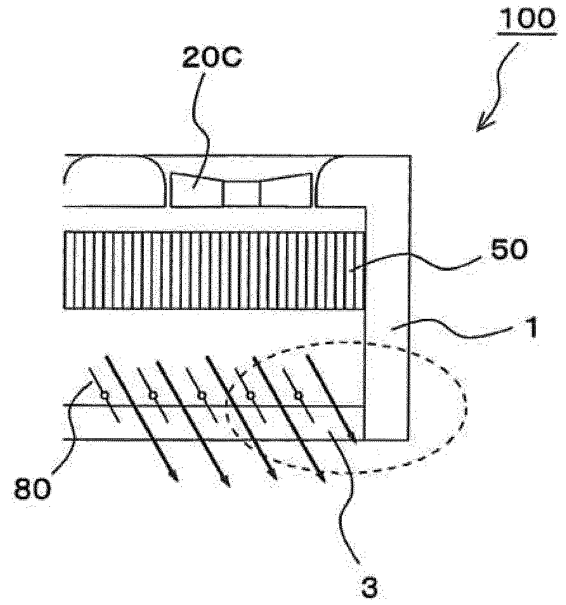


FIG. 53

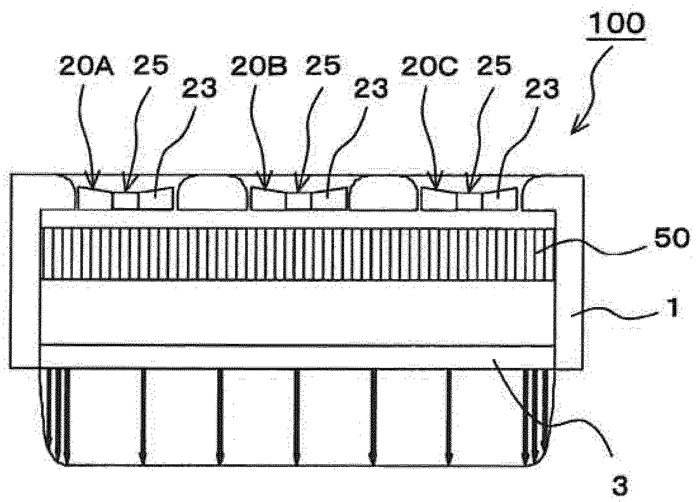


FIG. 54

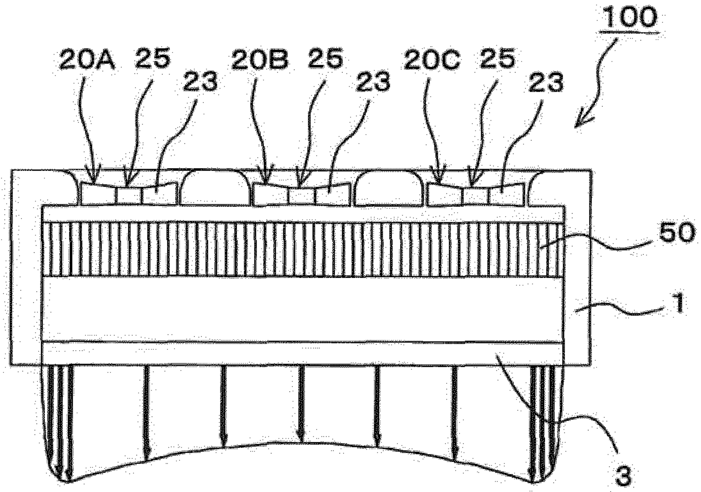
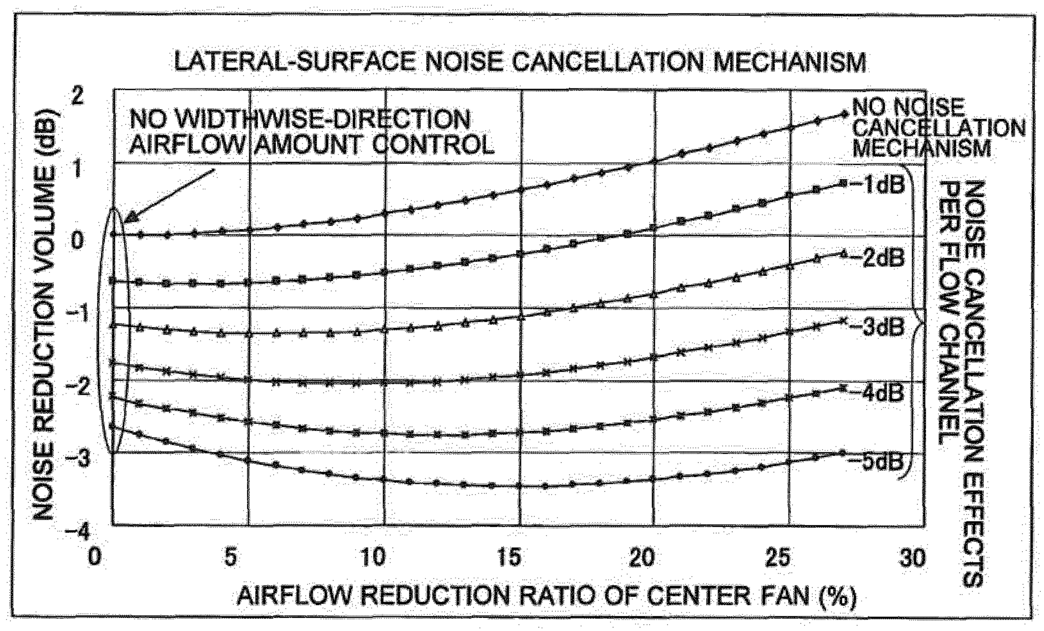
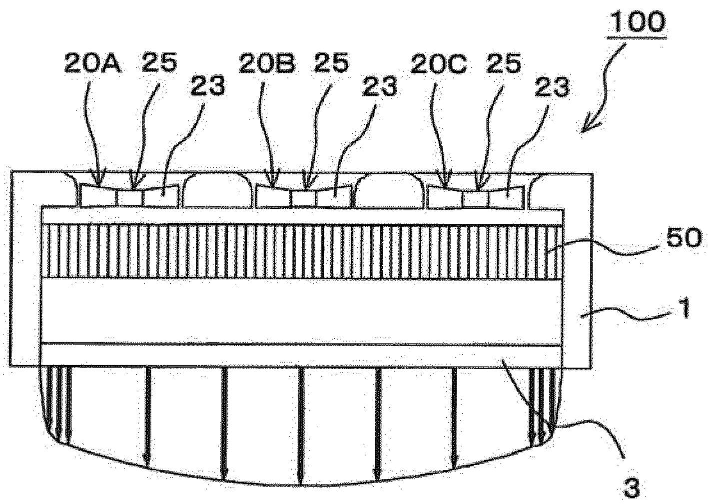

100
20A
25
23
20B
25
23
20C
25
23
50
1
3

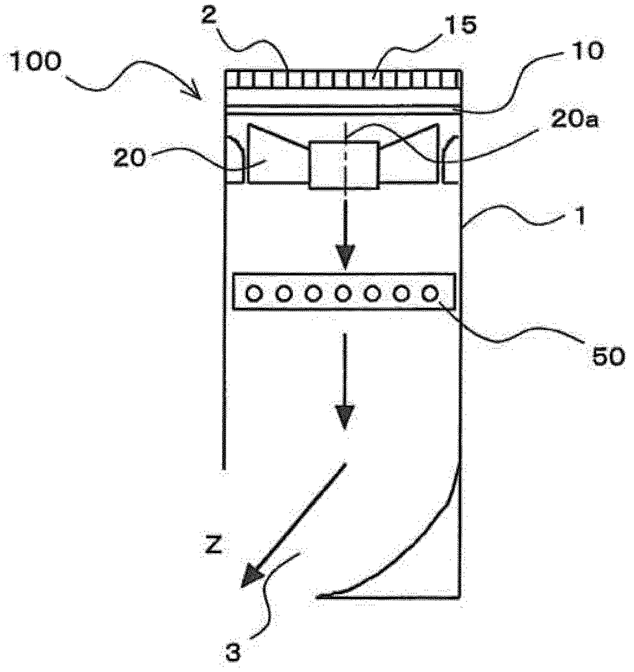
FIG. 55


LATERAL-SURFACE NOISE CANCELLATION MECHANISM
NOISE REDUCTION VOLUME (dB)
2
1
0
−1
−2
−3
−4
NO WIDTHWISE-DIRECTION AIRFLOW AMOUNT CONTROL
NO NOISE CANCELLATION MECHANISM
−1dB
−2dB
−3dB
−4dB
−5dB
NOISE CANCELLATION EFFECTS PER FLOW CHANNEL
0
5
10
15
20
25
30
AIRFLOW REDUCTION RATIO OF CENTER FAN (%)

F I G. 5 6



F I G. 5 7



F I G. 5 8

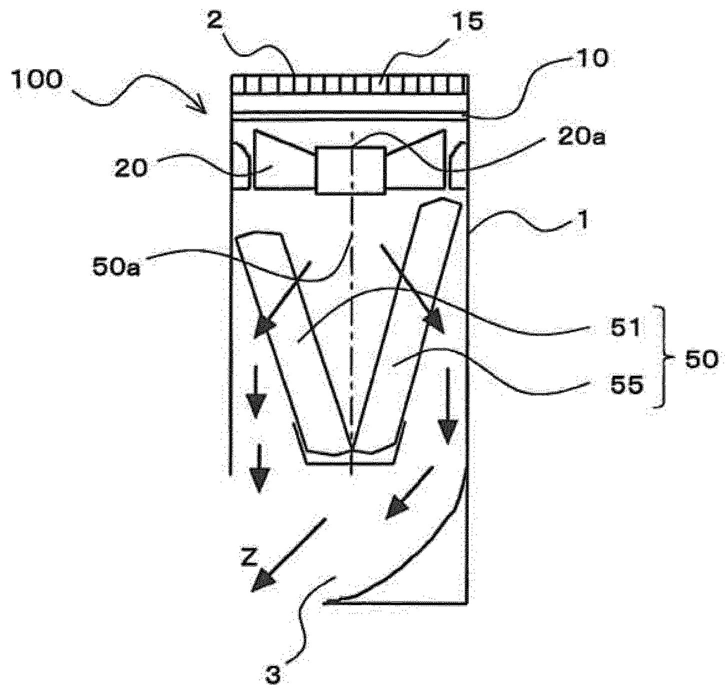


FIG. 59

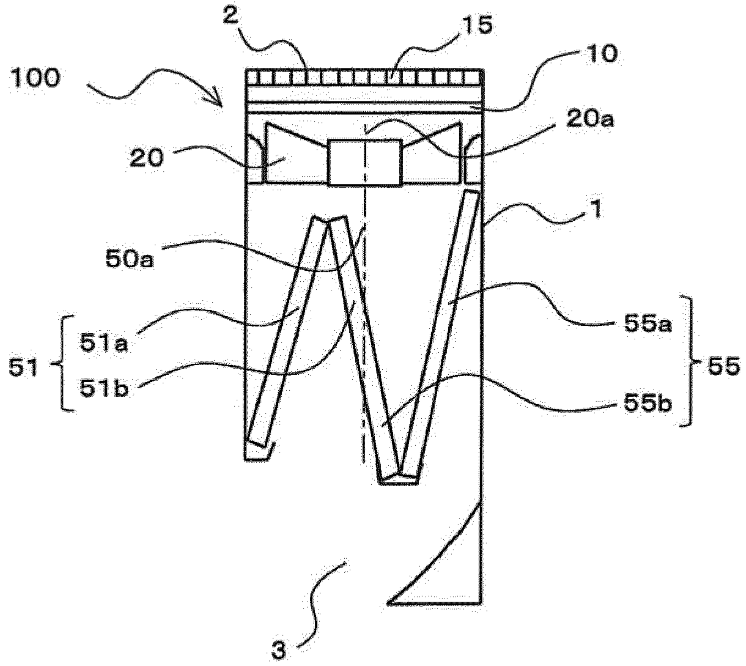

2
15
10
100
20a
20
1
50a
51a
55a
51
55
51b
55b
3

FIG. 60

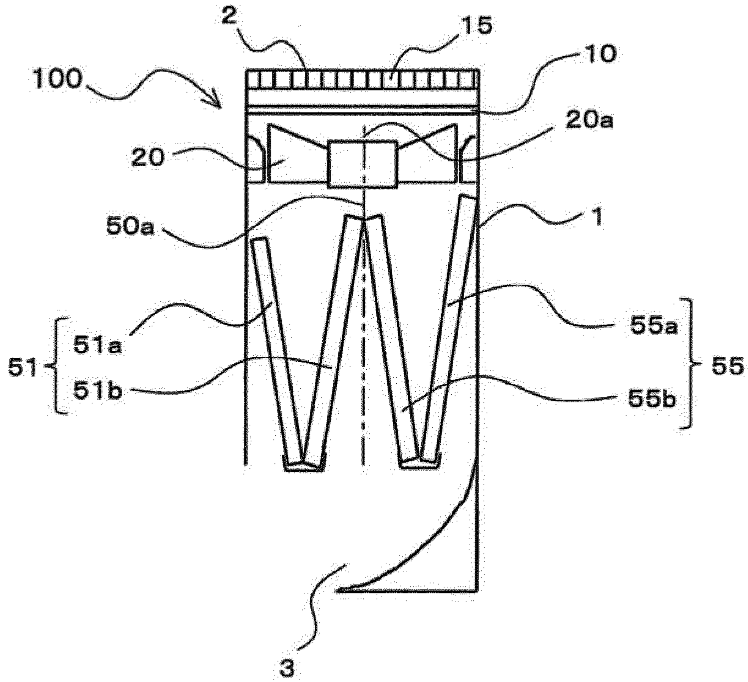

2
15
10
100
20a
20
1
50a
51a
55a
51
55
51b
55b
3

FIG. 61

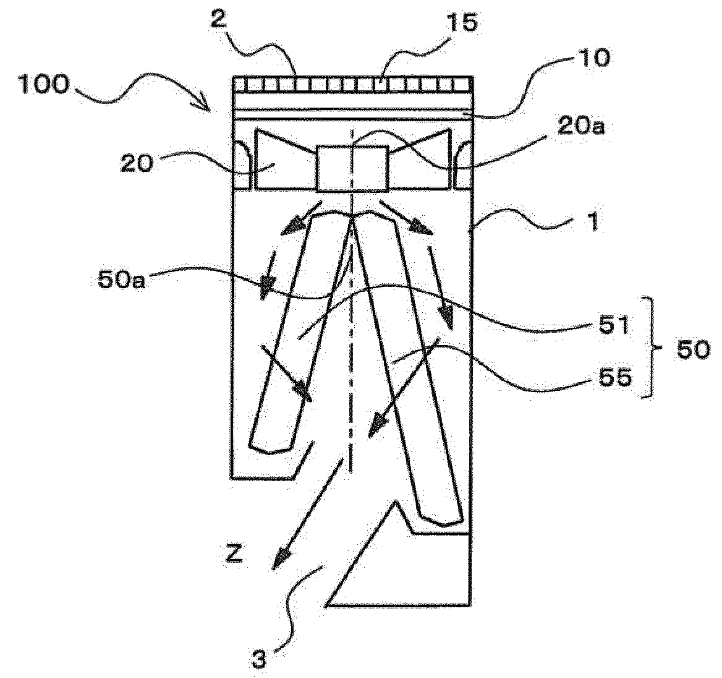
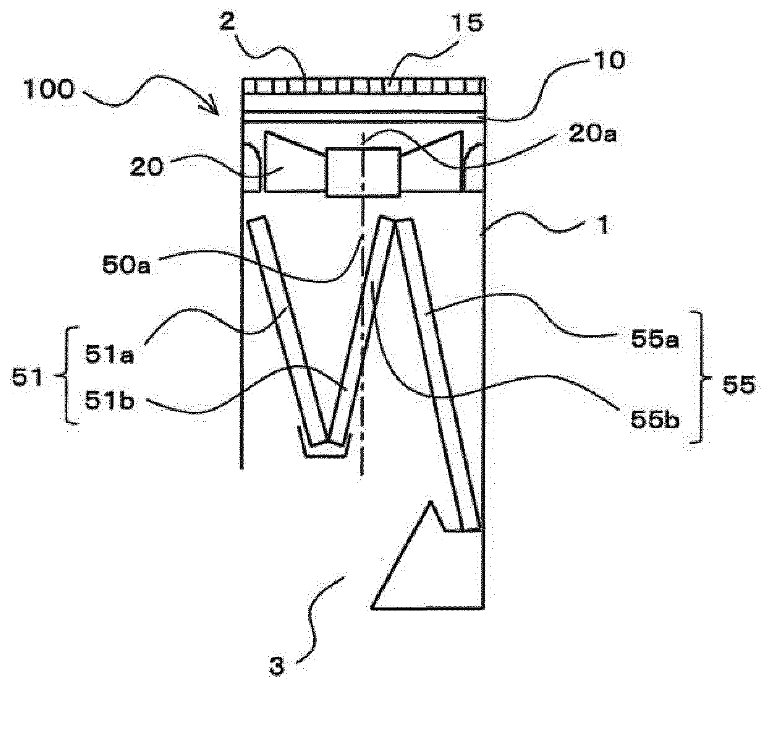
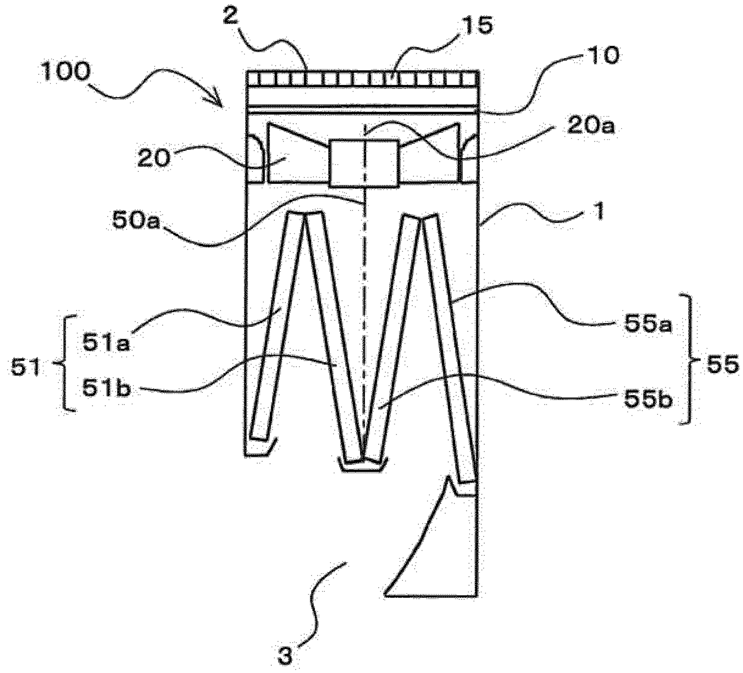

2
15
100
10
20a
20
1
50a
51
50
55
Z
3

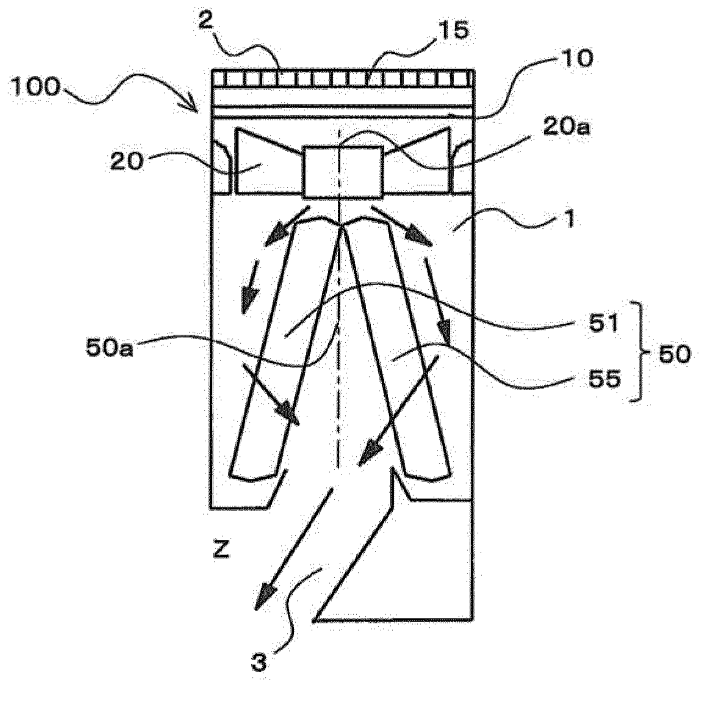
FIG. 62


2
15
100
10
20a
20
1
50a
51a
51
51b
55a
55
55b
3

F I G. 6 3


2
15
100
10
20a
20
50a
1
55a
51a
51
55
51b
55b
3

F I G. 6 4


2
15
100
10
20a
20
1
51
50a
50
55
Z
3

F I G. 6 5

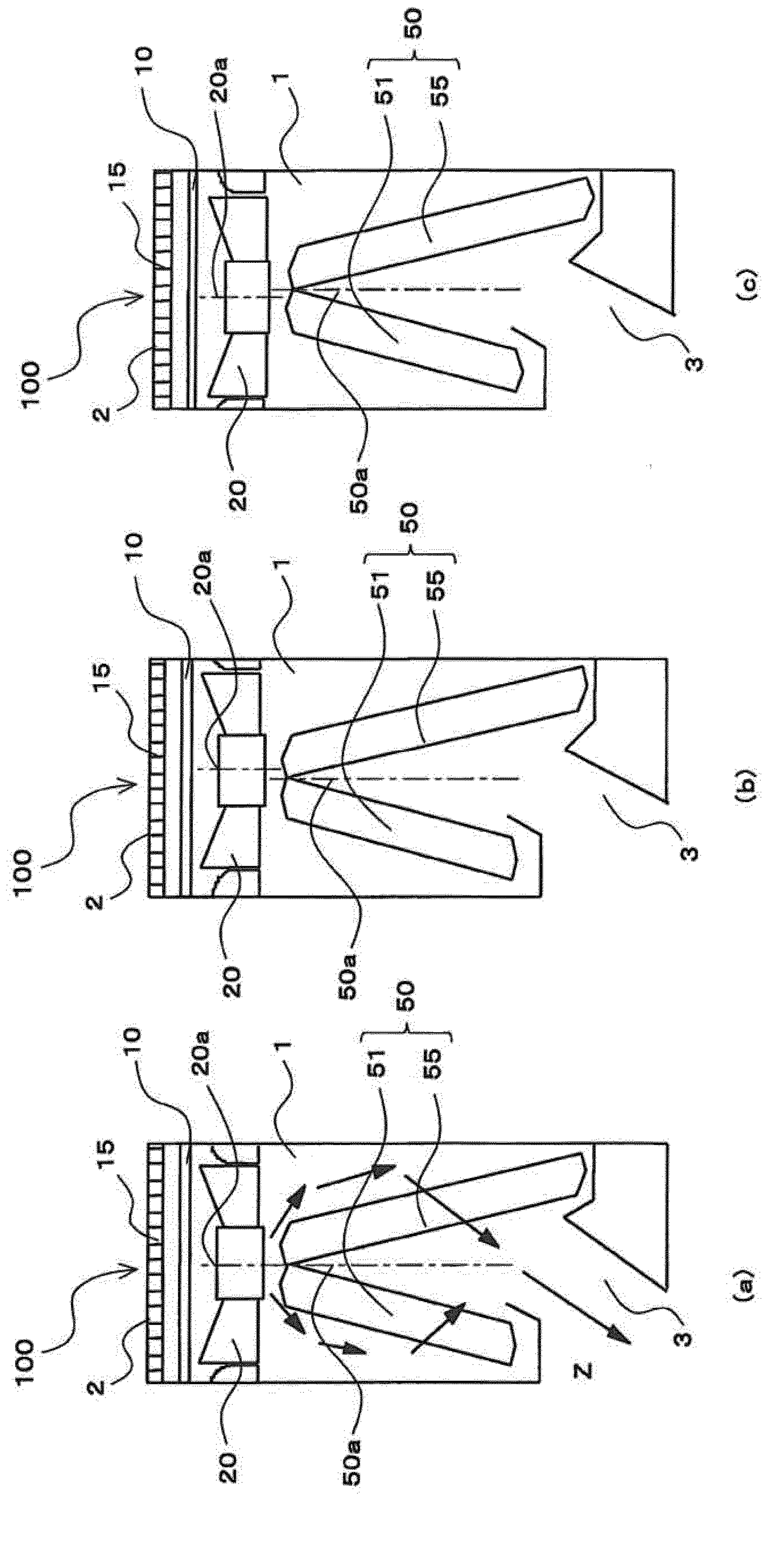
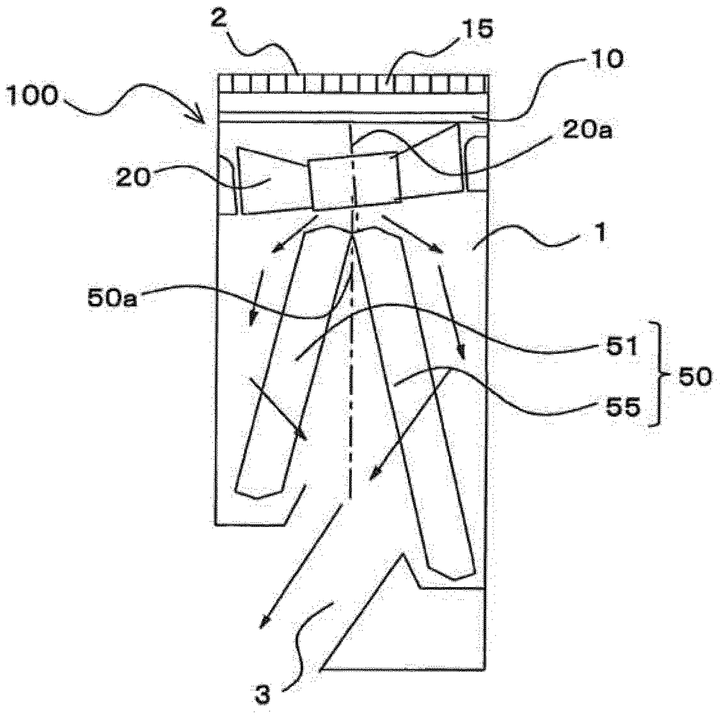
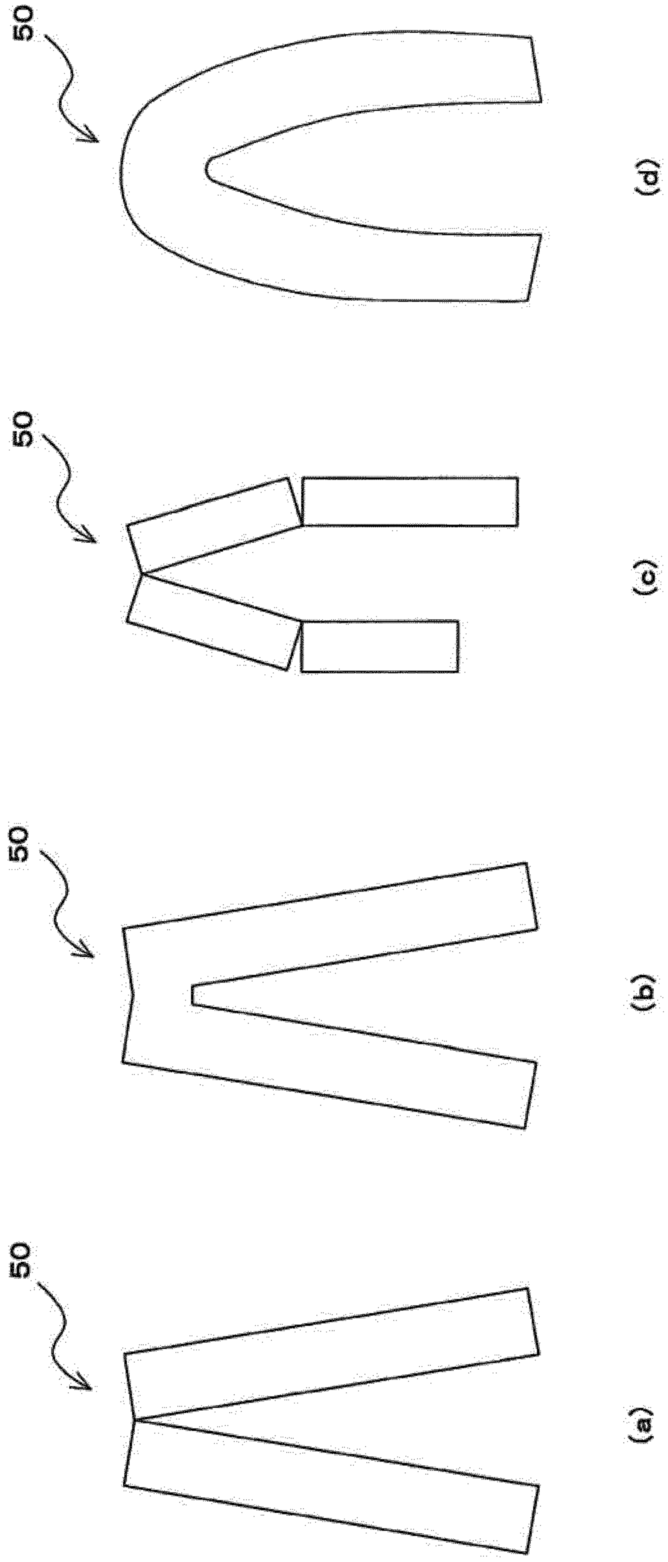


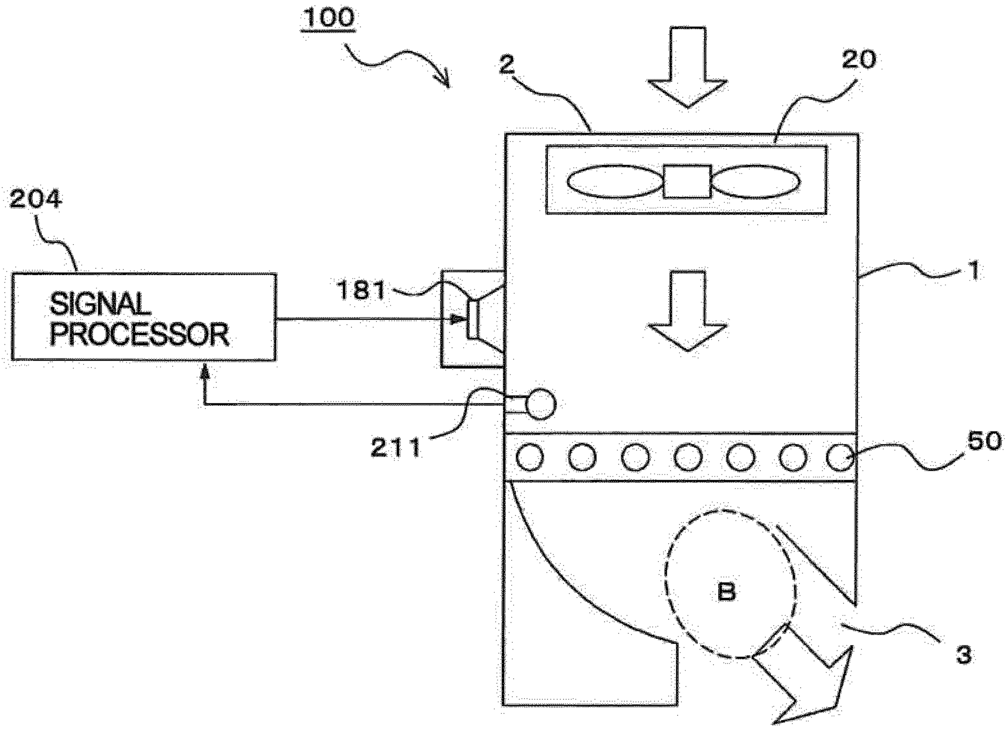
FIG. 66



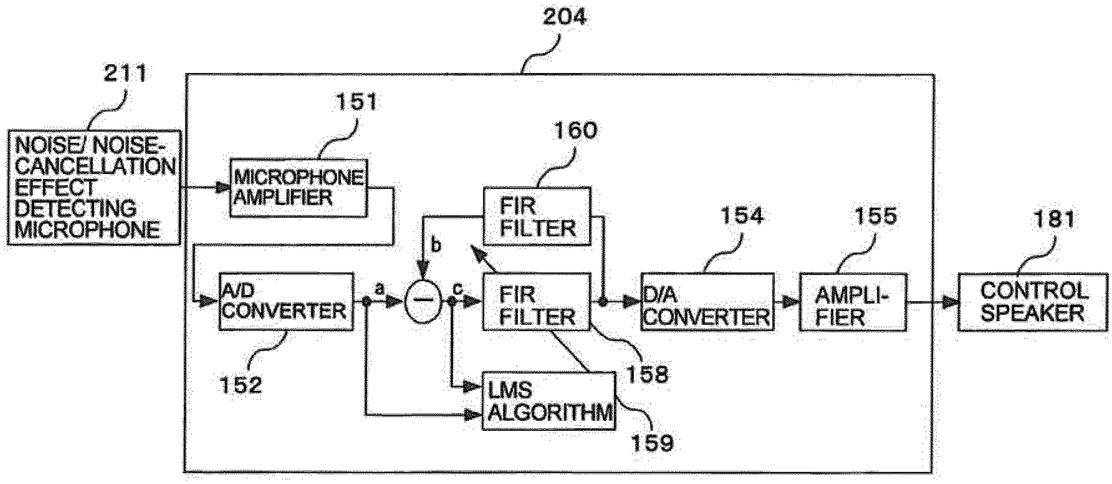
F I G. 6 7



F I G. 6 8



F I G. 6 9


204
211
NOISE/ NOISE-CANCELLATION EFFECT DETECTING MICROPHONE
151
MICROPHONE AMPLIFIER
160
FIR FILTER
154
155
181
b
A/D CONVERTER
a
c
FIR FILTER
D/A CONVERTER
AMPLI-FIER
CONTROL SPEAKER
152
158
LMS ALGORITHM
159

F I G. 7 0

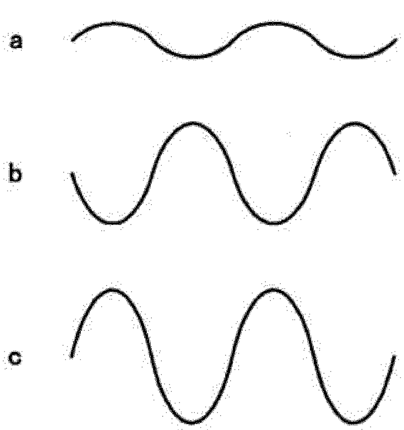

a
b
c

FIG. 71

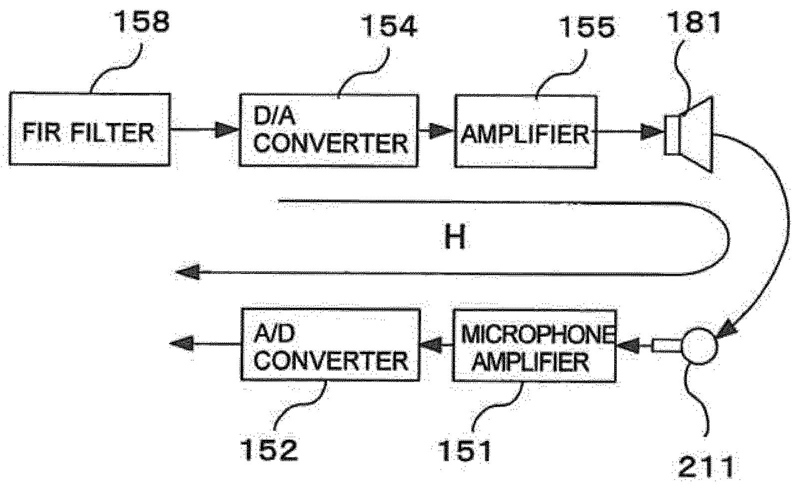
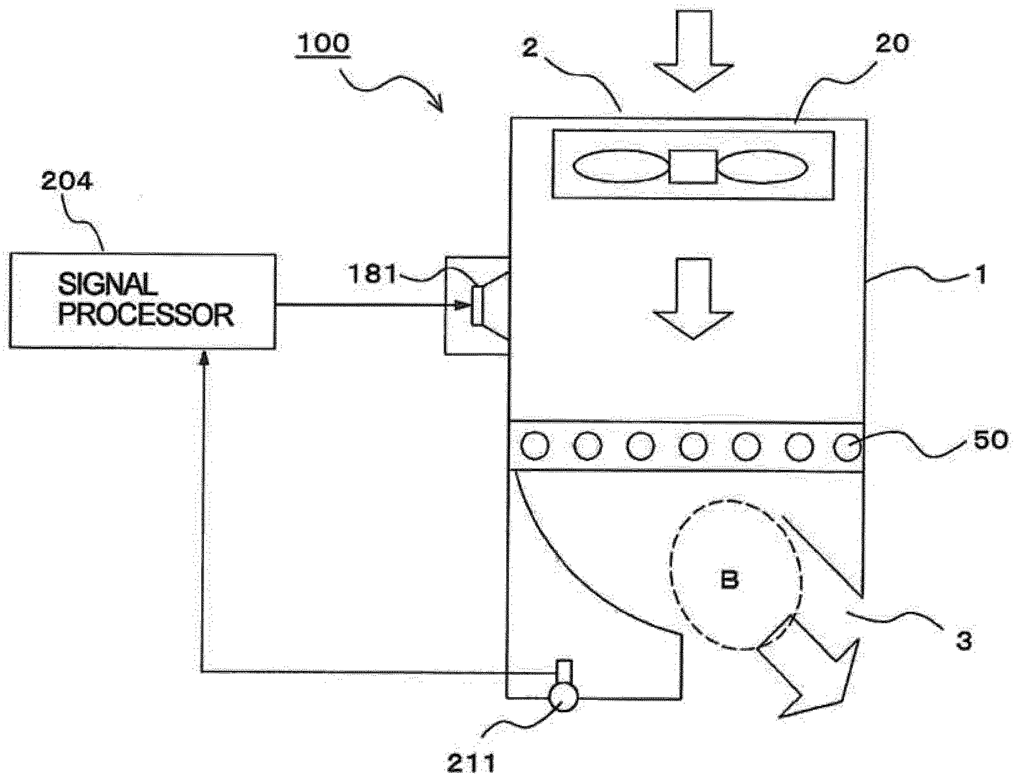
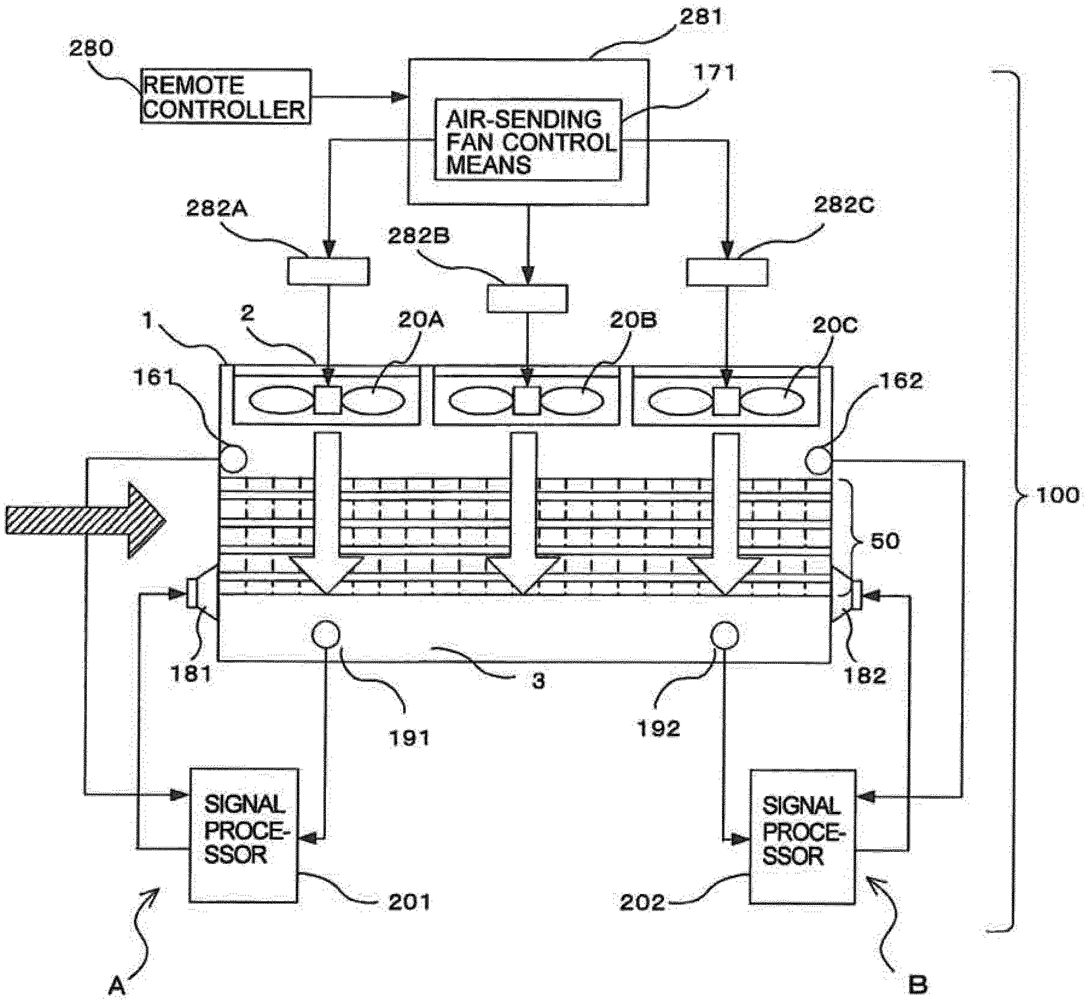

158
154
155
181
FIR FILTER
D/A
CONVERTER
AMPLIFIER
H
A/D
CONVERTER
MICROPHONE
AMPLIFIER
152
151
211

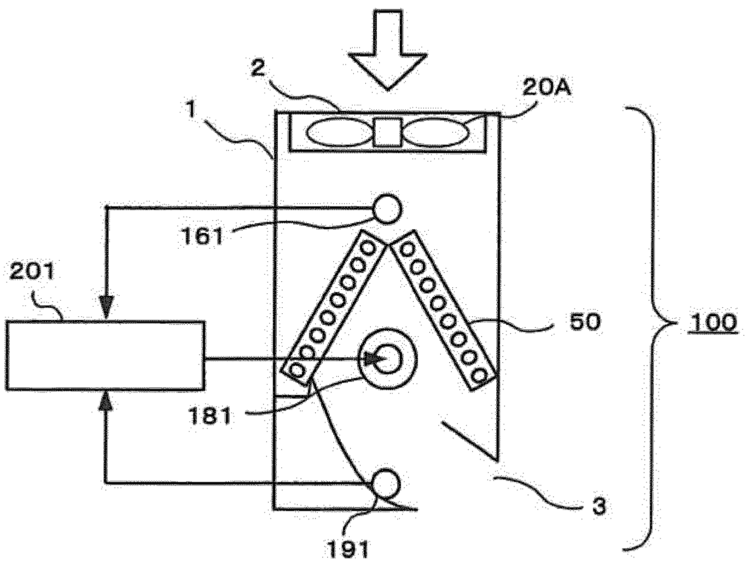
FIG. 72


100
2
20
204
SIGNAL
PROCESSOR
181
1
50
B
3
211

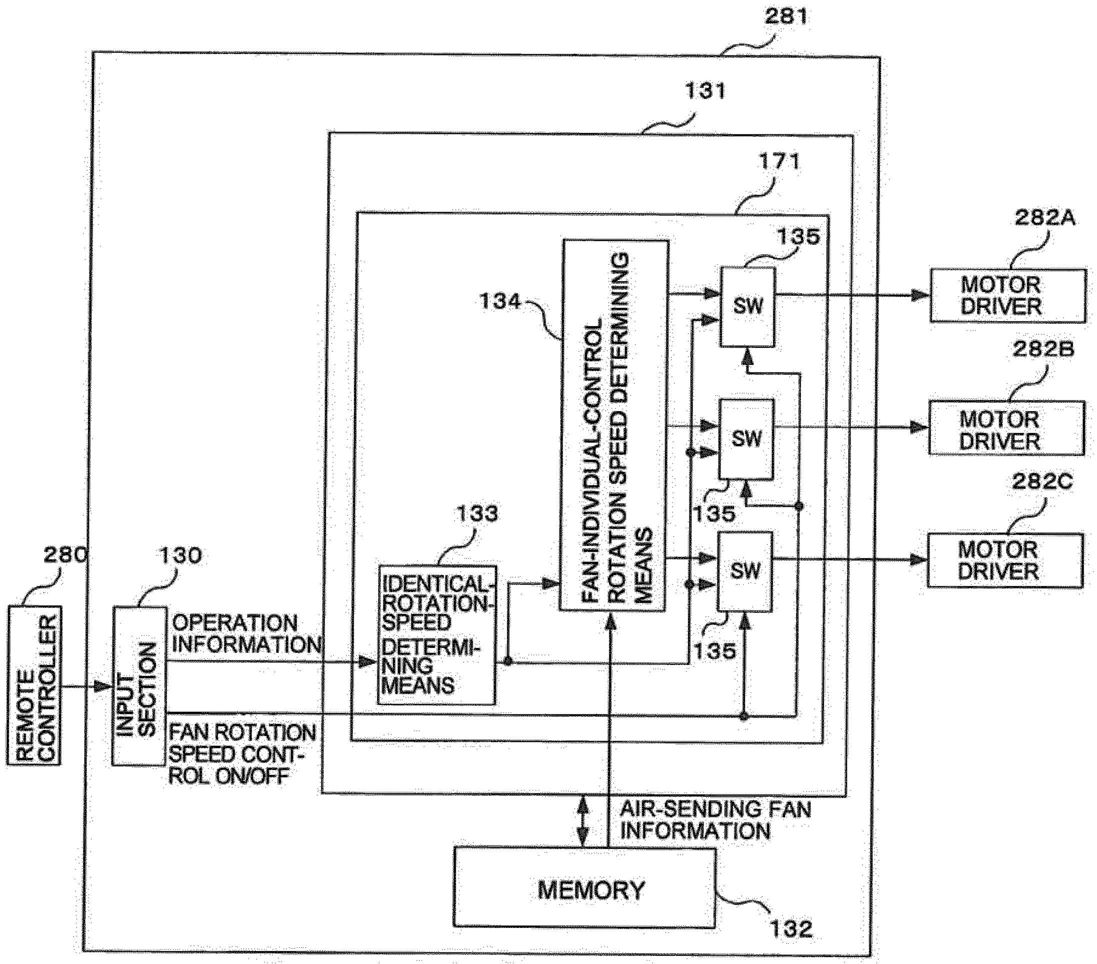
F I G. 7 3


280
REMOTE CONTROLLER
281
171
AIR-SENDING FAN CONTROL MEANS
282A
282B
282C
1
2
20A
20B
20C
161
162
100
50
181
182
3
191
192
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
201
202
A
B

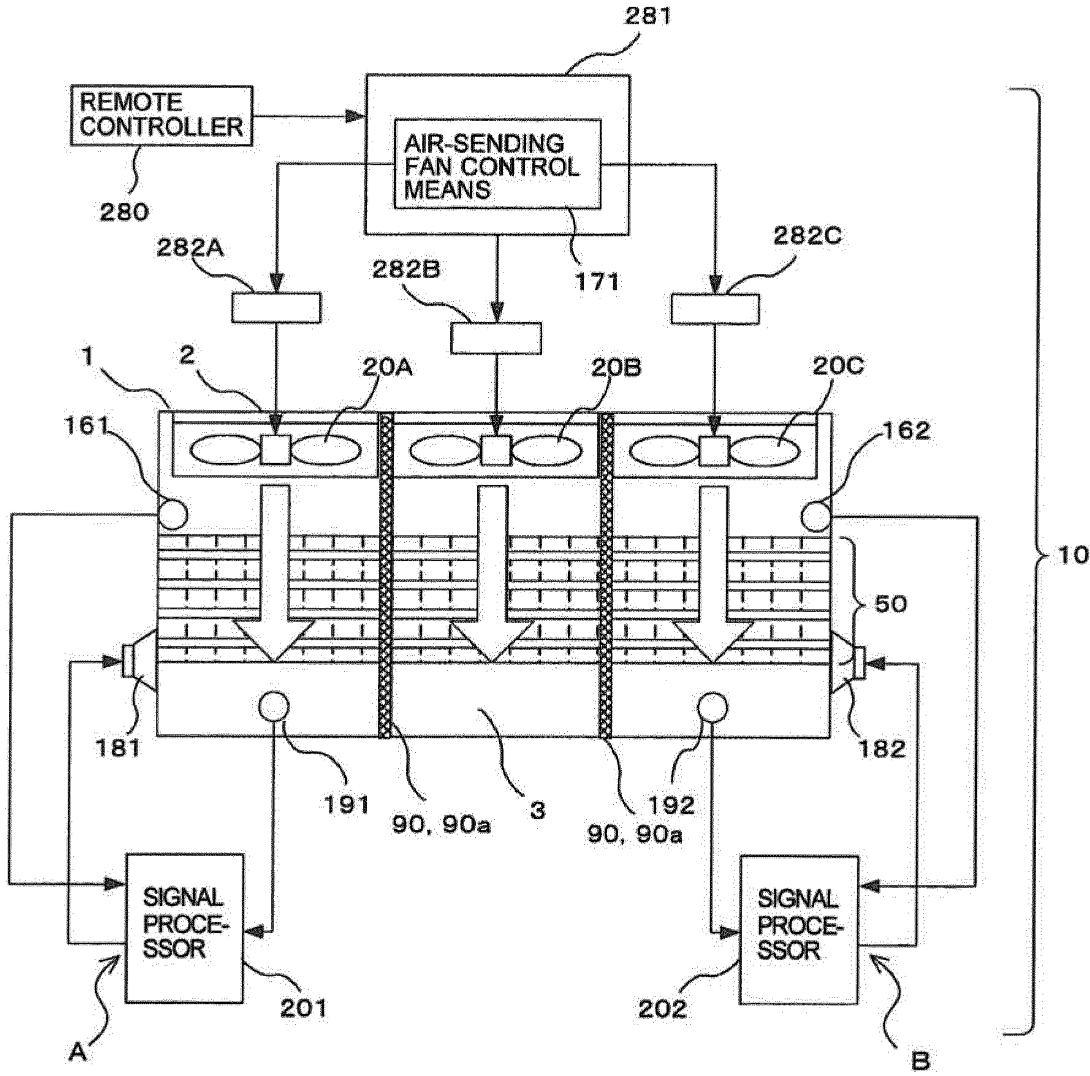
F I G. 7 4


2
20A
1
161
201
50
100
181
3
191

F I G. 7 5


281
131
171
135
282A
MOTOR DRIVER
134
SW
282B
MOTOR DRIVER
SW
FAN-INDIVIDUAL-CONTROL ROTATION SPEED DETERMINING MEANS
135
282C
133
MOTOR DRIVER
280
130
IDENTICAL-ROTATION-SPEED DETERMI-NING MEANS
SW
135
REMOTE CONTROLLER
INPUT SECTION
OPERATION INFORMATION
FAN ROTATION SPEED CONT-ROL ON/OFF
AIR-SENDING FAN INFORMATION
MEMORY
132

F I G. 7 6


281
REMOTE CONTROLLER
280
AIR-SENDING FAN CONTROL MEANS
171
282A
282B
282C
1
2
20A
20B
20C
161
162
100
50
181
182
191
192
3
90, 90a
90, 90a
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
201
202
A
B

F I G. 7 7

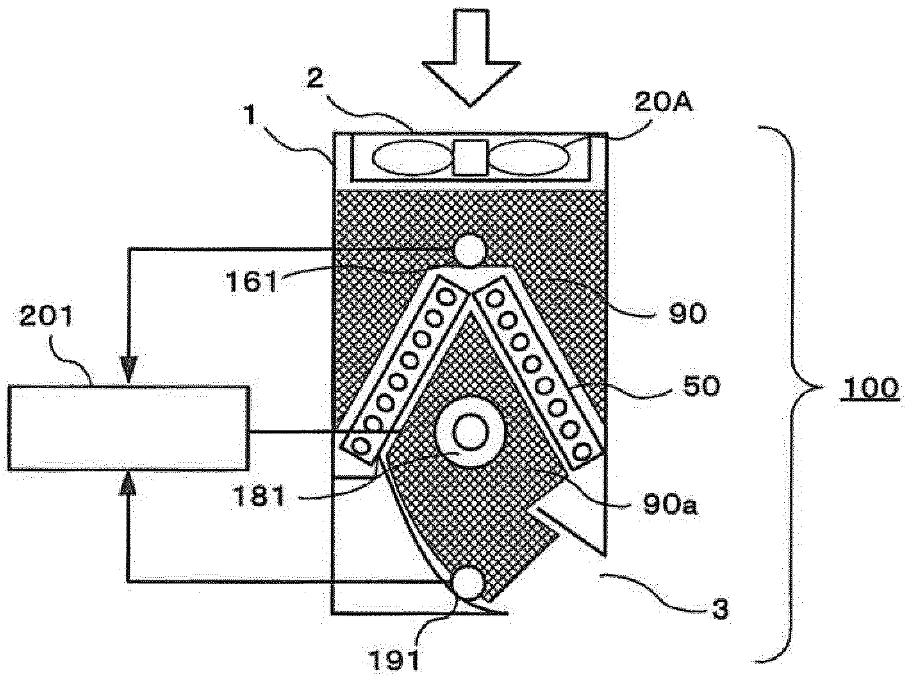


FIG. 78

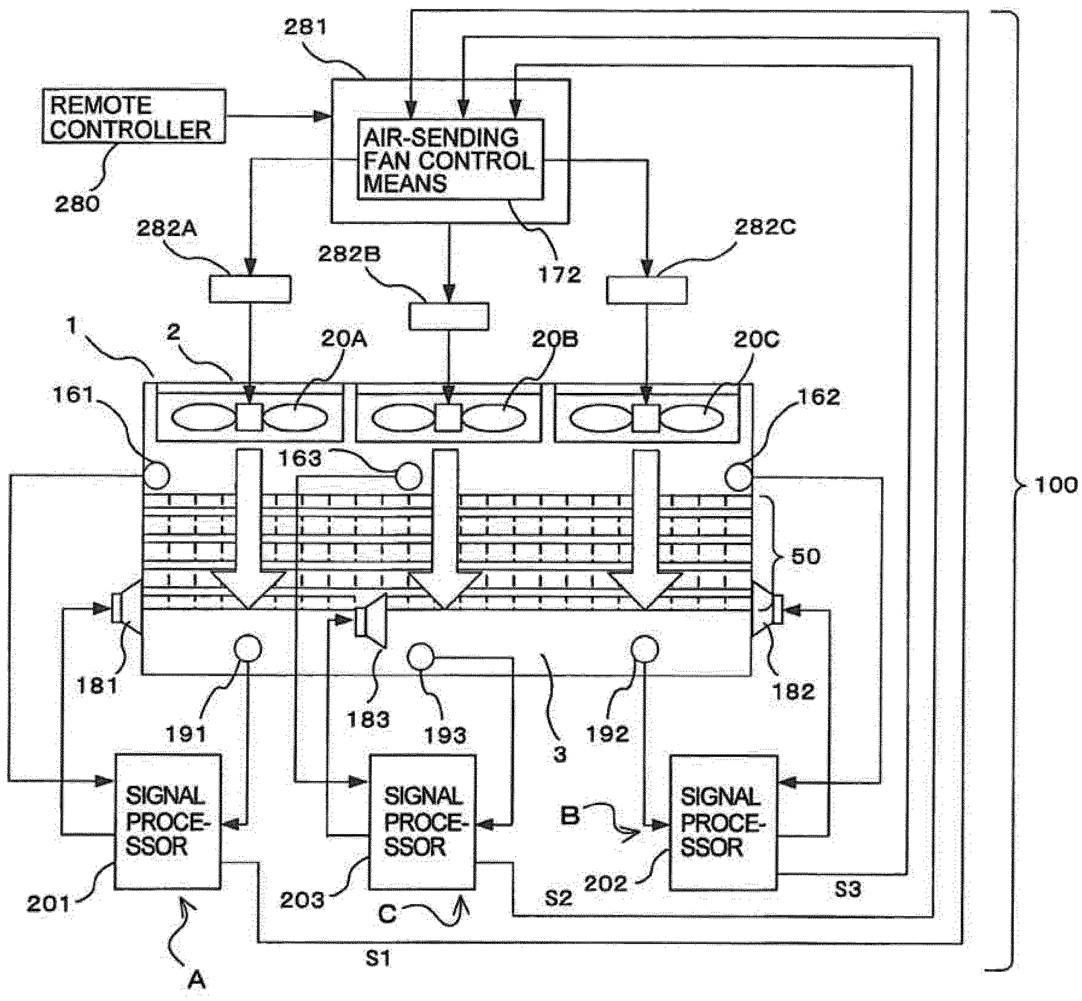
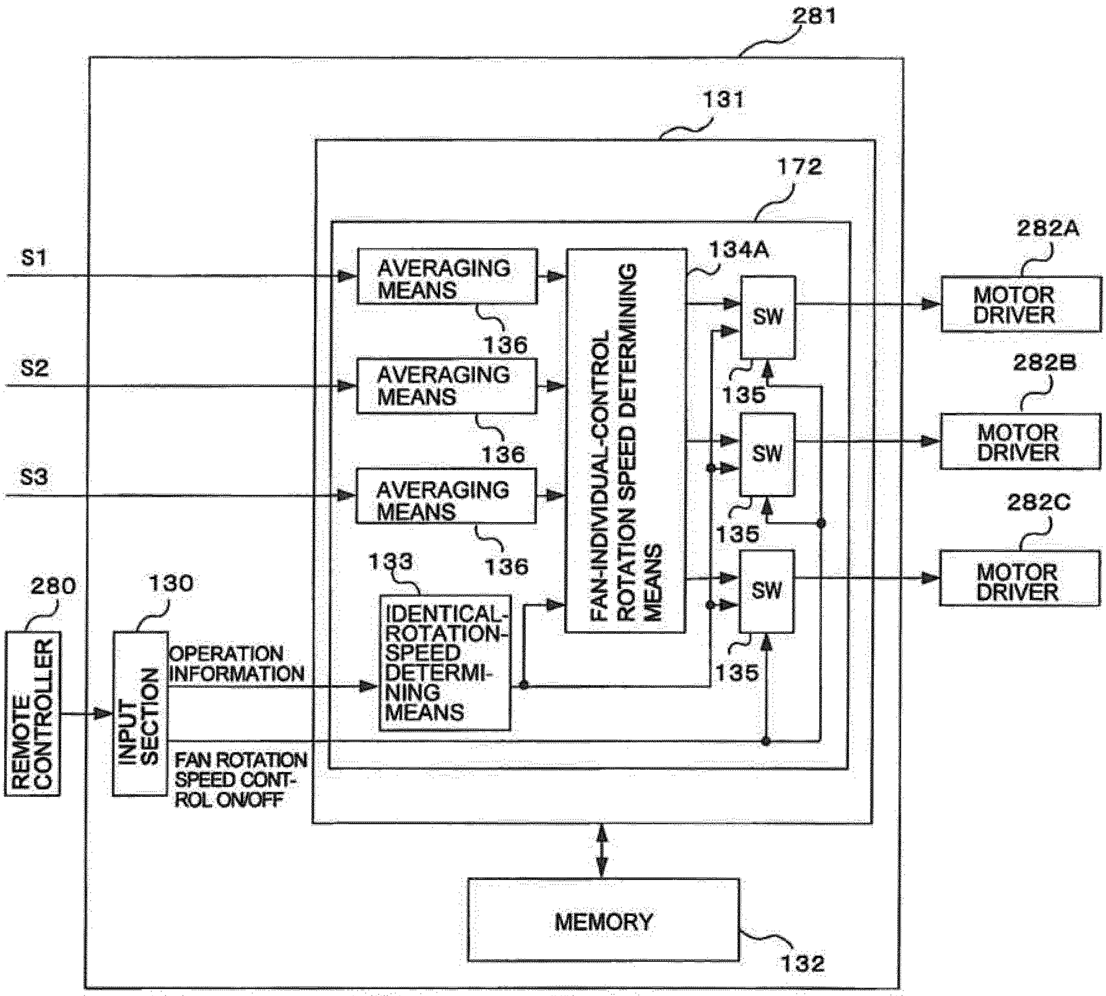
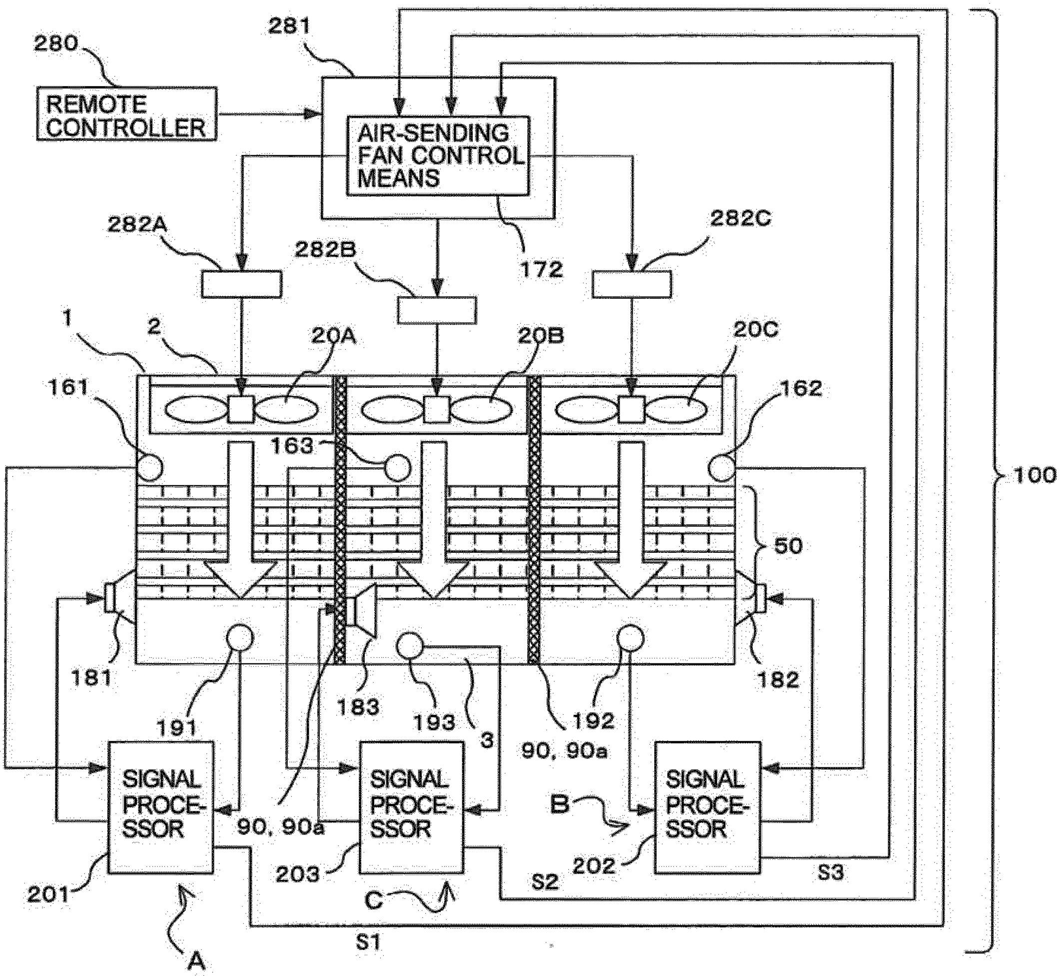

281
REMOTE CONTROLLER
280
AIR-SENDING FAN CONTROL MEANS
172
282A
282B
282C
1
2
20A
20B
20C
161
162
163
100
50
181
182
183
191
193
192
3
SIGNAL PROCESSOR
SIGNAL PROCESSOR
SIGNAL PROCESSOR
201
203
202
A
B
C
S1
S2
S3

FIG. 79



281
131
172
282A
134A
S1
AVERAGING MEANS
136
SW
MOTOR DRIVER
135
282B
S2
AVERAGING MEANS
136
SW
MOTOR DRIVER
FAN-INDIVIDUAL-CONTROL ROTATION SPEED DETERMINING MEANS
S3
AVERAGING MEANS
135
282C
133
136
SW
MOTOR DRIVER
280
130
IDENTICAL-ROTATION-SPEED DETERMI-NING MEANS
OPERATION INFORMATION
135
REMOTE CONTROLLER
INPUT SECTION
FAN ROTATION SPEED CONT-ROL ON/OFF
MEMORY
132

FIG. 80


280
281
REMOTE CONTROLLER
AIR-SENDING FAN CONTROL MEANS
282A
282B
172
282C
1
2
20A
20B
20C
161
163
162
100
50
181
183
182
191
193
3
192
90, 90a
SIGNAL PROCESSOR
SIGNAL PROCESSOR
SIGNAL PROCESSOR
90, 90a
B
201
203
202
S2
S3
C
A
S1

F I G. 8 1

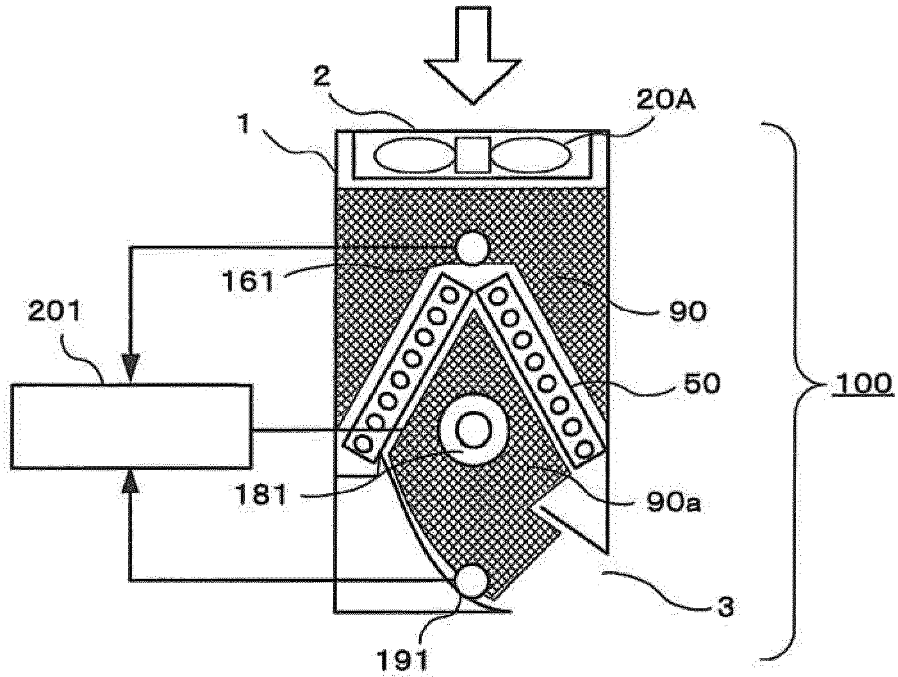
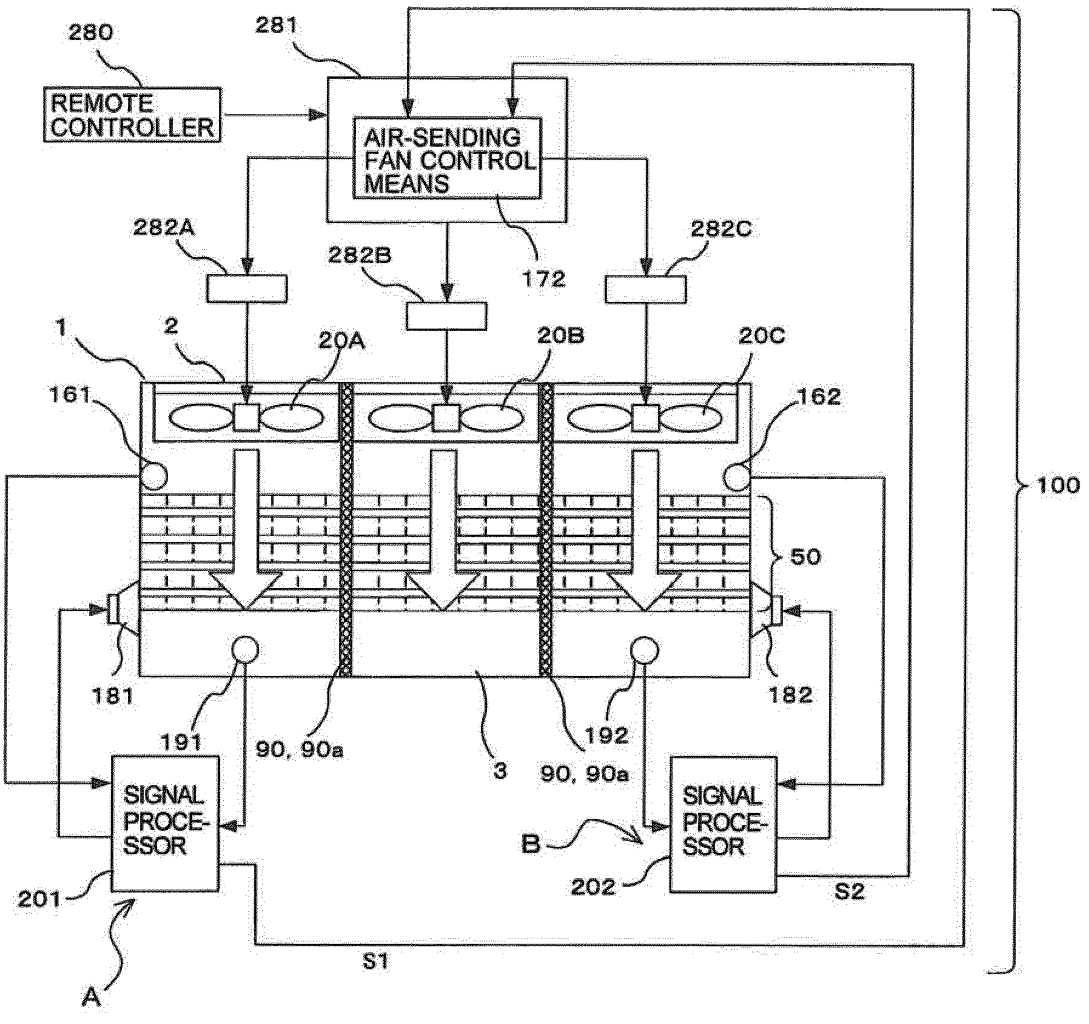


FIG. 82


280
281
REMOTE CONTROLLER
AIR-SENDING FAN CONTROL MEANS
282A
282B
172
282C
1
2
20A
20B
20C
161
162
100
50
181
182
191
90, 90a
3
192
90, 90a
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
B
201
202
S2
S1
A

F I G. 8 3

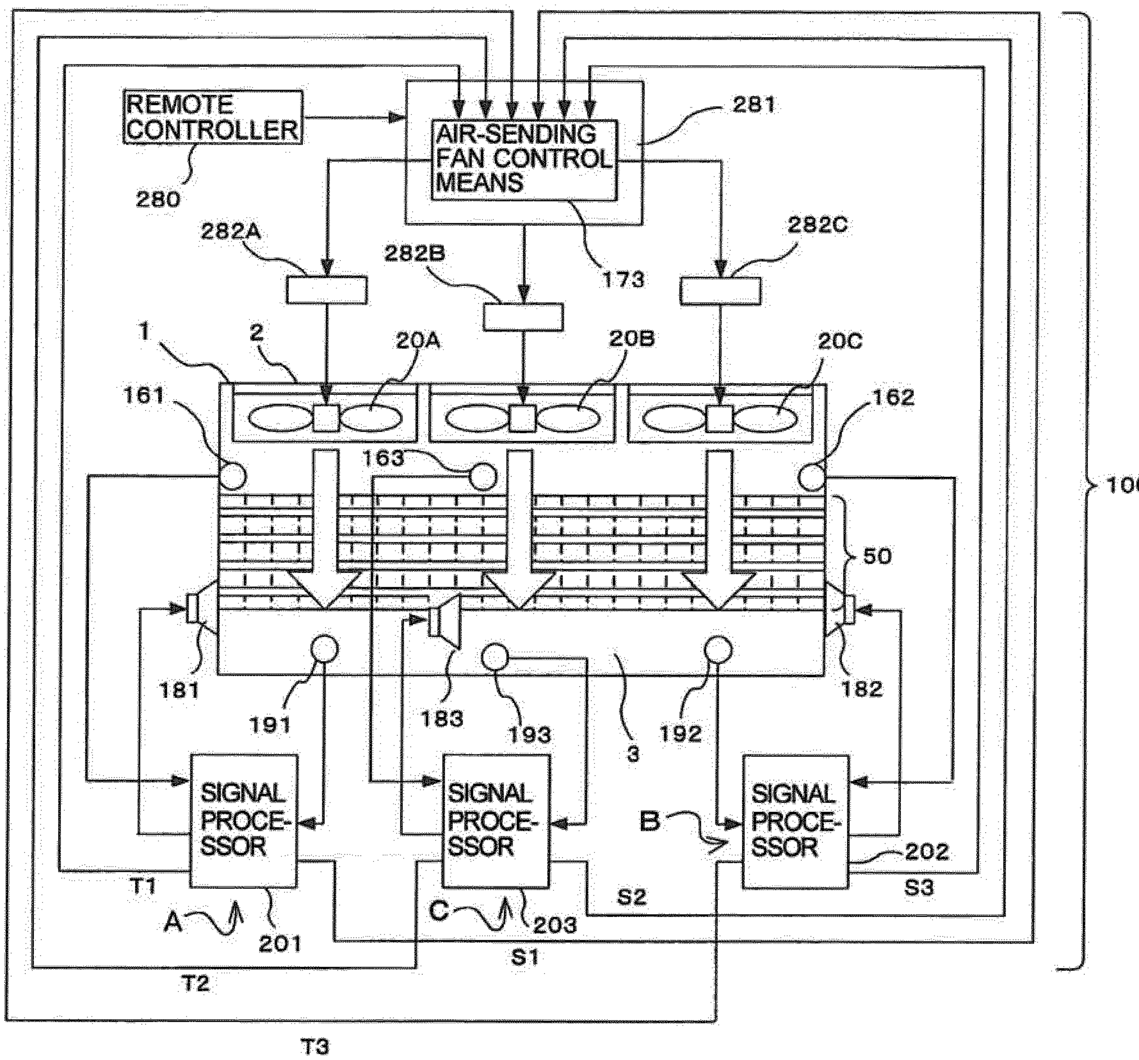
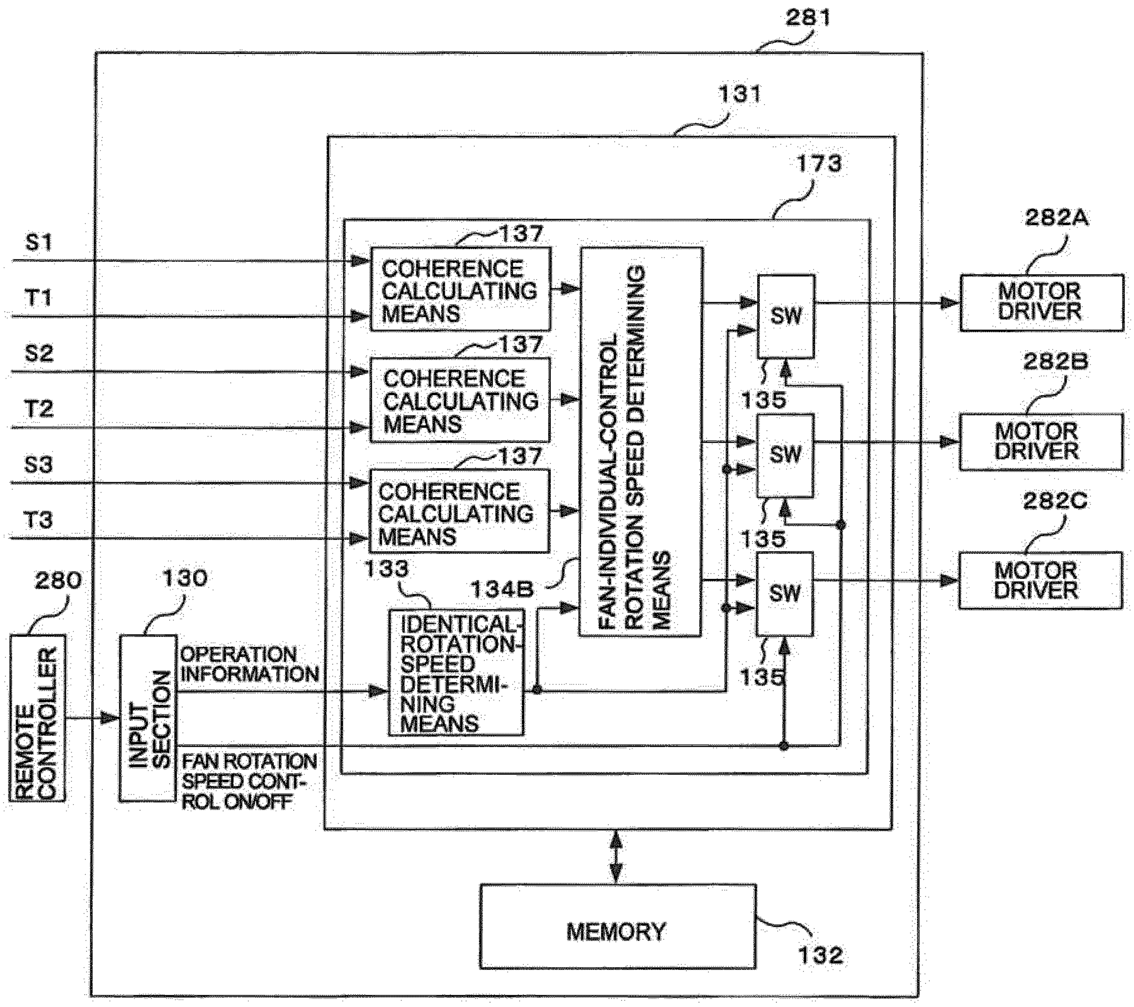
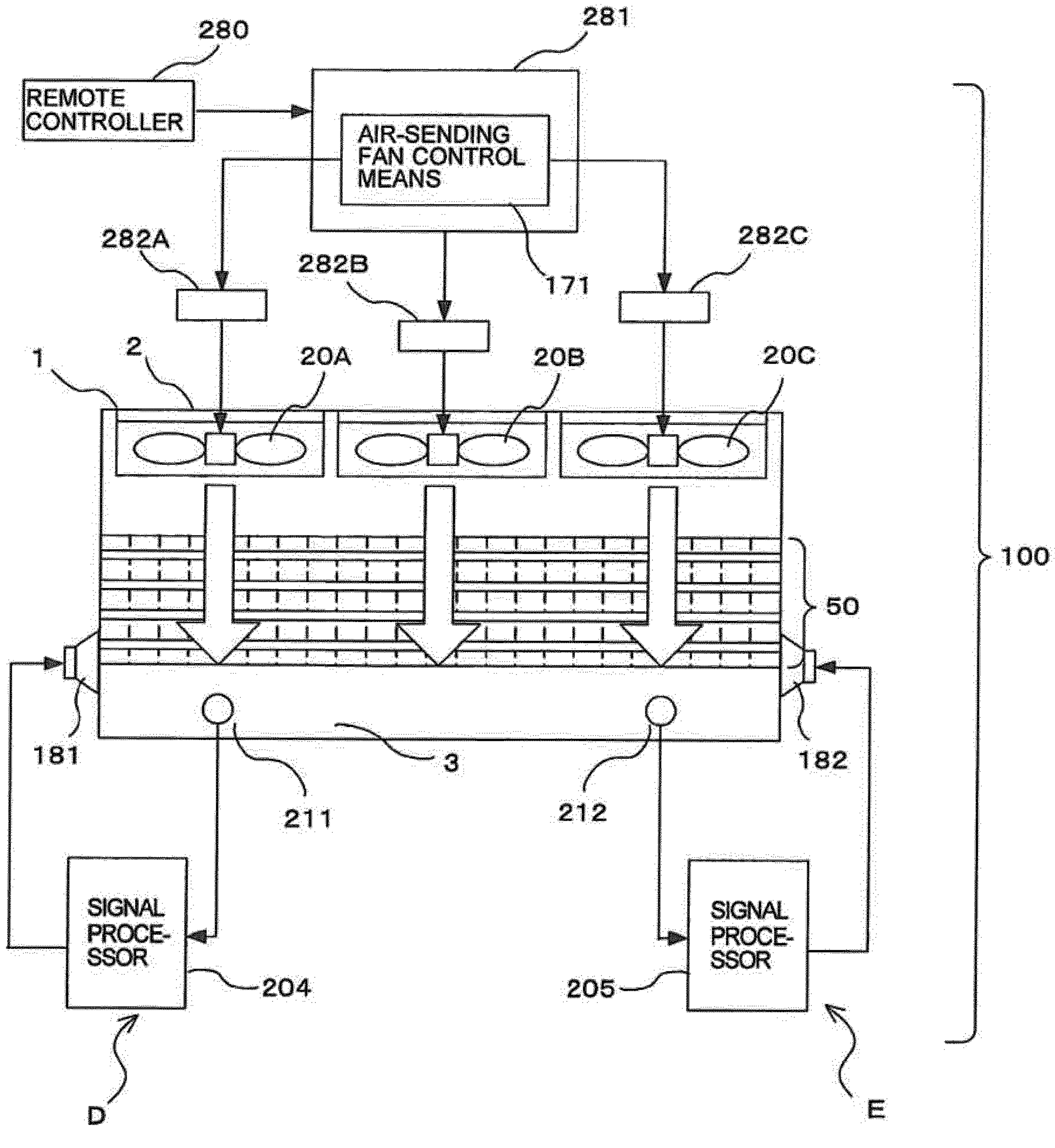

REMOTE CONTROLLER
AIR-SENDING FAN CONTROL MEANS
281
280
282A
282B
282C
173
1
2
20A
20B
20C
161
162
163
100
50
181
182
183
191
193
192
3
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
B
202
T1
S2
S3
A
C
201
203
S1
T2
T3

FIG. 84



281
131
173
S1
T1
S2
T2
S3
T3
137
COHERENCE CALCULATING MEANS
137
COHERENCE CALCULATING MEANS
137
COHERENCE CALCULATING MEANS
FAN-INDIVIDUAL-CONTROL ROTATION SPEED DETERMINING MEANS
SW
SW
SW
135
135
135
282A
MOTOR DRIVER
282B
MOTOR DRIVER
282C
MOTOR DRIVER
280
REMOTE CONTROLLER
130
INPUT SECTION
OPERATION INFORMATION
FAN ROTATION SPEED CONT-ROL ON/OFF
133
IDENTICAL-ROTATION-SPEED DETERMI-NING MEANS
134B
MEMORY
132

FIG. 85


280
REMOTE CONTROLLER
281
AIR-SENDING FAN CONTROL MEANS
171
282A
282B
282C
1
2
20A
20B
20C
100
50
181
182
3
211
212
SIGNAL PROCE-SSOR
204
SIGNAL PROCE-SSOR
205
D
E

F I G. 8 6

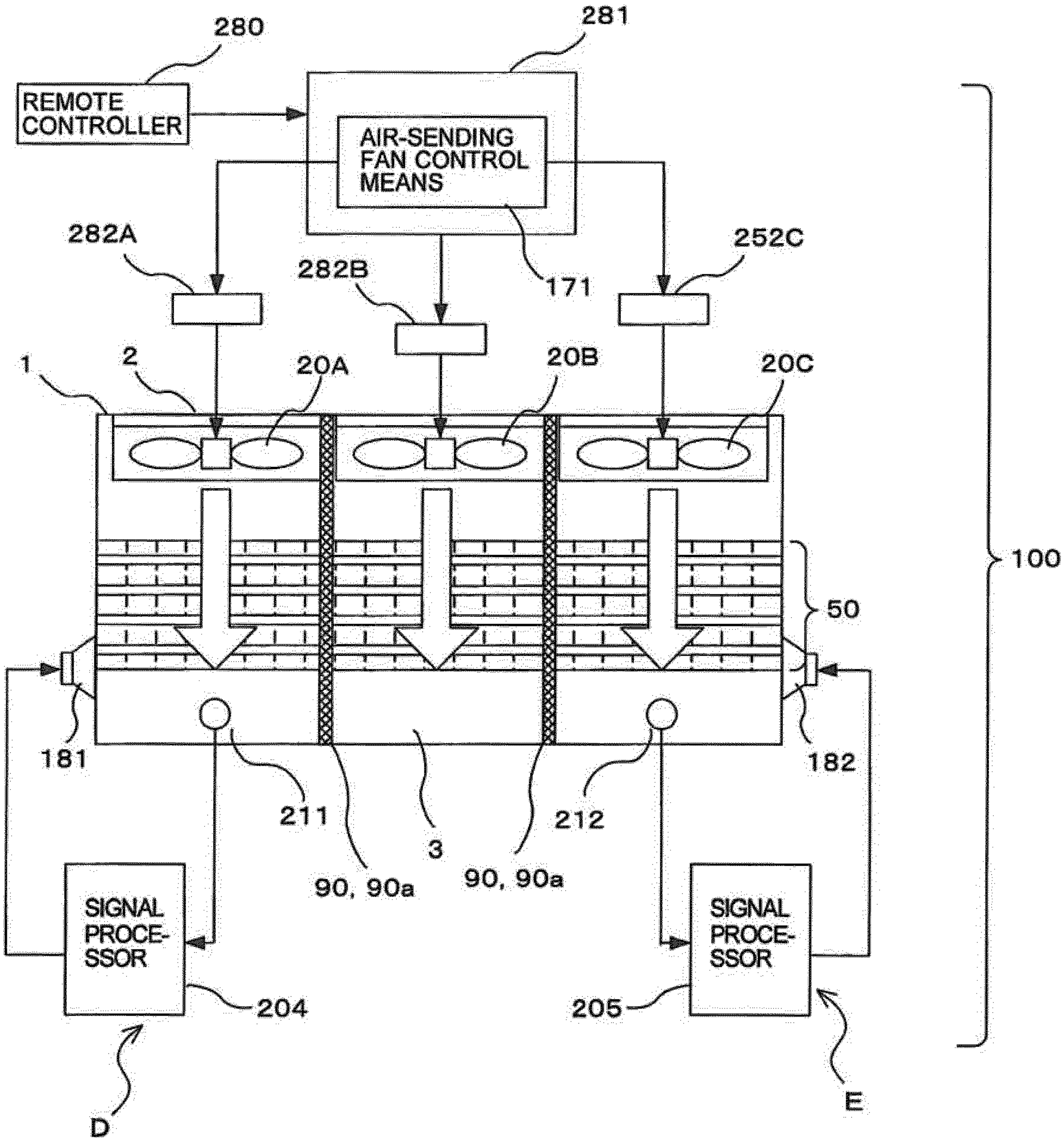
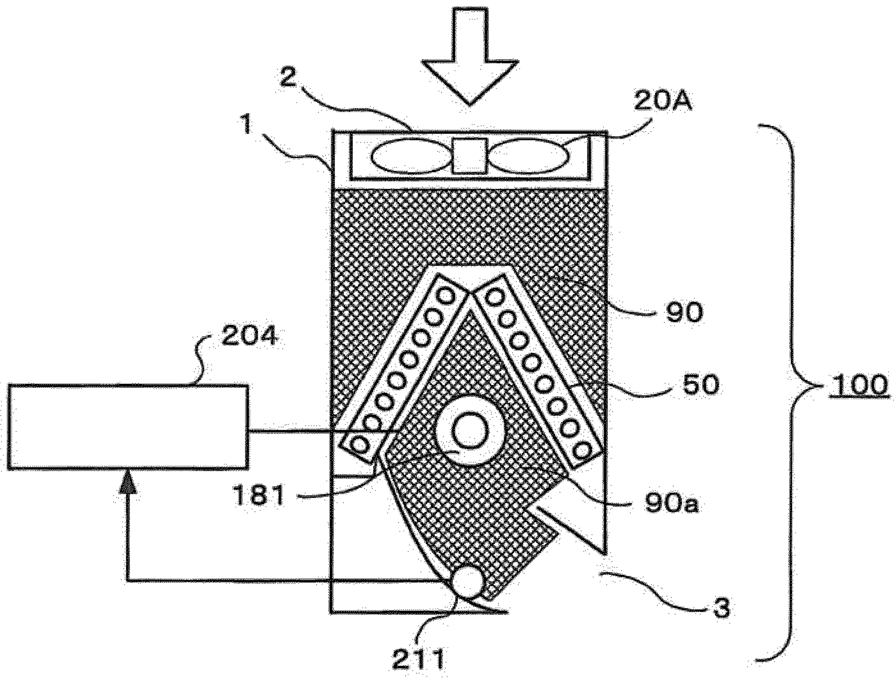
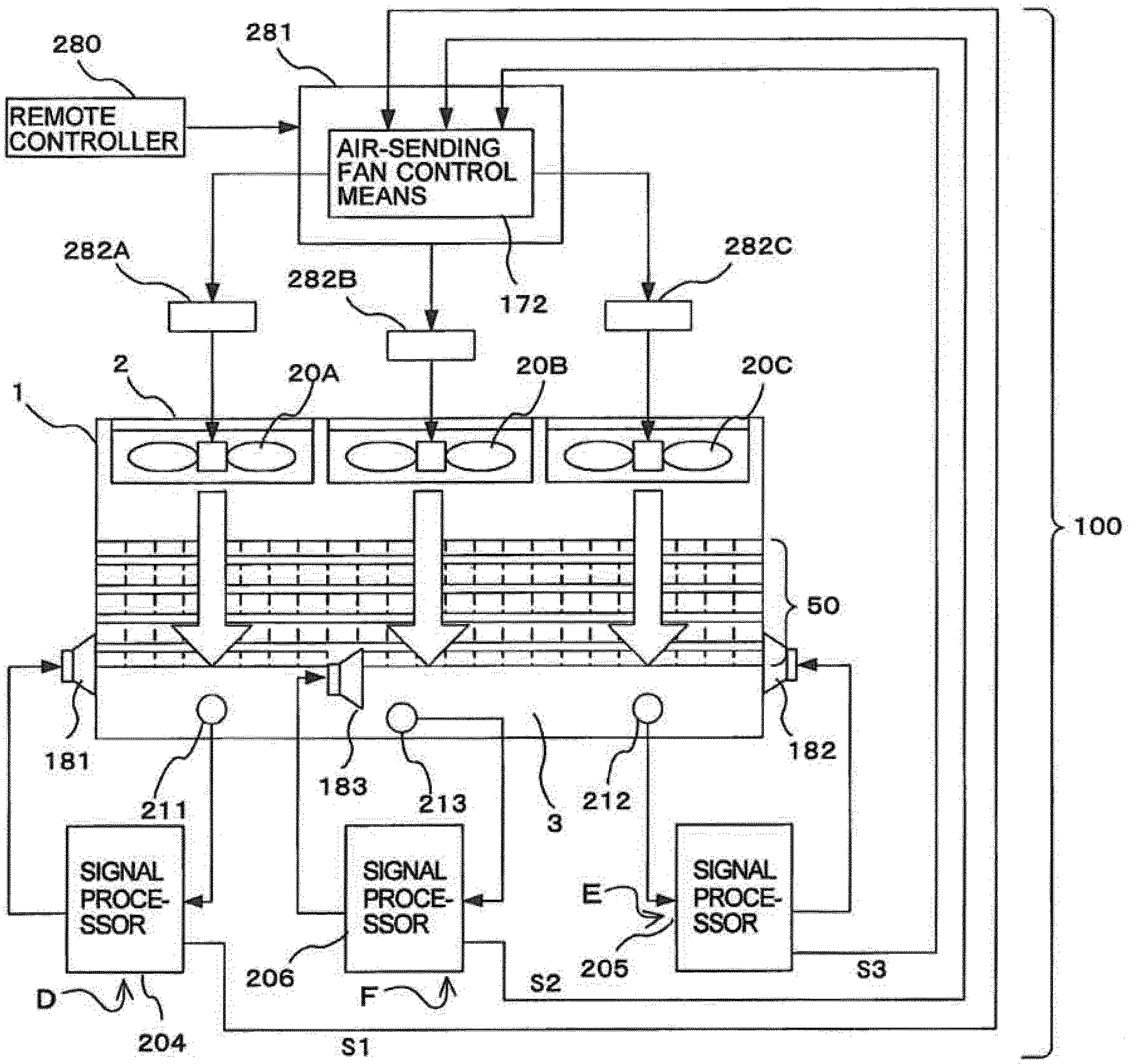

280
281
REMOTE CONTROLLER
AIR-SENDING FAN CONTROL MEANS
282A
282B
252C
171
1
2
20A
20B
20C
100
50
181
182
211
3
212
90, 90a
90, 90a
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
204
205
D
E

FIG. 87

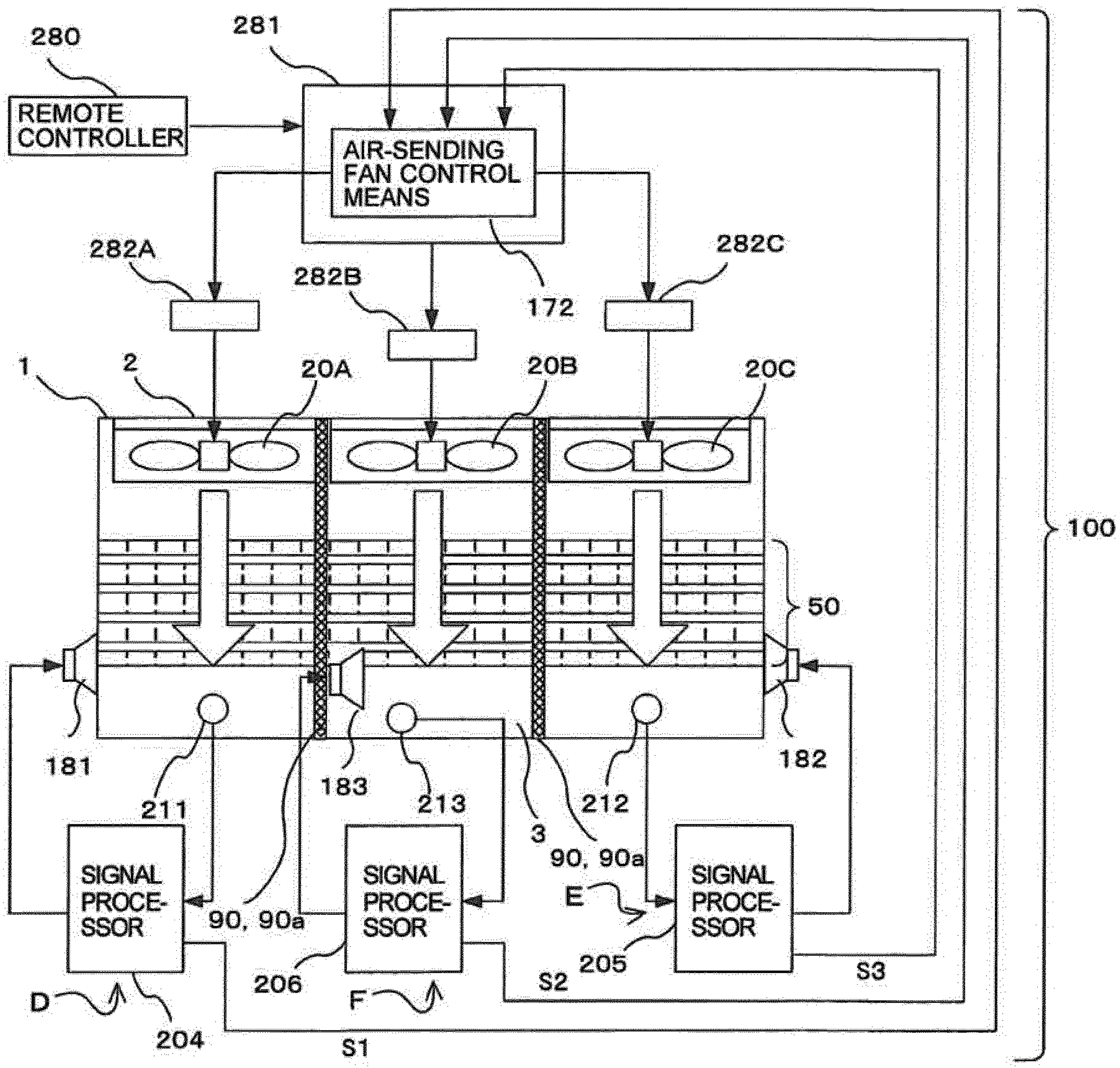


F I G. 8 8



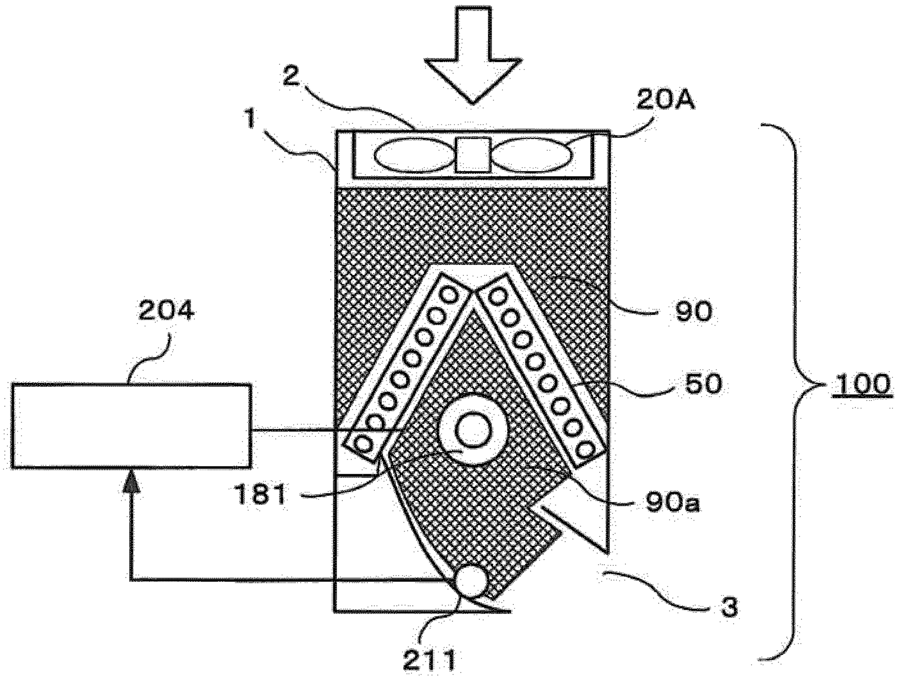
280
REMOTE CONTROLLER
281
AIR-SENDING FAN CONTROL MEANS
172
282A
282B
282C
2
1
20A
20B
20C
100
50
181
182
183
211
213
212
3
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
E
D
F
204
205
206
S1
S2
S3

F I G. 8 9



280
REMOTE CONTROLLER
281
AIR-SENDING FAN CONTROL MEANS
172
282A
282B
282C
1
2
20A
20B
20C
100
50
181
182
183
211
213
212
3
90, 90a
90, 90a
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
E
205
206
204
D
F
S1
S2
S3

FIG. 90



F I G. 9 1

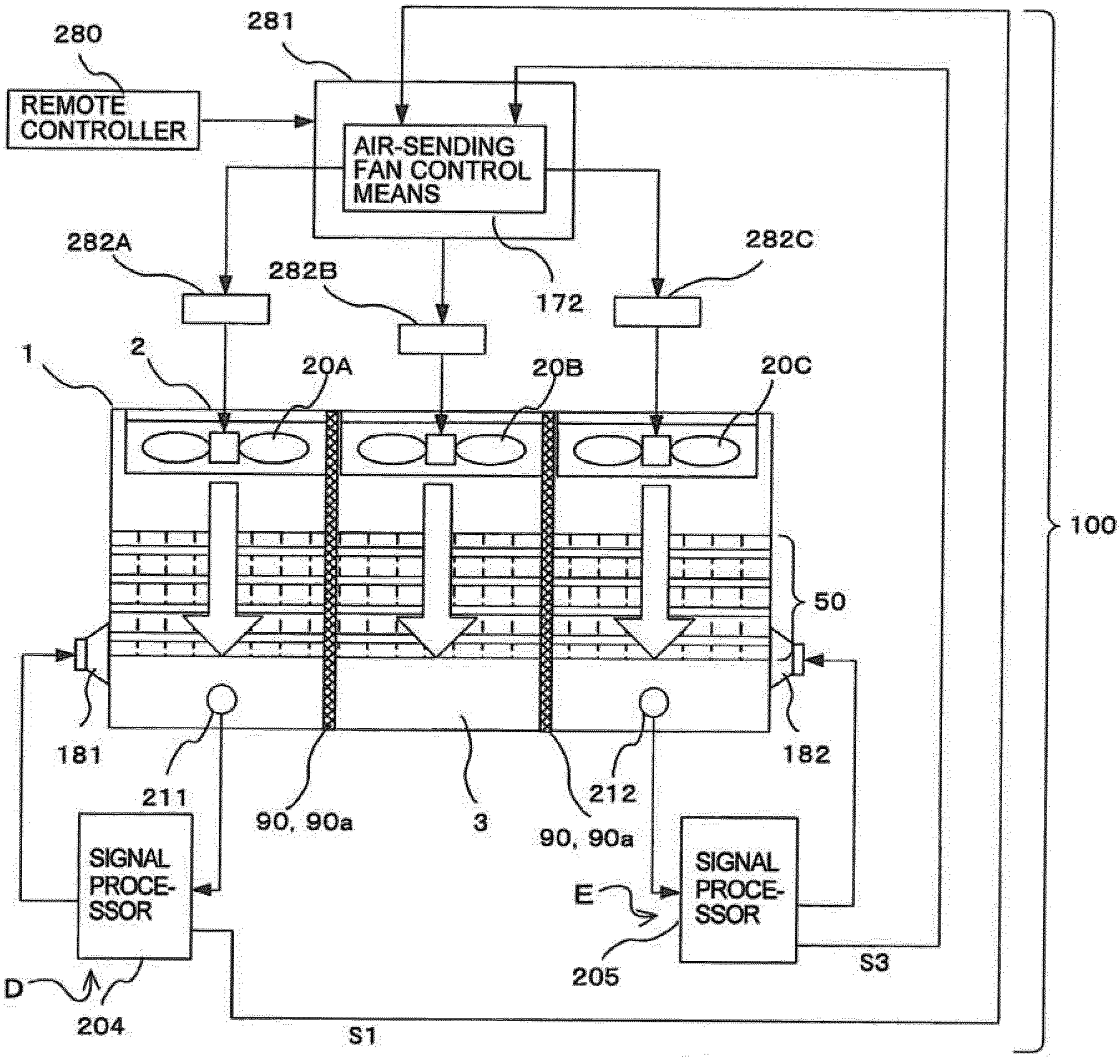

280
281
REMOTE CONTROLLER
AIR-SENDING FAN CONTROL MEANS
282A
282B
172
282C
1
2
20A
20B
20C
100
50
181
182
211
90, 90a
3
90, 90a
212
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
E
205
S3
D
204
S1

FIG. 92

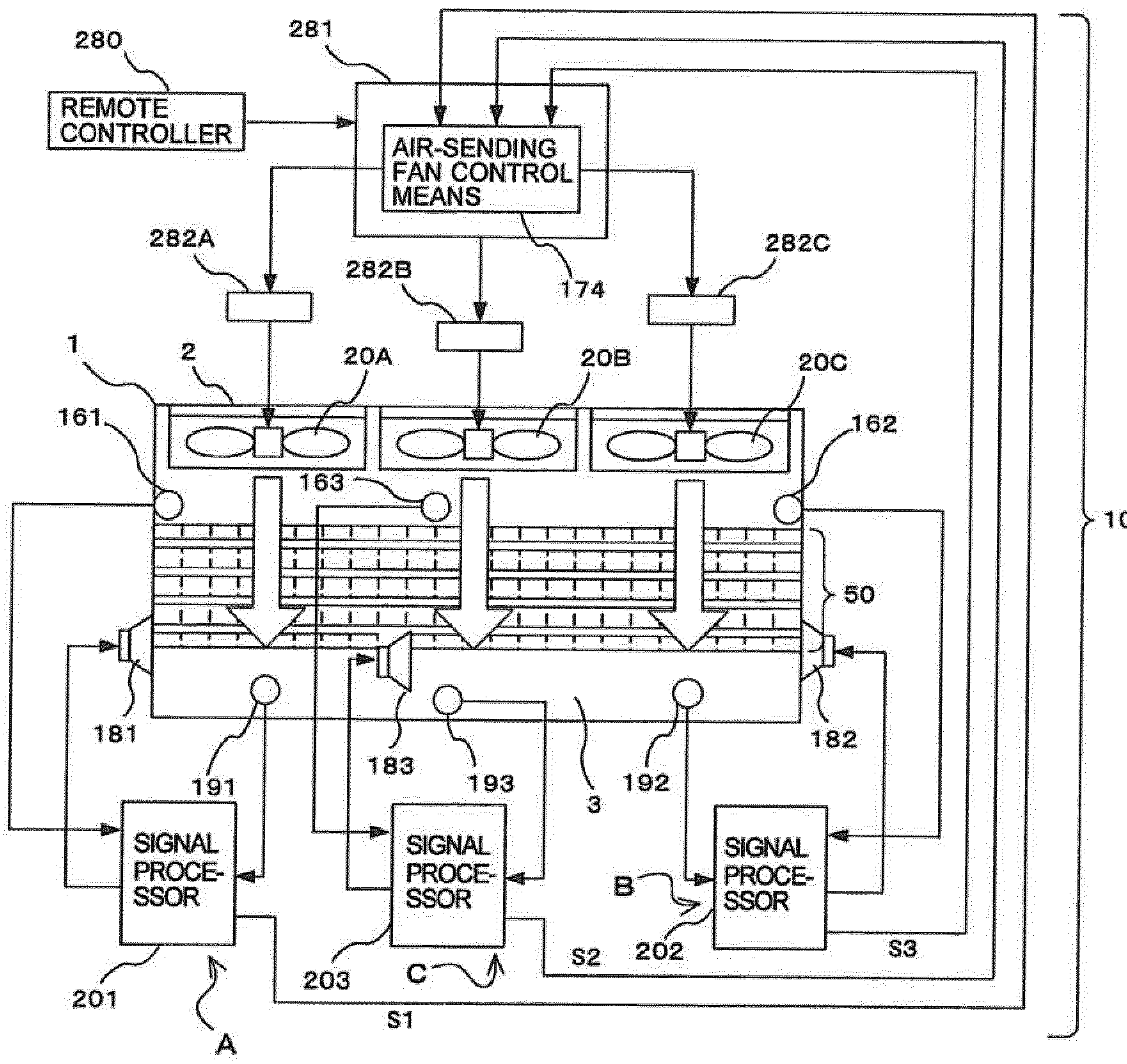
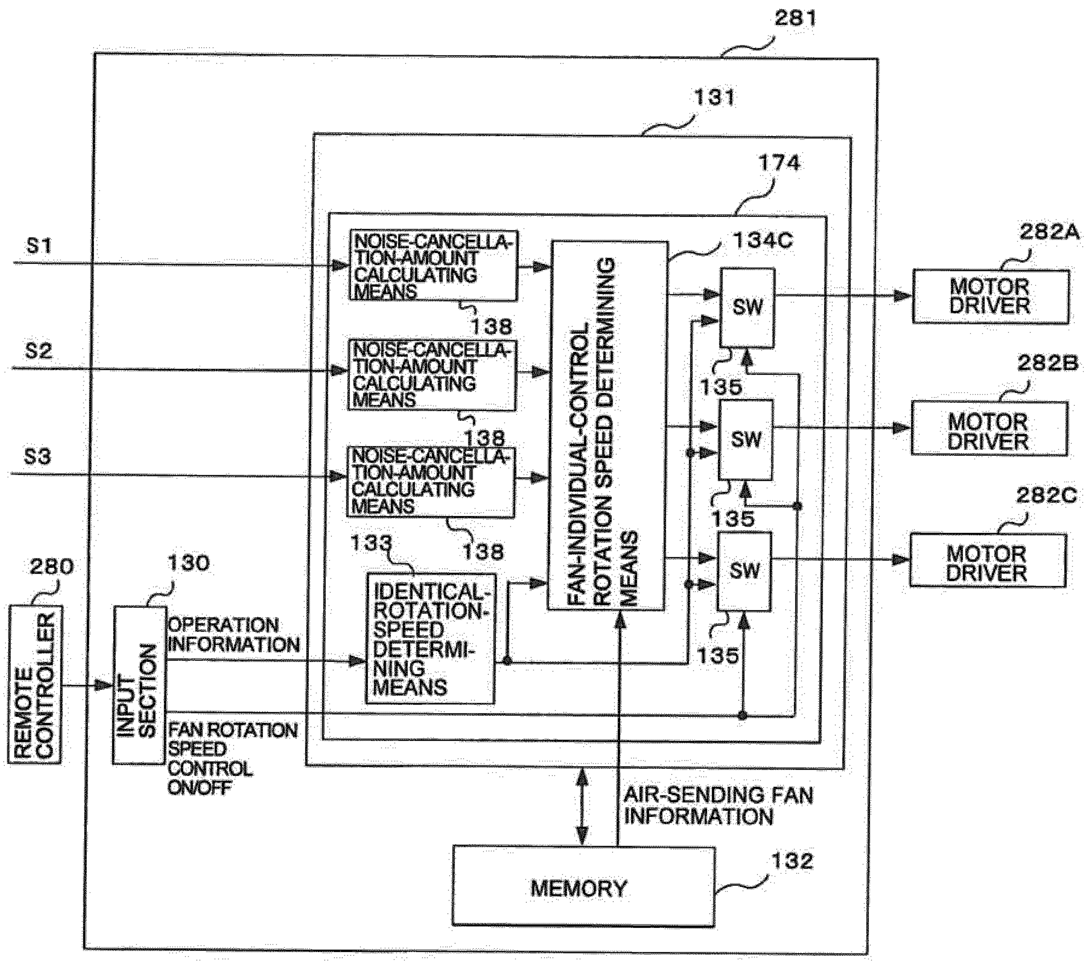
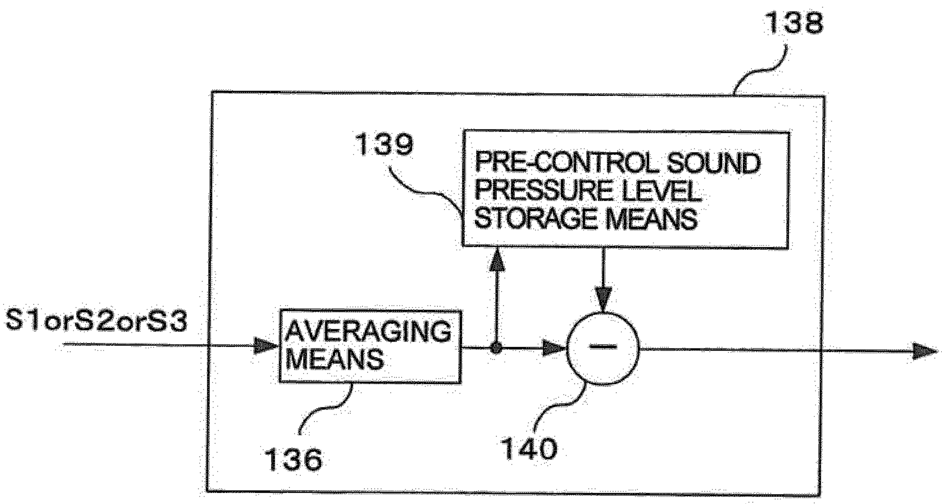

280
REMOTE CONTROLLER
281
AIR-SENDING FAN CONTROL MEANS
174
282A
282B
282C
1
2
20A
20B
20C
161
162
163
100
50
181
183
182
191
193
192
3
SIGNAL PROCESSOR
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
201
203
202
A
B
C
S1
S2
S3

FIG. 93

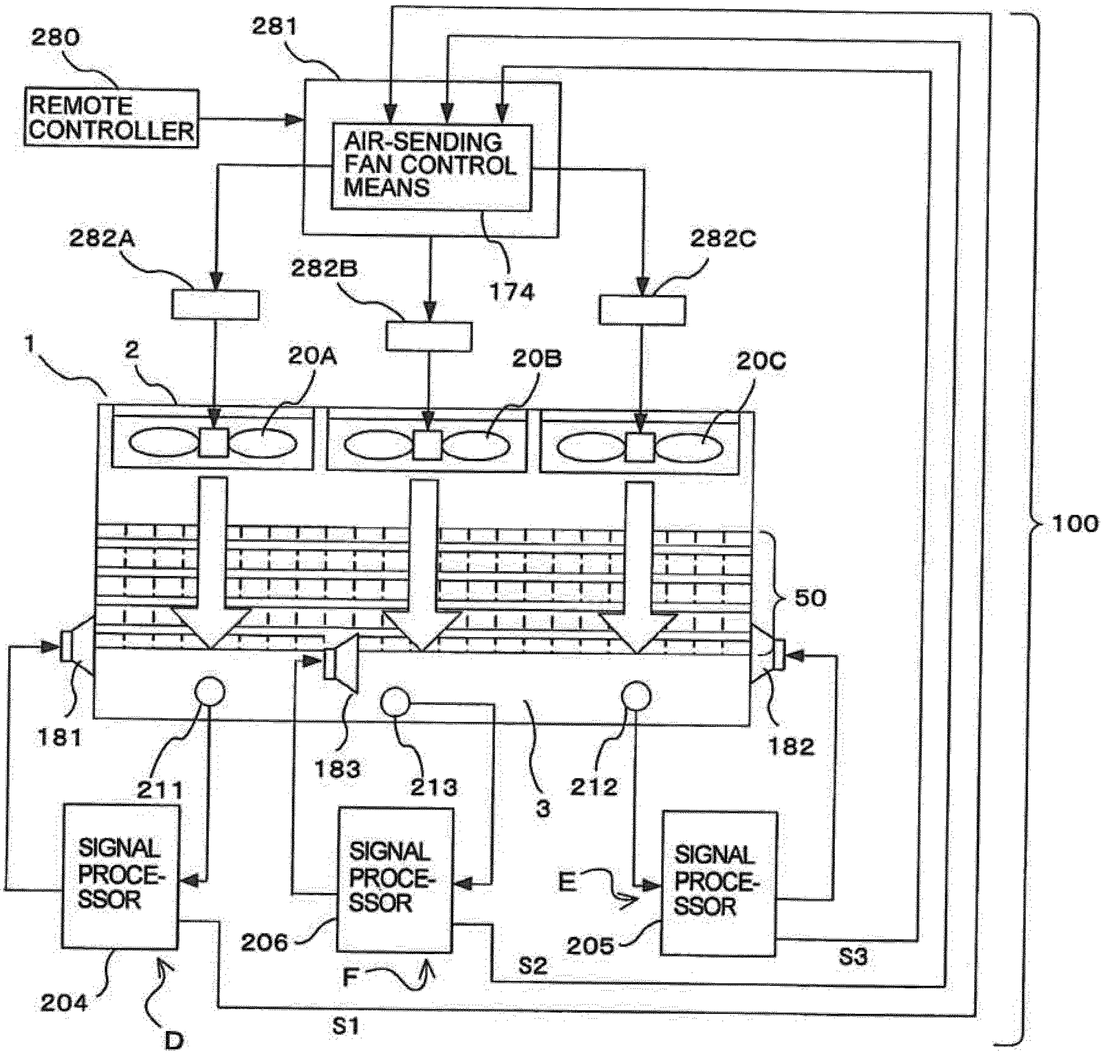


281
131
174
S1
S2
S3
NOISE-CANCELLATION-AMOUNT CALCULATING MEANS
138
NOISE-CANCELLATION-AMOUNT CALCULATING MEANS
138
NOISE-CANCELLATION-AMOUNT CALCULATING MEANS
138
133
IDENTICAL-ROTATION-SPEED DETERMINING MEANS
FAN-INDIVIDUAL-CONTROL ROTATION SPEED DETERMINING MEANS
134C
SW
135
SW
135
SW
135
282A
MOTOR DRIVER
282B
MOTOR DRIVER
282C
MOTOR DRIVER
280
REMOTE CONTROLLER
130
INPUT SECTION
OPERATION INFORMATION
FAN ROTATION SPEED CONTROL ON/OFF
AIR-SENDING FAN INFORMATION
MEMORY
132

FIG. 94


138
139
PRE-CONTROL SOUND PRESSURE LEVEL STORAGE MEANS
S1orS2orS3
AVERAGING MEANS
136
140

F I G. 9 5


280
REMOTE CONTROLLER
281
AIR-SENDING FAN CONTROL MEANS
174
282A
282B
282C
1
2
20A
20B
20C
100
50
181
183
182
211
213
212
3
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
SIGNAL PROCE-SSOR
204
206
205
D
E
F
S1
S2
S3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/004908

A. CLASSIFICATION OF SUBJECT MATTER
F24F1/00(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)
F24F1/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 120175/1974(Laid-open No. 46460/1976) (Kubota Tekko Kabushiki Kaisha), 06 April 1976 (06.04.1976), entire text; all drawings (Family: none)	1-15
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 157522/1978(Laid-open No. 73719/1980) (Matsushita Electric Industrial Co., Ltd.), 21 May 1980 (21.05.1980), entire text; fig. 3 (Family: none)	1-3,13-15

☒ 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 October, 2010 (25.10.10)	02 November, 2010 (02.11.10)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/004908

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 2005-169335 A (Matsushita Electric Industrial Co., Ltd.), 30 June 2005 (30.06.2005), paragraphs [0040] to [0049]; fig. 3 to 6 (Family: none)	1-3,13-15
Y	JP 2008-145099 A (Mitsubishi Electric Corp.), 26 June 2008 (26.06.2008), paragraph [0010]; fig. 4 (Family: none)	2
Y	JP 2000-329364 A (Mitsubishi Heavy Industries, Ltd.), 30 November 2000 (30.11.2000), entire text; fig. 1 (Family: none)	3,13-15
Y	JP 4-265500 A (Matsushita Electric Industrial Co., Ltd.), 21 September 1992 (21.09.1992), entire text; all drawings (Family: none)	4-12
Y	JP 10-227299 A (Daikin Industries, Ltd.), 25 August 1998 (25.08.1998), entire text; all drawings (Family: none)	4-12
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 148725/1988(Laid-open No. 70137/1990) (Toshiba Corp.), 28 May 1990 (28.05.1990), entire text; fig. 1 to 4 (Family: none)	4-12
Y	JP 2000-27798 A (Mitsubishi Electric Corp.), 25 January 2000 (25.01.2000), entire text; all drawings (Family: none)	4-12
Y	JP 2010-71475 A (Panasonic Corp.), 02 April 2010 (02.04.2010), paragraphs [0083] to [0089]; fig. 6, 7 (Family: none)	12
Y	JP 7-295575 A (Nippon Glass Co., Ltd.), 10 November 1995 (10.11.1995), entire text; fig. 1, 2 (Family: none)	12

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/004908

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 6-323564 A (Daikin Industries, Ltd.), 25 November 1994 (25.11.1994), entire text; fig. 1 (Family: none)	12
E,A	WO 2010/089920 A1 (Mitsubishi Electric Corp.), 12 August 2010 (12.08.2010), entire text; all drawings (Family: none)	1-15

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/004908

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)) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/004908

Continuation of Box No.III of continuation of first sheet(2)

The invention of claim 1 and the invention of claim 4 have the common technical feature that "the indoor unit of an air conditioner, which is provided with a casing, on the upper section of which an inlet port is formed, and on the lower side of the front surface section of which an outlet port is formed, an axial fan or a mixed flow fan which is provided on the downstream side of the inlet port within the casing, a heat exchanger which is provided on the upstream side of the outlet port which is the downstream side of the fan within the casing, and in which the air and refrigerant which are blown out from the fan are heat-exchanged.

However, the technical feature cannot be a special technical feature since the technical feature does not make a contribution over the prior art in the light of the disclosure of document 1. Furthermore, there exist no other same or corresponding special technical features between these inventions. And, the claims include the following two inventions (group).

(Invention 1) the inventions of claims 1-3, 13-15

The indoor unit of an air conditioner, which is provided with a casing, on the upper section of which an inlet port is formed, and on the lower side of the front section of which an outlet port is formed, an axial fan or a mixed flow fan which is provided on the downstream side of the inlet port within the casing, a heat exchanger which is provided on the upstream side of the outlet port which is the downstream side of the fan within the casing, and in which the air and refrigerant which are blown out from the fan are heat-exchanged, a filter for collecting dust from the air sucked into the casing, a fan motor to which the impeller of the fan is attached, or a member being affixed to which a support structure for rotatably supporting the impeller of the fan is affixed, and a motor stay having a rod-like or plate-like support member which affixes the member being affixed to the casing, wherein the filter and the motor stay are provided on the downstream side of the fan, and the motor stay is mounted on the upstream side of the filter, or mounted on the downstream side of the filter so that the distance between the motor stay and the filter is smaller than the maximum projection dimension which is the maximum of the projection dimensions of the cross section orthogonal to the longitudinal direction of the support member.

(Invention 2) the inventions of claims 4-12

The indoor unit of an air conditioner, which is provided with a casing, on the upper section of which an inlet port is formed, and on the lower side of the front surface section of which an outlet port is formed, an axial fan or a mixed flow fan which is provided on the downstream side of the inlet port within the casing, a heat exchanger which is provided on the upstream side of the outlet port which is the downstream side of the fan within the casing, and in which the air and refrigerant which are blown out from the fan are heat-exchanged, wherein the fan has an impeller and a housing surrounding the outer periphery section of the impeller, and is provided with a silence structure in the housing.

Document 1: Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 120175/1974 (Laid-open No. 46460/1976) (Kubota Tekko Kabushiki Kaisha), 06 April 1976, entire text, all drawings (Family: none)

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005003244 A **[0003]**