(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 602 566 A1

(12) # EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
12.06.2013 Bulletin 2013/24

(21) Application number: **11814215.7**

(22) Date of filing: **04.04.2011**

(51) Int Cl.:
F24F 11/04 *(2006.01)* ***F24F 13/06*** *(2006.01)*
F24F 13/20 *(2006.01)*

(86) International application number:
PCT/JP2011/002005

(87) International publication number:
WO 2012/017575 (09.02.2012 Gazette 2012/06)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **04.08.2010 JP 2010175187**

(71) Applicant: **Mitsubishi Electric Corporation**
Tokyo 100-8310 (JP)

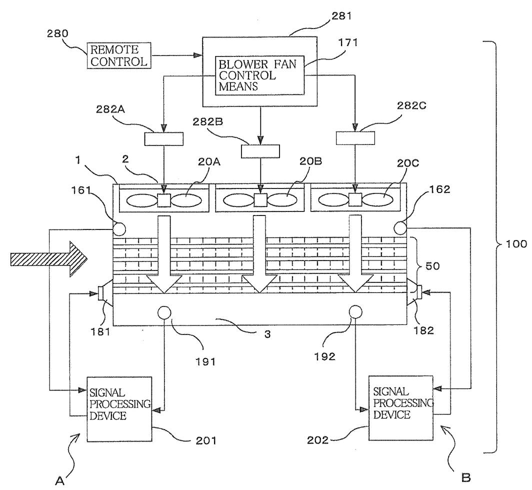
(72) Inventors:
- **MICHIHATA, Satoshi**
  Tokyo 100-8310 (JP)
- **YAMADA, Shouji**
  Tokyo 100-8310 (JP)
- **FUKUI, Tomoya**
  Tokyo 100-8310 (JP)
- **SAKODA, Kenichi**
  Tokyo 100-8310 (JP)
- **KAGA, Kunihiko**
  Tokyo 100-8310 (JP)
- **MORI, Takeshi**
  Tokyo 100-8310 (JP)
- **SUZUKI, Shinichi**
  Tokyo 100-8310 (JP)
- **TAKAMORI, Akira**
  Tokyo 100-8310 (JP)
- **MUKOYAMA, Takuya**
  Tokyo 100-8310 (JP)
- **SHIROTA, Mitsuhiro**
  Tokyo 100-8310 (JP)
- **TANIKAWA, Yoshinori**
  Tokyo
  1008310 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) ## AIR CONDITIONER

(57) To obtain an air-conditioning apparatus capable of further suppressing noise. An air-conditioning apparatus 100 includes a casing 1 formed with an inlet port 2 in an upper portion thereof and with an outlet port 3 on a front lower portion thereof; a plurality of axial flow or mixed flow fans 20 provided in parallel on a downstream side of the inlet port 2; a heat exchanger 50 provided on a downstream side of the fans 20 and on an upstream side of the outlet port 3; noise detection microphones 161 and 162 detecting noise emitted from the fans; control speakers 181 and 182 outputting a control sound that reduces noise; noise cancellation effect detection microphones 191 and 192 detecting a noise cancellation effect of the control sound; noise detection microphones 161 and 162; signal processing devices 201 and 202 that make the control speakers 181 and 182 output the control sound; and a controller 281 performing individual rotation speed control for the plurality of fans 20.

FIG. 35



Printed by Jouve, 75001 PARIS (FR)

Description

Technical Field

[0001] The present invention relates to an air-conditioning apparatus that houses a fan and a heat exchanger in a casing and that includes a noise cancellation unit (a speaker and a microphone) for canceling noise that is generated by the fan.

Background Art

[0002] Hitherto, there exists an air-conditioning apparatus that houses a fan and a heat exchanger in its casing. As such an air-conditioning apparatus, there has been proposed "an air-conditioning apparatus including a main body casing having an inlet port and an outlet port, and a heat exchanger disposed in the main body casing, in which a fan unit constituted by a plurality of propeller fans provided along the width direction of the outlet port is disposed in the outlet port" (see Patent Literature 1, for example). As well as disposing the fan unit in the outlet port so as to facilitate control of the air flow direction, this air-conditioning apparatus disposes a fan unit with the same configuration in the inlet port so as to improve performance of the heat exchanger by increase in air volume.

Citation List

Patent Literature

[0003]

[Patent Literature 1] Japanese Unexamined Patent Application Publication No. 2005-3244 (paragraphs 0012, 0013, and 0018 to 0021, and Figs. 5 and 6)

Summary of Invention

Technical Problem

[0004] An air-conditioning apparatus such as the one in Patent Literature 1 provides a heat exchanger on the upstream side of a fan unit (air-sending device). As such, since a movable fan unit is provided on the outlet port side, drop in air volume, back flow, and the like are caused by air passage change accompanied by the fan movement and instable flow due to asymmetric suction. Further, air with turbulent airflow flows into the fan unit.

Accordingly, the air-conditioning apparatus such as the one in Patent Literature 1 is encountered with a problem in which the fan unit itself becomes a source of noise (becomes a cause for worsening of noise) due to turbulent airflow flowing into the outer circumference of the blades (propellers) of the fan unit where the flow velocity becomes fast.

[0005] Therefore, in order to solve the above problem, the applicant has filed an international application (International Application No. PCT/JP2009/67265) of "an indoor unit of an air-conditioning apparatus including a casing formed with an inlet port at the top and with an outlet port on the front bottom side; an axial flow or mixed flow air sending device provided in the casing on the downstream side of the inlet port; and a heat exchanger provided in the casing on the downstream side of the fan and on the upstream side of the outlet port, the heat exchanger exchanging heat between air that has been blown out from the fan and a refrigerant".

[0006] An object of the invention is to obtain an air-conditioning apparatus, including an axial flow or mixed flow air-sending device (fan), that is capable of further suppressing noise by including a noise cancellation unit (a speaker and a microphone) at an appropriate position of the air-conditioning apparatus.

Solution to Problem

[0007] An air-conditioning apparatus according to the invention includes a casing formed with an inlet port in an upper portion thereof and with an outlet port on a front lower portion thereof; a plurality of axial flow or mixed flow fans provided in parallel on a downstream side of the inlet port in the casing; a heat exchanger provided on a downstream side of the fans and on an upstream side of the outlet port, the heat exchanger exchanging heat between air that has been blown out from the fans and a refrigerant; a noise detection device detecting noise emitted from the fans; a control sound output device outputting a control sound that reduces the noise; a noise cancellation effect detection device detecting a noise cancellation effect of the control sound; a control sound generation device making the control sound output device output the control sound on the basis of detection results of the noise detection device and the noise cancellation effect detection device; and a controller performing individual rotation speed control for the plurality of fans The controller controls at least one rotation speed of the plurality of fans on the basis of a noise cancellation effect at the time when the control sound is interfered with the noise emitted from the fan.

[0008] Further, the air-conditioning apparatus according to the invention includes a casing formed with an inlet port in an upper portion thereof and with an outlet port on a front lower portion thereof; a plurality of axial flow or mixed flow fans provided in parallel on a downstream side of the inlet port in the casing; a heat exchanger provided on a downstream side of the fans and on an upstream side of the outlet port, the heat exchanger exchanging heat between air that has been blown out from the fans and a refrigerant; a control sound output device outputting a control sound that reduces noise emitted from the fans; a noise/noise cancellation effect detection device detecting the noise, the noise/noise cancellation effect detection device detecting a noise cancellation effect of the control sound; a control sound generation device making the control sound output device output the control sound on the basis of a detection result of the noise/noise cancellation effect detection device; and a controller performing individual rotation speed control for the plurality of fans. The controller controls at least one rotation speed of the plurality of fans on the basis of a noise cancellation effect at the time when the control sound is interfered with the noise emitted from the fan.

[0009] Furthermore, the air-conditioning apparatus according to the invention includes a casing formed with an inlet port in an upper portion thereof and with an outlet port on a front lower portion thereof; a plurality of axial flow or mixed flow fans provided in parallel on a downstream side of the inlet port in the casing; a heat exchanger provided on a downstream side of the fans and on an upstream side of the outlet port, the heat exchanger exchanging heat between air that has been blown out from the fans and a refrigerant; a noise detection device detecting noise emitted from the fans; a control sound output device outputting a control sound that reduces the noise; a noise cancellation effect detection device detecting a noise cancellation effect of the control sound; a control sound generation device making the control sound output device output the control sound on the basis of detection results of the noise detection device and the noise cancellation effect detection device; and a controller performing individual rotation speed control for the plurality of fans. The controller performs at least either one of rotation speed control that increases rotation speed of the fans that are disposed at two ends of the casing and rotation speed control that reduces the rotation speed of one or some of the fans other than the fans that are disposed at the two ends of the casing.

[0010] Still further, the air-conditioning apparatus according to the invention includes a casing formed with an inlet port in an upper portion thereof and with an outlet port on a front lower portion thereof; a plurality of axial flow or mixed flow fans provided in parallel on a downstream side of the inlet port in the casing; a heat exchanger provided on a downstream side of the fans and on an upstream side of the outlet port, the heat exchanger exchanging heat between air that has been blown out from the fans and a refrigerant; a control sound output device outputting a control sound that reduces noise emitted from the fans; a noise/noise cancellation effect detection device detecting the noise, the noise/noise cancellation effect detection device detecting a noise cancellation effect of the control sound; a control sound generation device making the control sound output device output the control sound on the basis of a detection result of the noise/noise cancellation effect detection device; and a controller performing individual rotation speed control for the plurality of fans. The controller performs at least either one of rotation speed control that increases rotation speed of the fans that are disposed at two ends of the casing and rotation speed control that reduces the rotation speed of one or some of the fans other than the fans that are disposed at the two ends of the casing.

Advantageous Effects of Invention

[0011] The air-conditioning apparatus according to the invention includes "a noise cancellation mechanism including a noise detection device, a control sound output device, a noise cancellation effect detection device, and a control sound generation device" or "a noise cancellation mechanism including a control sound output device, a noise/noise cancellation effect detection device, and a control sound generation device". Further, the air-conditioning apparatus according to the invention includes a plurality of blower fans and a controller that individually controls the rotation speed of the blower fans. Accordingly, noise of the air-conditioning apparatus can be reduced by controlling the rotation speed of each blower fan on the basis of a noise cancellation effect.

Brief Description of Drawings

[0012]

[Fig. 1] Fig. 1 is a longitudinal sectional view of an indoor unit of an air-conditioning apparatus according to Embodiment 1 of the invention.

[Fig. 2] Fig. 2 is an external perspective view of the indoor unit of the air-conditioning apparatus according to Embodiment 1 of the invention.

[Fig. 3] Fig.3 is a perspective view of the indoor unit according to Embodiment 1 of the invention viewed from the right front side.

[Fig. 4] Fig.4 is a perspective view of the indoor unit according to Embodiment 1 of the invention viewed from the right rear side.

[Fig. 5] Fig.5 is a perspective view of the indoor unit according to Embodiment 1 of the invention viewed from the left front side.

[Fig. 6] Fig. 6 is a perspective view of a drain pan according to Embodiment 1 of the invention.

[Fig. 7] Fig. 7 is a longitudinal sectional view illustrating the position where dew condensation occurs in the indoor unit according to Embodiment 1 of the invention.

[Fig. 8] Fig. 8 is a block diagram of a signal processing device according to Embodiment 1 of the invention.

[Fig. 9] Fig. 9 is a longitudinal sectional view of another exemplary indoor unit of the air-conditioning apparatus according to Embodiment 1 of the invention.

[Fig. 10] Fig. 10 is a longitudinal sectional view of an indoor unit according to Embodiment 2 of the invention.

[Fig. 11] Fig. 11 is a block diagram illustrating a signal processing device according to Embodiment 2 of the invention.

[Fig. 12] Fig. 12 is a diagram of waveforms for illustrating a method of calculating noise to be canceled from sound after interference.

[Fig. 13] Fig. 13 is a block diagram for illustrating a method of estimating a control sound according to Embodiment 2 of the invention.

[Fig. 14] Fig. 14 is a longitudinal sectional view of another exemplary indoor unit according to Embodiment 2 of the invention.

[Fig. 15] Fig. 15 is a longitudinal sectional view of an indoor unit according to Embodiment 3 of the invention.

[Fig. 16] Fig. 16 is a characteristic diagram illustrating the coherence property between a noise detection microphone and a noise cancellation effect detection microphone in accordance to the disposed positions of the two microphones.

[Fig. 17] Fig. 17 is a longitudinal sectional view of an indoor unit according to Embodiment 4 of the invention.

[Fig. 18] Fig. 18 is a longitudinal sectional view of an indoor unit according to Embodiment 5 of the invention.

[Fig. 19] Fig. 19 is a bottom view of the fan (as viewed from a bottom of Fig. 18) according to Embodiment 5 of the invention.

[Fig. 20] Fig. 20 is a cross-sectional view taken along the line M-M of Fig. 19.

[Fig. 21] Fig. 21 is a block diagram illustrating a signal processing device according to Embodiment 5 of the invention.

[Fig. 22] Fig. 22 is a diagram illustrating the result of an experiment in which airflow blown out from the fan of Embodiment 5 of the invention was visualized.

[Fig. 23] Fig. 23 is a block diagram illustrating a circuit of weighting means according to Embodiment 5 of the invention.

[Fig. 24] Fig. 24 is a chart illustrating coherence properties between a detected sound of a noise detection microphone 161 and a detected sound of a noise cancellation effect detection microphone 191 when a fan 20 was operated while the noise detection microphone 161 was disposed outside a cylindrical region S.

[Fig. 25] Fig. 25 is a chart illustrating coherence properties between a detected sound of the noise detection microphone 161 and a detected sound of the noise cancellation effect detection microphone 191 when the fan 20 was operated while the noise detection microphone 161 was disposed inside the cylindrical region S.

[Fig. 26] Fig. 26 is a longitudinal sectional view of another exemplary indoor unit according to Embodiment 5 of the invention.

[Fig. 27] Fig. 27 is a longitudinal sectional view of still another exemplary indoor unit according to Embodiment 5 of the invention.

[Fig. 28] Fig. 28 is a cross-sectional view illustrating another mounting example of the noise detection microphone according to Embodiment 5 of the invention.

[Fig. 29] Fig. 29 is a longitudinal sectional view of an indoor unit according to Embodiment 6 of the invention.

[Fig. 30] Fig. 30 is a longitudinal sectional view of another exemplary indoor unit according to Embodiment 6 of the invention.

[Fig. 31] Fig. 31 is a longitudinal sectional view of still another exemplary indoor unit according to Embodiment 6 of the invention.

[Fig. 32] Fig. 32 is a cross-sectional view illustrating another mounting example of the noise detection microphone according to Embodiment 6.

[Fig. 33] Fig. 33 is a longitudinal sectional view of an indoor unit according to Embodiment 7 of the invention.

[Fig. 34] Fig. 34 is a block diagram illustrating a signal processing device according to Embodiment 7 of the invention.

[Fig. 35] Fig. 35 is a front view of an indoor unit according to Embodiment 8 of the invention.

[Fig. 36] Fig. 36 is a side view of an indoor unit according to Embodiment 8 of the invention.

[Fig. 37] Fig. 37 is a block diagram illustrating a controller according to Embodiment 8 of the invention.

[Fig. 38] Fig. 38 is a front view of another exemplary indoor unit according to Embodiment 8 of the invention.

[Fig. 39] Fig. 39 is a left side view of the indoor unit illustrated in Fig. 38.

[Fig. 40] Fig. 40 is a front view of an indoor unit according to Embodiment 9 of the invention.

[Fig. 41] Fig. 41 is a block diagram illustrating a controller according to Embodiment 9 of the invention.

[Fig. 42] Fig. 42 is a front view of another exemplary indoor unit according to Embodiment 9 of the invention.

[Fig. 43] Fig. 43 is a left side view of the indoor unit illustrated in Fig. 42.

[Fig. 44] Fig. 44 is a front view of still another exemplary indoor unit according to Embodiment 9 of the invention.

[Fig. 45] Fig. 45 is a front view of an indoor unit according to Embodiment 10 of the invention.

[Fig. 46] Fig. 46 is a block diagram illustrating a controller according to Embodiment 10 of the invention.

[Fig. 47] Fig. 47 is a front view of an indoor unit according to Embodiment 11 of the invention.

[Fig. 48] Fig. 48 is a front view of another exemplary indoor unit according to Embodiment 11 of the invention.

[Fig. 49] Fig. 49 is a left side view of the indoor unit illustrated in Fig. 48.

[Fig. 50] Fig. 50 is a front view of an indoor unit according to Embodiment 12 of the invention.

[Fig. 51] Fig. 51 is a front view of another exemplary indoor unit according to Embodiment 12 of the invention.

[Fig. 52] Fig. 52 is a left side view of the indoor unit illustrated in Fig. 51.

[Fig. 53] Fig. 53 is a front view of still another exemplary indoor unit according to Embodiment 12 of the invention.

[Fig. 54] Fig. 54 is a front view of an indoor unit according to Embodiment 15 of the invention.

[Fig. 55] Fig. 55 is a block diagram illustrating a controller according to Embodiment 15 of the invention.

[Fig. 56] Fig. 56 is a block diagram illustrating noise cancellation amount calculating means according to Embodiment 15 of the invention.

[Fig. 57] Fig. 57 is a front view of an indoor unit according to Embodiment 16 of the invention.

Description of Embodiments

[0013] Specific embodiments of an air-conditioning apparatus (more specifically, indoor units of an air-conditioning apparatus) according to the invention will be described below. Note that, in Embodiment 1, basic configurations of the units constituting the indoor unit of the air-conditioning apparatus will be described. Further, from Embodiment 2 and thereafter, detailed configurations of the units or other examples will be described. Furthermore, in each of the subsequent embodiments, the invention will be described with a wall-mounted indoor unit as its example. Additionally, in the figures of each embodiment, the shapes, size, and the like of each unit (or components of each unit) may partially differ.

Embodiment 1

<Basic Configuration>

[0014] Fig. 1 is a longitudinal sectional view of an indoor unit (referred to as an "indoor unit 100") of an air-conditioning apparatus according to Embodiment 1 of the invention. Further, Fig. 2 is an external perspective view of the indoor unit. Note that, in Embodiment 1 and the embodiments described thereafter, description will be given assuming that the left side of Fig. 1 is the front side of the indoor unit 100. Configuration of the indoor unit 100 will be described with reference to Figs. 1 and 2.

(Overall Configuration)

[0015] The indoor unit 100 supplies conditioned air to areas subject to air conditioning such as an indoor space by using a refrigeration cycle that circulates a refrigerant. The indoor unit mainly includes a casing 1 that is formed with inlet ports 2 for suctioning indoor air therein and an outlet port 3 for supplying conditioned air into the area subject to air conditioning; fans 20 that is accommodated in the casing 1, that suctions indoor air from the inlet ports 2, and that blows out conditioned air from the outlet port 3; and a heat exchanger 50 that is disposed in an air passage from the fans 20 to the outlet port 3 and that generates conditioned air by exchanging heat between a refrigerant and the indoor air. Further, an air passage (arrow Z) is in communication with the inside of the casing by these components. The inlet ports 2 are openly formed in the upper portion of the casing 1. The outlet port 3 is openly formed in the lower portion of the casing 1 (more specifically, the front lower portion of the casing 1). The fans 20 are disposed on the downstream side of the inlet ports 2 and on the upstream side of the heat exchanger 50, and include, for example, an axial flow fan, a mixed flow fan, or the like.

[0016] Further, the indoor unit 100 is provided with a controller 281 that controls the rotation speed of the fans 20 and the orientation (angle) of a horizontal vane 70 and a vertical vane described below. Note that the controller 281 may be omitted from the figures illustrating Embodiment 1 and the subsequent embodiments.

[0017] As regards the indoor unit 100 configured as above, since the fans 20 are provided on the upstream side of the heat exchanger 50, occurrence of swirl flow of air blown out from the outlet port 3 and unevenness of wind speed distribution can be suppressed compared to the indoor units of conventional air-conditioning apparatuses that are provided with fans 20 in the outlet port 3. Accordingly, it is possible to send comfortable air to the area subject to air conditioning. Further, since there is no complicated structure such as a fan in the outlet port 3, it is possible to easily perform measures against dew condensation occurring at the boundary between warm air and cold air during a cooling operation. Furthermore, since fan motors 30 are not exposed to conditioned air such as hot air and cold air, it will be possible to achieve long operational life.

(Fan)

[0018] Typically, in an indoor unit of an air-conditioning apparatus, the fan cannot be made large since there is a restriction in the disposing space. Accordingly, in order to obtain the desired amount of air volume, a plurality of fans with appropriate sizes is disposed in parallel. As shown in Fig. 2, the indoor unit 100 according to Embodiment 1 has three fans 20 disposed in parallel along the longitudinal direction of the casing 1 (in other words, in the longitudinal direction of the outlet port 3). In a typical sized indoor unit of an air-conditioning apparatus as of now, two to four fans 20 are desirable to obtain the intended heat exchange capacity. In the indoor unit according to Embodiment 1, it is possible to obtain substantially the same amount of air volume in each of the fans 20 by configuring the shape of the fans to be all the same and by operating all the fans 20 with the same operating rotation speed.

[0019] With the above configuration, by combining the number, shape, size, and the like of the fans 20 in accordance with the required air volume and air flow resistance in the indoor unit 100, it is possible to design optimum fans corresponding to indoor units 100 with various specifications.

(Bell Mouth)

[0020] The indoor unit 100 according to Embodiment 1 is disposed with a duct-shaped bell mouth 5 around each fan 20. The bell mouth 5 is for smoothly guiding the suction and discharge air into and out of the fan. As shown in Fig. 1, the bell mouth 5 according to Embodiment 1 has a substantially circular geometry in planar view. Further, the bell mouth 5 according to Embodiment 1 has the following shape in a longitudinal section. An upper portion 5a has a substantially arcuate shape in which an end portion widens as it extends upwards. A middle portion 5b is a straight portion in which the diameter of the bell mouth is constant. A lower portion 5c has a substantially arcuate shape in which an end portion widens as it extends downwards. Further, the end of the upper portion 5a (the arcuate portion on the inlet side) of the bell mouth 5 forms the inlet port 2.
Although the bell mouth 5 illustrated in Fig. 1 of Embodiment 1 has a duct shape that is configured to have a height higher than that of an impeller of the fan 20, the invention is not limited to this. The bell mouth may be a semi-opened type in which the height of the bell mouth 5 is configured to be lower than that of the impeller of the fan 20. Further, the bell mouth 5 may be configured with only the end portions 5a and 5b without the straight portion of 5b illustrated in Fig. 1.

[0021] Note that the bell mouth 5 may be integrally formed with the casing 1 so as to reduce the parts count and to improve its strength. Further, for example, the bell mouth 5, the fan 20, the fan motor 30, and the like may be modularized and be configured to be detachable from the casing 1 so as to increase maintenanceability.

[0022] Furthermore, in Embodiment 1, the end portion of the upper portion 5a of the bell mouth 5 (the arcuate portion on the inlet side) is configured with a uniform shape with respect to the aperture plane of the bell mouth 5 in the circumferential direction. That is, the bell mouth 5 does not have any structure such as a notch or a rib in the rotation direction of the rotation shaft 20a of the fan 20 and has a uniform shape with axial symmetry.

[0023] By configuring the bell mouth 5 as such, the end portion of the upper portion 5a of the bell mouth 5 (the arcuate portion on the inlet side) will have a uniform shape relative to the rotation of the fan; hence, regarding the suction flow of the fan 20, one with uniform flow is achieved. Accordingly, noise generated by drifts of the suction flow of the fan 20 can be reduced.

(Regarding Partition Plate)

[0024] As shown in Fig. 2, the indoor unit 100 according to Embodiment 1 is provided with a partition plate 90 between each neighboring fans 20. These partition plates 90 are disposed between the heat exchanger 50 and the fans 20. That is, the air passage between the heat exchanger 50 and the fans 20 is divided into plural air passages (into three in Embodiment 3). Since the partition plates 90 are disposed between the heat exchanger 50 and the fans 20, end portions of the partition plates 90 that are on the side in contact with the heat exchanger 50 are formed along the heat exchanger 50. More specifically, as shown in Fig. 1, the heat exchanger 50 is disposed with a substantially inverted V-shape in a longitudinal section from the front side to the rear side of the indoor unit 100 (that is, a longitudinal section when the indoor unit 100 is viewed from the right side. Hereinafter referred to as a "right side longitudinal section"). Accordingly, the end portion of each partition plate 90 on the heat exchanger 50 side also has a substantially inverted V-shape.

[0025] Note that the position of the end portion of each partition plate 90 on the fan 20 side may be determined as follows. If there is sufficient distance between the neighboring fans 20 such that the fans will not influence each other on the suction side, the end portion of each partition plate 90 on the fan 20 side may be provided up to the exit plane of the fan 20. However, if the neighboring fans 20 are close to each other such that the fans will influence each other on the suction side and if it is possible to form the end portion of the upper portion 5a of the bell mouth 5 (the arcuate portion on the inlet side) to have a sufficiently large shape, then the end portion of each partition plate 90 on the fan 20 side may be extended to the upstream side (inlet side) of the fan 20 so that there will be no influence to the neighboring air passage (so that the neighboring fans 20 will not influence each other on their inlet sides).

[0026] Further, the partition plate 90 may be formed of various materials. For example, the partition plate 90 may be formed of metal such as steel, aluminum, or the like. Further, the partition plate 90 may be formed of resin or the like, for example. However, since the heat exchanger 50 becomes high in temperature during a heating operation, a slight space may be provided between the partition plate 90 and the heat exchanger 50 if the partition plate 90 is formed of a material such as resin that has a low melting point. If the partition plate 90 is of a material that has a high melting point such as aluminum, steel, or the like, the partition plate 90 may be disposed in contact with the heat exchanger 50. If the heat exchanger 50 is, for example, a fin-and-tube heat exchanger, the partition plate 90 may be inserted between the fins of the heat exchanger 50.

[0027] As described above, the air passage between the heat exchanger 50 and the fans 20 is divided into plural air passages (into three in Embodiment 3). Noise generated in the duct can be reduced by providing a sound absorbing material to the air passages, that is, to the partition plates 90, the casing 1, and the like.

[0028] Further, these divided air passages are each formed into a substantially rectangular shape with sides of L1 and L2 in planar view. That is, the breadth of each divided air passage is L1 and L2. Accordingly, for example, the air volume that has been generated by the fan 20, disposed in the substantially rectangular shape formed with L1 and L2, reliably passes through the area of the heat exchanger 50 surrounded by L1 and L2, which is positioned downstream of the fan 20.

[0029] By dividing the air passage in the casing 1 into plural air passages, even if the flow field created downstream of each fan 20 includes a swirling component, the air blown out from each fan 20 cannot travel freely to the longitudinal direction (a direction perpendicular to the sheet of Fig. 1) of the indoor unit 100. Accordingly, the air blown out from each fan 20 can be made to pass through the area of the heat exchanger 50 that is the area downstream of the fan 20 surrounded by L1 and L2. As a result, unevenness of air volume distribution of the air flowing into the entire heat exchanger 50 in the longitudinal direction (a direction perpendicular to the sheet of Fig. 1) can be suppressed and a high heat exchange capacity can be obtained. Further, by separating the inside of the casing 1 with partition plates 90, it is possible to prevent, between each neighboring fans 20, interference of the swirl flows generated by the neighboring fans 20. Accordingly, it is possible to suppress loss of fluid energy due to interference between swirl flows; hence, along with improvement of wind speed distribution, it is possible to reduce pressure loss in the indoor unit 100 as well. Note that the partition plate 90 does not have to be formed of a single plate and may be formed of plural plates. For example, the partition plate 90 may be divided into two, such that one is on a front side heat exchanger 51 side and the other is on a rear side heat exchanger 55 side. Naturally, it is preferable that there is no gap between each connection of the plates constituting the partition plate 90. By dividing the partition plate 90 into plural plates, ease of assembly of the partition plate 90 is increased.

(Fan Motor)

[0030] The fan 20 is rotatably driven by the fan motor 30. The fan motor 30 that is used may be an inner rotor type or an outer rotor type. If the fan motor 30 is of an outer rotor type, one configured with a rotor that is integral with a boss 21 of the fan 20 (the boss 21 made to include the rotor) is also used. Further, by sizing the fan motor 30 to be smaller than the size of the boss 21 of the fan 20, the airflow generated by the fan 20 can be prevented from being deteriorated. Furthermore, by disposing the motor inside the boss 21, the dimension in the shaft direction can be made short. By configuring the fan motor 30 and the fan 20 to have an easy-to-detach structure, ease of maintenance is increased.

[0031] Note that a brushless DC motor that is relatively high in cost may be used as the fan motor 30 to achieve improvement in efficiency, long life, and improvement in controllability; however, it is needless to say that other types of motors may be employed to satisfy the primary function of an air-conditioning apparatus. Further, the circuit for driving the fan motor 30 may be integral with the fan motor 30 or may be configured externally with the implementation of dust-proofing and fire-proofing measures.

[0032] The fan motor 30 is mounted to the casing 1 with a motor stay 16. Further, the fan motor 30 may be a box type (the fan 20, a housing, the fan motor 30, the bell mouth 5, the motor stay 16, and the like being modularized as one) that is used to cool CPUs and the like and may be configured to be detachable from the casing 1; hence, ease of maintenance is increased and the precision of tip clearance of the fan 20 can be improved. Generally, the fan performance is higher when the tip clearance is smaller and thus is more preferable.

[0033] Note that the driving circuit of the fan motor 30 may be configured inside the fan motor 30 or may be configured outside thereof.

(Motor Stay)

[0034] The motor stay 16 includes a fixing member 17 and a supporting member 18. The fan motor 30 is mounted to the fixing member 17. The supporting member 18 is a member for securing the fixing member 17 to the casing 1. The supporting member 18 is, for example, rod-shaped and is provided so as to radially extend from the outer circumference of the fixing member 17, for example. As shown in Fig. 1, the supporting member 18 according to Embodiment 1 is provided so as to extend in the horizontal direction. Note that the supporting member 18 may be blade shaped or plate shaped to give the member a stator vane effect.

(Heat Exchanger)

[0035] The heat exchanger 50 of the indoor unit 100 according to Embodiment 1 is provided on the downwind side of the fans 20. This heat exchanger 50 may employ a fin-and-tube heat exchanger, for example. As shown in Fig. 1, the heat exchanger 50 is separated at a symmetry line 50a in the right side longitudinal section. The symmetry line 50a is a line that separates the installation range of the heat exchanger 50 in this section into left and right at a substantially middle portion thereof. That is, the front side heat exchanger 51 is disposed on the front side (left side of the sheet of Fig. 1) relative to the symmetry line 50a and the rear side heat exchanger 55 is disposed on the rear side (right side of the sheet of Fig. 1) relative to the symmetry line 50a. Further, the front side heat exchanger 51 and the rear side heat exchanger 55 are disposed in the casing 1 such that the distance between the front side heat exchanger 51 and the rear side heat exchanger 55 increases with respect to the flow direction of the air, that is, are disposed such that the section of the heat exchanger 50 in the right side longitudinal section has a substantially inverted V-shape. That is, the front side heat exchanger 51 and the rear side heat exchanger 55 are disposed so as to be inclined against the flow direction of the air supplied from the fans 20.

[0036] Further, the heat exchanger 50 is featured in that the air passage area of the rear side heat exchanger 55 is larger than the air passage area of the front side heat exchanger 51. That is, in the heat exchanger 50, the air volume in the rear side heat exchanger 55 is larger than the air volume in the front side heat exchanger 51. In Embodiment 1, the length of the rear side heat exchanger 55 in the longitudinal direction is longer than the front side heat exchanger 51 in the longitudinal direction when viewed in the right side longitudinal section. Accordingly, the air passage area of the rear side heat exchanger 55 is larger than the air passage area of the front side heat exchanger 51. Note that other configurations of the front side heat exchanger 51 and the rear side heat exchanger 55 (such as the length in the depth direction of Fig. 1) are the same. That is, the heat transfer area of the rear side heat exchanger 55 is larger than the heat transfer area of the front side heat exchanger 51. Further, the rotation shaft 20a of the fan 20 is disposed in the upper portion of the symmetry line 50a.

[0037] By configuring the heat exchanger 50 as above, occurrence of swirl flow of air blown out from the outlet port 3 and unevenness of wind speed distribution can be suppressed compared to the indoor units of conventional air-conditioning apparatuses that are provided with fans in the outlet port. Further, by configuring the heat exchanger 50 as above, the air volume in the rear side heat exchanger 55 is larger than the air volume in the front side heat exchanger 51. Furthermore, due to this difference in air volume, when air that has passed through the front side heat exchanger 51 and air that has passed through the rear side heat exchanger 55 merge, the merged air is bent towards the front side (the outlet port 3 side). Accordingly, there will be no need to drastically bend the airflow in the vicinity of the outlet port 3; thus, it is possible to reduce pressure loss in the vicinity of the outlet port 3.

[0038] Additionally, in the indoor unit 100 according to Embodiment 1, the direction of air flowing out from the rear side heat exchanger 55 is from the rear side to the front side. Accordingly, in the indoor unit 100 according to Embodiment 1, it is easier to bend the flow of air that has passed the heat exchanger 50 compared to a heat exchanger 50 that is disposed in a substantially V-shape in the right side longitudinal section.

[0039] Since the indoor unit 100 includes plural fans 20, the weight tends to become heavy. When the indoor unit 100 becomes heavy, the wall for installing the indoor unit 100 needs to be stronger, causing to restrict the installation. Therefore, it is preferable that the weight of the heat exchanger 50 is reduced. Further, in the indoor unit 100, since the fans 20 are disposed on the upstream side of the heat exchanger 50, the height of the indoor unit 100 becomes large which tends to become a restriction for the installation. Therefore, it is preferable that the heat exchanger 50 is reduced in weight. Further, it is preferable that the heat exchanger 50 is reduced in size.

[0040] Accordingly, in Embodiment 1, the heat exchanger 50 is devised so as to reduce its size by using a fin-and-tube heat exchanger as the heat exchanger 50 (the front side heat exchanger 51 and the rear side heat exchanger 55). More specifically, the heat exchanger 50 according to Embodiment 1 includes a plurality of fins 56 arranged with a predetermined gap therebetween and a plurality of heat transfer pipes 57 that penetrate through the fins 56. In Embodiment 1, the fins 56 are arranged in the left-right direction of the casing 1 (the direction perpendicular to the sheet of Fig. 1). That is, the heat transfer pipes 57 penetrate through the fins 56 along the left-right direction of the casing 1 (the direction perpendicular to the sheet of Fig. 1). Further, in Embodiment 1, two rows of heat transfer pipes 57 are disposed in the air flowing direction of the heat exchanger 50 (the width direction of the fins 56) in order to improve the heat transfer efficiency of the heat exchanger 50. The heat transfer pipes 57 are disposed in a substantially staggered manner in the right side longitudinal section.

[0041] Further, the heat exchanger 50 is devised so as to reduce its size by configuring the heat transfer pipes 57 with circular pipes with a small diameter (diameter of substantially 3 mm to substantially 7 mm) and by employing R32 as the refrigerant flowing in the heat transfer pipes 57 (the refrigerant used in the air-conditioning apparatus provided with the indoor unit 100 and in this indoor unit 100). That is, the heat exchanger 50 exchanges heat between the refrigerant flowing inside the heat transfer pipes 57 and indoor air via the fins 56. Accordingly, when the heat transfer pipes 57 are made small, compared to heat exchangers with heat transfer pipes with a large diameter, pressure loss of the refrigerant becomes large with the same circulating amount of refrigerant. However, compared to R410A, R32 has larger latent heat of vaporization under the same temperature and thus can exert the same capacity with less circulating amount of refrigerant. Accordingly, by using R32, it is possible to reduce the amount of refrigerant used and to reduce pressure loss in the heat exchanger 50. Therefore, the size of the heat exchanger 50 can be reduced by configuring the heat transfer pipes 57 with small circular pipes and by using R32 as the refrigerant.

[0042] Further, in the heat exchanger 50 according to Embodiment 1, the heat exchanger 50 is devised so as to reduce its weight by forming the fins 56 and the heat transfer pipes 57 with aluminum or aluminum alloy. Note that if the weight of the heat exchanger 50 is not an installation restriction, the heat transfer pipes 57 may, naturally, be constituted by copper.

(Finger Guard and Filter)

[0043] Further, the indoor unit 100 according to Embodiment 1 is provided with a finger guard 15 and a filter 10 at the inlet ports 2. The finger guard 15 is disposed with an object to disable a hand to be in contact with the rotating fan 20. Accordingly, the shape of the finger guard 15 may be any that can avoid a hand from being in contact with the fan 20. For example, the finger guard 15 may be latticed-shaped or may be round-shaped including plural large- and small-sized rings. Further, the finger guard 15 may be constituted by materials such as resin or may be constituted by a metal material; however, if strength is required, it is desirable that the guard is constituted by metal. Furthermore, the finger guard 15 is preferably thin, and of a strong material and shape from the viewpoint of reduction of air flow resistance and maintenance of strength. The filter 10 is provided to prevent dust from flowing into the indoor unit 100. The filter 10 is detachably provided to the casing 1. Further, although not shown, the indoor unit 100 according to Embodiment 1 may include an automatic cleaning mechanism that cleans the filter 10 automatically.

(Wind Direction Control Vane)

[0044] Further, in the indoor unit 100 according to Embodiment 1, the outlet port 3 is provided with a horizontal vane 70 and vertical vanes (not shown) that control the direction to blow out the airflow.

(Drain Pan)

[0045] Fig.3 is a perspective view of the indoor unit according to Embodiment 1 of the invention viewed from the right front side. Fig. 4 is a perspective view of the indoor unit viewed from the right rear side. Fig. 5 is a perspective view of the indoor unit viewed from the left front side. Further, Fig. 6 is a perspective view of a drain pan according to Embodiment 1 of the invention. Note that in order to facilitate understanding of the shape of the drain pan, Figs. 3 and 4 each illustrate a section of the right side of the indoor unit 100 and Fig. 5 illustrates a section of the left side of the indoor unit 100.

[0046] A front side drain pan 110 is provided under the lower end portion of the front side heat exchanger 51 (the end portion on the front side of the front side heat exchanger 51). A rear side drain pan 115 is provided under the lower end portion of the rear side heat exchanger 55 (the end portion on the rear side of the rear side heat exchanger 55). Note that, in Embodiment 1, the rear side drain pan 115 and the rear side portion 1b of the casing 1 is integrally formed. A connecting port 116, to which a drain hose 117 is connected, is provided at each of the left end and the right end of the rear side drain pan 115. Note that the drain hose 117 does not need to be connected to both of the connecting ports 116, and it is only sufficient to connect the drain hose 117 to either one of the connecting ports 116. For example, when the drain hose 117 needs to be taken out from the right side of the indoor unit 100 during installation work of the indoor unit 100, the drain hose 117 may be connected to the connecting port 116 provided on the right end of the rear side drain pan 115 and the connecting port 116 provided on the left end of the rear side drain pan 115 may be covered with a rubber cap or the like.

[0047] The front side drain pan 110 is disposed at a higher position than that of the rear side drain pan 115. Further, a drainage channel 111 , which is a channel where drain moves therethrough, is provided between the front side drain pan 110 and the rear side drain pan 115 at each of the left ends and the right ends of the drain pans. The end of each drainage channel 111 on the front side is connected to the front side drain pan 110. The drainage channel 111 is provided so as to incline downwards from the front side drain pan 110 to the rear side drain pan 115. Further, the end of each drainage channel 111 on the rear side is formed with a tongue portion 111 a. The end of each drainage channel 111 on the rear side is disposed so as to cover the upper side of the rear side drain pan 115.

[0048] Dew condensation occurs on the heat exchanger 50 when the indoor air is cooled by the heat exchanger 50 during a cooling operation. Then, dew attached to the front side heat exchanger 51 drips from the lower end of the front side heat exchanger 51 and is collected in the front side drain pan 110. Dew attached to the rear side heat exchanger 55 drips from the lower end of the rear side heat exchanger 55 and is collected in the rear side drain pan 115.
Further, in Embodiment 1, since the front side drain pan 110 is provided at a higher position than that of the rear side drain pan 115, dew collected in the front side drain pan 110 flows through the drainage channels 111 towards the rear side drain pan 115. Then this drain drips from the tongue portion 111a of each drainage channel 111 to the rear side drain pan 115 and is collected in the rear side drain pan 115. The drain that has been collected in the rear side drain pan 115 passes through the drain hose 117 and is discharged outside the casing 1 (indoor unit 100).

[0049] By providing the front side drain pan 110 at a higher position than that of the rear side drain pan 115 as in Embodiment 1, drain collected in each drain pan can be gathered in the rear side drain pan 115 (the drain pan that is disposed on the most rear side of the casing 1). Thus, by providing a connecting port 116 of the drain hose 117 to the rear side drain pan 115, it will be possible to discharge drain that has been collected in the front side drain pan 110 and the rear side drain pan 115 outside the casing 1. Accordingly, there is no need to detach the drain pan connected with the drain hose 117 when opening the front side and the like of the casing 1 and performing maintenance (cleaning and the like of the heat exchanger 50); hence, workability of maintenance and the like is improved.

[0050] Further, since the drainage channel 111 is provided to both the left end and the right end, even if the indoor unit 100 is installed in an inclined state, drain collected in the front side drain pan 110 can be reliably guided to the rear side drain pan 115. Additionally, since the connecting port for connecting the drain hose 117 is provided to both the left end and the right end, it is possible to select the direction to which the hose is pulled out in accordance with the installation condition of the indoor unit 100; hence, workability when installing the indoor unit 100 is improved. Furthermore, since the drainage channel 111 is disposed so as to cover the upper region of the rear side drain pan 115 (that is, there is no need for a connecting mechanism between the drainage channel 111 and the rear side drain pan 115), detachment of the front side drain pan 110 is facilitated; hence, ease of maintenance is increased.

[0051] Note that the drainage channel 111 may be disposed such that the end of the drainage channel 111 on the rear side is connected to the rear side drain pan 115 so that the front side drain pan 110 covers the upper region of the drainage channel 111. Even with such a configuration, it will be possible to obtain the same advantageous effect to the configuration in which the drainage channel 111 is disposed so as to cover the upper region of the rear side drain pan 115. Further, the front side drain pan 110 does not necessarily have to be disposed at a higher position than that of the rear side drain pan 115. It is possible to discharge drain that has been collected by the front side drain pan 110 and the rear side drain pan 115 from the drain hose connected to the rear side drain pan 115 even if the front side drain pan 110 and the rear side drain pan 115 are disposed at the same height.

(Nozzle)

[0052] Further, in the indoor unit 100 according to Embodiment 1, in the right side longitudinal section, a length d1 of an opening of a nozzle 6 on an inlet side (a narrowed length d1 between the drain pans defined by the front side drain pan 110 and the rear side drain pan 115) is configured to be larger than a length d2 of an opening of the nozzle 6 on an outlet side (the length of the outlet port 3). That is, the nozzle 6 of the indoor unit 100 is d1 > d2 (see Fig. 1).

[0053] The reason for the nozzle 6 being d1 > d2 is as follows. Note that since d2 has influence on the reachability of the airflow that is one of the basic functions of the indoor unit, hereinafter, description is given of a case in which d2 of the indoor unit 100 according to Embodiment 1 is a length that is similar to the length of an outlet port of a conventional indoor unit.

[0054] By shaping the nozzle 6 to be d1 > d2 in a longitudinal section, the air passage of the air becomes larger and it will be possible to increase an angle A of the heat exchanger 50 that is disposed on its upstream side (the angle between the front side heat exchanger 51 and the rear side heat exchanger 55 on the downstream side of the heat exchanger 50). Accordingly, since the wind speed distribution occurring in the heat exchanger 50 is alleviated and the air passage of the air downstream of the heat exchanger 50 can be made large, it is possible to reduce pressure loss in the entire indoor unit 100. Further, the flow can be guided to the outlet port 3 after the unevenness of the wind speed distribution that has been occurring near the inlet of the nozzle 6 is uniformized with the flow contraction effect.

[0055] For example, if d1 = d2, the unevenness of the wind speed distribution that has occurred near the inlet of the nozzle 6 (biased flow to the rear side, for example) directly becomes the unevenness of the wind speed distribution at the outlet port 3. That is, if d1 = d2, air is blown out from the outlet port 3 in a state with uneven wind speed distribution. Further, for example, if d1 < d2, flow contraction loss becomes large when air that has passed through the front side heat exchanger 51 and the rear side heat exchanger 55 merge near the inlet of the nozzle 6. Therefore, if d1 < d2, loss amounting to the flow contraction loss occurs when no diffuse effect can be obtained in the outlet port 3.

(ANC)

[0056] Further, the indoor unit 100 according to Embodiment 1 is disposed with an active noise cancellation mechanism as illustrated in Fig. 1.

[0057] More specifically, the noise cancellation mechanism of the indoor unit 100 according to Embodiment 1 includes a noise detection microphone 161, a control speaker 181, a noise cancellation effect detection microphone 191, and a signal processing device 201. The noise detection microphone 161 is a noise detection device that detects the operation sound (noise) of the indoor unit 100 including the blast noise of the fan 20. This noise detection microphone 161 is disposed between a fan 20 and the heat exchanger 50. In Embodiment 1, the noise detection microphone 161 is provided in the casing 1 on the front side. The control speaker 181 is a control sound output device that outputs a control sound corresponding to the noise. This control speaker 181 is disposed below the noise detection microphone 161 and is disposed above the heat exchanger 50. In Embodiment 1, the control speaker 181 is provided in the casing 1 on the front side so as to face the middle of the air passage. The noise cancellation effect detection microphone 191 is a noise cancellation effect detection device that detects the noise cancellation effect of the control sound. Since this noise cancellation effect detection microphone 191 detects the noise coming out from the outlet port 3, it is provided near the outlet port 3. Further, the noise cancellation effect detection microphone 191 is mounted so as not to be hit by the discharged air from the outlet port 3 to a position avoiding the wind flow. The signal processing device 201 is a control sound generation device that makes the control speaker 181 output a control sound on the basis of the detection result of the noise detection microphone 161 and the noise cancellation effect detection microphone 191. The signal processing device 201 is accommodated in the controller 281, for example.

[0058] Fig. 8 is a block diagram of the signal processing device according to Embodiment 1. An electric signal that has been input from each of the noise detection microphone 161 and the noise cancellation effect detection microphone 191 is amplified by a microphone amplifier 151, and is converted from an analog signal into a digital signal by an A/D converter 152. The converted digital signals are input to an FIR filter 158 and an LMS algorithm 159. The FIR filter 158 generates a control signal that is corrected so as to have the same amplitude as and a phase opposite to a noise that has reached a position where the noise cancellation effect detection microphone 191 is disposed after being detected by the noise detection microphone 161. This control signal is converted from a digital signal to an analog signal by a D/A converter 154, is amplified by an amplifier 155, and is emitted as a control sound from the control speaker 181.

[0059] When an air-conditioning apparatus performs a cooling operation and the like, as shown in Fig. 7, the temperature of region B between the heat exchanger 50 and the outlet port 3 is decreased by the cold air, resulting in occurrence of dew condensation that is water droplets of water vapor in the air. Accordingly, in the indoor unit 100, a water receiver or the like (not shown) is mounted so as to prevent water droplets from coming out from the outlet port 3 to the vicinity of the outlet port 3. Note that since the region that is upstream of the heat exchanger 50, in which the noise detection microphone 161 and the control speaker 181 is disposed, is positioned upstream of the region that is cooled by the cold air, no dew condensation occurs.

[0060] Next, a description will be given on a method of suppressing the operation sound of the indoor unit 100. The operation sound (noise) of the indoor unit 100 including the blast noise of the fan 20 is detected by the noise detection microphone 161 that is mounted between the fan 20 and the heat exchanger 50, is turned into a digital signal through the microphone amplifier 151 and the A/D converter 152, and is input to the FIR filter 158 and the LMS algorithm 159.

[0061] A tap coefficient of the FIR filter 158 is successively updated by the LMS algorithm 159. In the LMS algorithm 159, the tap coefficient is updated in accordance with Equation 1 ($h(n+1) = h(n) + 2 \bullet \mu \bullet e(n) \bullet x(n)$). The optimum tap coefficient is updated such that an error signal "e" approaches zero.

Note that "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 controls a filter coefficient update amount for each sampling event.

[0062] In this way, the digital signal that has passed through the FIR filter 158, the tap coefficient of which has been updated by the LMS algorithm 159, is converted into an analog signal by the D/A converter 154, is amplified by the amplifier 155, and is emitted as a control sound from the control speaker 181, which is mounted between the fan 20 and the heat exchanger 50, into the air passage inside the indoor unit 100.

[0063] On the other hand, in the lower end of the indoor unit 100, the noise cancellation effect detection microphone 191 that has been mounted to the outside wall direction of the outlet port 3 so as not to be hit by the wind discharged from the outlet port 3 detects the resultant sound after the noise, which has propagated through the air passage from the fan 20 and which has come out from the outlet port 3, has been interfered with the sound emitted from the control speaker 181. Since the sound detected by the noise cancellation effect detection microphone 191 has been input to the error signal of the above-described LMS algorithm 159, the tap coefficient of the FIR filter 158 is updated such that this sound after interference approaches zero. As a result, the noise in the vicinity of the outlet port 3 can be suppressed by the control sound that has passed through the FIR filter 158.

[0064] As above, in the indoor unit 100 applied with the active noise reduction method, the noise detection microphone 161 and the control speaker 181 is disposed between the fan 20 and the heat exchanger 50, and the noise cancellation effect detection microphone 191 is mounted to a position where the microphone is not hit by the wind flow from the outlet port 3. Accordingly, since there is no need to mount components required for the active noise reduction in region B where dew condensation occurs, attachment of water droplets to the control speaker 181, the noise detection microphone 161, and the noise cancellation effect detection microphone 191 can be prevented and deterioration of noise cancellation performance and malfunction of the speakers and microphones can be prevented.

[0065] Note that the mounting positions of the noise detection microphone 161, the control speaker 181, and the noise cancellation effect detection microphone 191 illustrated in Embodiment 1 are exemplary and explanatory only. For example, as shown in Fig. 9, the noise cancellation effect detection microphone 191 may be disposed between the fan 20 and the heat exchanger 50 along with the noise detection microphone 161 and the control speaker 181. Further, a microphone has been cited as exemplary means for detecting noise and the noise cancellation effect after the noise has been canceled out with the control sound; however, it may be configured with an acceleration sensor or the like that detects vibration of the casing. Further, by perceiving sound as a disturbance in air flow, noise and the noise cancellation effect after the noise has been canceled out with the control sound may be detected as a disturbance in air flow. That is, a flow rate sensor that detects the flow of air, a hot-wire probe, and the like may be used as means for detecting noise and the noise cancellation effect after the noise has been canceled out with the control sound. It is possible to increase the gain of the microphone to detect the flow of air.

[0066] Further, in Embodiment 1, the FIR filter 158 and the LMS algorithm 159 are used in the signal processing device 201. However, any adaptive signal processing circuit that makes the sound detected by the noise cancellation effect detection microphone 191 approach zero may be used, and may be one using a filtered-X algorithm that is commonly employed by active noise reduction methods. Further, the signal processing device 201 does not need to employ adaptive signal processing, and may be configured to generate a control sound using a fixed tap coefficient. Furthermore, the signal processing device 201 does not need to employ digital signal processing, and may be an analog signal processing circuit.

[0067] Furthermore, although the description is given in Embodiment 1 of a case in which the heat exchanger 50 that cools the air to the extent of causing dew condensation is disposed, the invention can also be applied to a case in which a heat exchanger causing no dew condensation to occur is used. Thus, performance degradation of the noise detection microphone 161, the control speaker 181, and noise cancellation effect detection microphone 191 can be advantageously prevented without the need to consider whether the heat exchanger 50 will cause dew condensation.

Embodiment 2

[0068] Other embodiments of the active noise reduction method will be described below. Note that, in Embodiment 2, like functions and configurations to Embodiment 1 are denoted by like reference signs.

[0069] Fig. 15 is a longitudinal sectional view of the indoor unit according to Embodiment 2 of the invention. Note that, in Fig. 10, the right side of the drawing is the front side of the indoor unit 100.

Point that differ between the indoor unit 100 according to Embodiment 1 and the indoor unit 100 described in Embodiment 2 is that while in Embodiment 1, generation of the control sound is performed in the signal processing device 201 using two microphones, that is, the noise detection microphone 161 and the noise cancellation effect detection microphone 191, for performing active noise reduction, in the indoor unit 100 of Embodiment 2, these microphones are replaced with one microphone, that is, a noise/noise cancellation effect detection microphone 211. Further, due to this, the signal processing method differs from that of Embodiment 1, and therefore the content of a signal processing device 204 differ from that of the signal processing device 201.

[0070] On the wall below the fan 20, the control speaker 181 outputting a control sound corresponding to the noise is arranged to face the middle of the air passage from the wall, and further below, a noise/noise cancellation effect detection microphone 211 that detects the resultant sound after the noise, which has propagated through the air passage from the fan 20 and which has come out from the outlet port 3, has been interfered with the sound emitted from the control speaker 181. The control speaker 181 and the noise/noise cancellation effect detection microphone 211 are disposed between the fan 20 and the heat exchanger 50.

[0071] An output signal of the noise/noise cancellation effect detection microphone 211 is input to the signal processing device 204 serving as control sound generation means that generates a signal (control sound) which controls the control speaker 181.

[0072] Fig. 11 is a block diagram of the signal processing device according to Embodiment 2. Fig. 11 is a block diagram of the signal processing device 204. An electric signal that has been converted from a sound signal by the noise/noise cancellation effect detection microphone 211 is amplified by the microphone amplifier 151, and is converted from an analog signal into a digital signal by the A/D converter 152. The converted signal is input to the LMS algorithm 159, and further, a differential signal between the converted signal and a signal obtained by convolving the output signal of the FIR filter 158 with a FIR filter 160 is input to the FIR filter 158 and the LMS algorithm 159. Next, a convolution operation is performed on the differential signal by the FIR filter 158 using the tap coefficient calculated by the LMS algorithm 159. After that, the differential signal is converted from a digital signal into an analog signal by the D/A converter 154, is amplified by the amplifier 155, and is output as a control sound from the control speaker 181.

[0073] Next, a description will be given on a method of suppressing the operation sound of the indoor unit 100. The sound after the operation sound (noise) including the blast noise of the fan 20 of the indoor unit 100 is interfered with the control sound output from the control speaker 181 is detected by the noise/noise cancellation effect detection microphone 211 that has been mounted between the fan 20 and the heat exchanger 50, is turned into a digital signal through the microphone amplifier 151 and the A/D converter 152.

[0074] In order to perform the same method of suppressing the operation sound described in Embodiment 1, the noise to be canceled needs to be input to the FRI filter 158 and, as illustrated in Equation 1, sound after interference of the noise to be canceled that is to be the input signal and the control sound that is to be the error signal needs to be input to the LMS algorithm 159. However, since the noise/noise cancellation effect detection microphone 211 can only detect the resultant sound after interference of the control sound, it is necessary to create the noise to be canceled from the sound detected by the noise/noise cancellation effect detection microphone 211.

[0075] Fig. 12 shows a waveform of the resultant sound after interference of the noise and the control sound ("a" in Fig. 12), a waveform of the control sound ("b" in Fig. 12), and a waveform of the noise ("c" in Fig. 12). According to the superposition principle of sound, since b+c=a, in order to obtain "c" from "a", the difference between "a" and "b" is used; thus "c" can be obtained. That is, the noise to be reduced can be created from the difference between the sound after interference detected by the noise/noise cancellation effect detection microphone 211 and the control sound.

[0076] Fig. 13 is a diagram showing a route in which the output control signal from the FIR filter 158, after being output from the control speaker 181 as the control sound, is detected by the noise/noise cancellation effect detection microphone 211, and is input to the signal processing device 204. This route passes through the D/A converter 154, the amplifier 155, a route from the control speaker 181 to the noise/noise cancellation effect detection microphone 211, the noise/noise cancellation effect detection microphone 211, the microphone amplifier 151, and the A/D converter 152.

[0077] Supposing that this route has a transmission characteristic H, the FIR filter 160 shown in Fig. 11 is one in which this transmission characteristic H is estimated. By convolving the output signal of the FIR filter 158 with the FIR filter 160, the control sound can be estimated as a signal "b" detected by the noise/noise cancellation effect detection microphone 211. Then, by using the difference with the sound "a" after interference detected by the noise/noise cancellation effect detection microphone 211, the noise "c" to be reduced is generated.

[0078] The noise "c" to be reduced, which is generated as described above, is supplied as an input signal to the LMS algorithm 159 and the FIR filter 158. The digital signal that has passed through the FIR filter 158, the tap coefficient of which has been updated by the LMS algorithm 159, is converted into an analog signal by the D/A converter 154, is amplified by the amplifier 155, and is emitted as the control sound from the control speaker 181, which is mounted between the fan 20 and the heat exchanger 50, into the air passage inside the indoor unit 100.

[0079] On the other hand, the noise/noise cancellation effect detection microphone 211 which is mounted below the control speaker 181 detects a resultant sound after interference of the noise, which has propagated through the air passage from the fan 20 and which has been emitted from the outlet port 3 into the room, and the control sound emitted from the control speaker 181. Since the sound detected by the noise/noise cancellation effect detection microphone 211 has been input to the error signal of the above-described LMS algorithm 159, the tap coefficient of the FIR filter 158 is updated such that this sound after interference approaches zero. As a result, the noise in the vicinity of the outlet port 3 can be suppressed by the control sound that has passed through the FIR filter 158.

[0080] As above, in the indoor unit 100 applied with the active noise reduction method, by disposing the noise/noise cancellation effect detection microphone 211 and the control speaker 181 between the fan 20 and the heat exchanger 50, there will be no need to mount the components required for the active noise reduction in region B where dew condensation occurs; hence, attachment of water droplets to the control speaker 181 and the noise/noise cancellation effect detection microphone 211 can be prevented and deterioration of noise cancellation performance and malfunction of the speakers and microphones can be prevented.

[0081] Note that although in Embodiment 2, the noise/noise cancellation effect detection microphone 211 is disposed on the upstream side of the heat exchanger 50, the microphone may be disposed at the lower end of the indoor unit 100, as in Fig. 14, where the wind discharged from the outlet port 3 does not hit the microphone (a position avoiding the wind flow). Further, a microphone has been cited as exemplary means for detecting noise and the noise cancellation effect after the noise is canceled out with the control sound; however, it may be configured with an acceleration sensor or the like that detects vibration of the casing. Furthermore, by perceiving sound as a disturbance in air flow, noise and the noise cancellation effect after the noise has been canceled out with the control sound may be detected as a disturbance in air flow. That is, a flow rate sensor that detects the flow of air, a hot-wire probe, and the like may be used as means for detecting noise and the noise cancellation effect after the noise has been canceled out with the control sound. It is possible to increase the gain of the microphone to detect the flow of air.

[0082] Further, in Embodiment 2, the FIR filter 158 and the LMS algorithm 159 are used as an adaptive signal processing circuit of the signal processing device 204. However, any adaptive signal processing circuit that makes the sound detected by the noise/noise cancellation effect detection microphone 211 approach zero may be used, and may be one using a filtered-X algorithm that is commonly employed by active noise reduction methods. Further, the signal processing device 204 does not need to employ adaptive signal processing, and may be configured to generate a control sound using a fixed tap coefficient. Furthermore, the signal processing device 204 does not need to employ digital signal processing, and may be an analog signal processing circuit.

[0083] Furthermore, although the description is given in Embodiment 2 of a case in which the heat exchanger 50 that cools the air to the extent of causing dew condensation is disposed, the invention can also be applied to a case in which a heat exchanger causing no dew condensation to occur is used. Thus, performance degradation of the noise/noise cancellation effect detection microphone 211, the control speaker 181, and the like can be advantageously prevented without the need to consider whether the heat exchanger 50 will cause dew condensation.

Embodiment 3

[0084] A noise cancellation mechanism can be disposed at a position described below, for example. Note that, in Embodiment 3, like functions and configurations to Embodiments 1 and 2 are denoted by like reference signs.

[0085] In Embodiment 3, among the noise cancellation mechanism, the noise detection microphone 161 (corresponding to a "noise detection device"), the control speaker 181 (corresponding to a "control sound output device"), and the noise cancellation effect detection microphone 191 (corresponding to a "noise cancellation effect detection device") are provided on the downstream side of the heat exchanger 50. Accordingly, influence of the turbulent airflow generated by the fan 20 exerted to the noise cancellation effect detection microphone 191 can be reduced, and the route of the control sound generated from the control speaker 181 reaching the control point can be shortened. As such, the indoor unit 100 according to Embodiment 3 can perform high-precision noise control with the noise cancellation mechanism. Further, the indoor unit according to Embodiment 3 is capable of reducing cost of the signal processing device.

[0086] Further details will be described below.

Fig. 15 is a longitudinal sectional view of the indoor unit according to Embodiment 3 of the invention. Same as Fig. 1, the left side of the drawing is the front side of the indoor unit 100 in Fig. 15. The configuration of the indoor unit 100 will be described with reference to Fig. 15.

In the configuration of the indoor unit 100, the disposed position of the noise detection microphone 161 and the control speaker 181, which are noise cancellation mechanisms, are different from that of Fig. 1. Other configurations are the same as that of the indoor unit 100 according to Embodiment 1.

[0087] The noise cancellation mechanism of the indoor unit 100 includes the noise detection microphone 161, the control speaker 181, the noise cancellation effect detection microphone 191, and the signal processing device 201. The noise detection microphone 161 is mounted on the downstream side of the heat exchanger 50. The noise cancellation effect detection microphone 191 is mounted in the vicinity of the outlet port 3 (for example, the portion of the nozzle 6 forming the outlet port 3) that is on the downstream side of the heat exchanger 50. Further, the control speaker 181 is provided on the side of the casing 1 (more specifically, below the heat exchanger 50 and near the noise cancellation effect detection microphone 191). Furthermore, the control speaker 181 and the noise cancellation effect detection microphone 191 are disposed to face the middle of the air passage from the wall of the casing 1.

[0088] Note that the installation position of the noise cancellation effect detection microphone 191 is not limited to the nozzle 6 of the outlet port 3, and may be anywhere in the opening portion of the outlet port 3. For example, the noise cancellation effect detection microphone 191 may be mounted to a lower portion or to the side of the outlet port 3. Further, although in Embodiment 3, the control speaker 181 is mounted to the side of the casing 1, the control speaker 181 may be mounted to the front side or the rear side of the casing 1. Furthermore, the noise detection microphone 161 does not necessarily have to be provided on the downstream side of the heat exchanger 50 as long as the control speaker 181 and the noise cancellation effect detection microphone 191 are provided on the downstream side of the heat exchanger 50.

[0089] Further, output signals of the noise detection microphone 161 and the noise cancellation effect detection microphone 191 are input to a signal processing device 201 that generates a signal (control sound) which controls the control speaker 181. The configuration of the signal processing device 201 is exactly the same as that of the indoor unit 100 according to Embodiment 1.

[0090] Now, in order for the noise cancellation mechanism according to Embodiment 3 to obtain a high noise cancellation effect, coherence between the sound detected by the noise detection microphone 161 and the sound detected by the noise cancellation effect detection microphone 191 needs to be high. However, if the noise detection microphone 161 and the noise cancellation effect detection microphone 191 are disposed in the region where there is turbulent airflow due to the rotation of an impeller 25 of the fan 20 (for example, in the indoor unit 100, the air passage between the fan 20 and the heat exchanger 50), pressure fluctuation components generated by the turbulent airflow that are different from the original noise components are detected and coherence between the two microphones is reduced.

[0091] Accordingly, in the indoor unit 100 according to Embodiment 3, the noise detection microphone 161 and the noise cancellation effect detection microphone 191 are disposed on the downstream side of the heat exchanger 50. Since a fan 20 is disposed on the upstream side of the heat exchanger 50 in the indoor unit 100, it is possible to dispose the heat exchanger 50 between the noise detection microphone 161 and the noise cancellation effect detection microphone 191, and the fan 20. When the noise detection microphone 161 and the noise cancellation effect detection microphone 191 are disposed as above, since the turbulent airflow generated in the fan 20 is suppressed by passing through the fins 56 of the heat exchanger 50, influence exerted to the noise detection microphone 161 and the noise cancellation effect detection microphone 191 by the turbulent airflow can be reduced. Accordingly, coherence between the noise detection microphone 161 and the noise cancellation effect detection microphone 191 is increased, and, thus, a high noise cancellation effect is obtained.

[0092] Fig. 16 is a characteristic diagram illustrating the coherence property between the noise detection microphone and the noise cancellation effect detection microphone in accordance to the disposed positions of the two microphones. Now, Fig. 16(a) is a characteristic diagram illustrating the coherence property between the noise detection microphone 161 and the noise cancellation effect detection microphone 191 when the two microphones are provided on the upstream side of the heat exchanger (more specifically, between the fan 20 and the heat exchanger 50). Further, Fig. 16(b) is a characteristic diagram illustrating the coherence property between the noise detection microphone 161 and the noise cancellation effect detection microphone 191 when the two microphones are provided on the downstream side of the heat exchanger. When comparing between Fig. 16(a) and Fig. 16(b), it can be understood that in the indoor unit 100 that has a fan 20 on the upstream side of the heat exchanger 50, coherence between the two microphones increases by providing the noise detection microphone 161 and the noise cancellation effect detection microphone 191 on the downstream side of the heat exchanger 50.

[0093] Further, the noise cancellation effect is also influenced by the distance from the installation position of the control speaker 181 to the installation position (control point) of the noise cancellation effect detection microphone 191. That is, the noise cancellation effect is also influenced by the length of the propagation path of the control sound that has been emitted from the control speaker 181 reaching the control point (the installation position of the noise cancellation effect detection microphone 191). More specifically, the amplitude characteristics and the phase characteristics of the control sound that has been emitted from the control speaker 181 changes in the propagation path before reaching the control point (the installation position of the noise cancellation effect detection microphone 191). If the amplitude characteristics and the phase characteristics are changed in the propagation path turning the control sound into one without the same amplitude as and a phase opposite to the noise, the noise cancellation effect is reduced.

[0094] In order to suppress such reduction in the noise cancellation effect caused by the propagation path, a common filtered-X algorithm resolves the above described problem by acquiring the propagation path of the control sound in advance and applying a correction in the course of generating the control sound. However, when the propagation path becomes long, the number of filter taps becomes large resulting in increase in arithmetic processing. Further, in a case of change in the sound velocity due to change in air temperature and the like, if the propagation path is long, the error between the acquired propagation path and the actual propagation path becomes large, and the noise cancellation effect is reduced.

[0095] Accordingly, in order to suppress reduction in the noise cancellation effect caused by the propagation path, it is preferable to dispose the control speaker 181 and the noise cancellation effect detection microphone 191 close to each other. By disposing the control speaker 181 and the noise cancellation effect detection microphone 191 as such, it will be possible to shorten the propagation distance of the control sound, and, thus, it will be possible to keep the change in the amplitude characteristics and the phase characteristics to be small. That is, by disposing the control speaker 181 and the noise cancellation effect detection microphone 191 close to each other, it will be possible to superpose sound with high precision; hence, a high noise cancellation effect is obtained. Accordingly, in the indoor unit 100 according to Embodiment 3, the control speaker 181 is provided on the downstream side of the heat exchanger 50 that is the installation position of the noise cancellation effect detection microphone 191. As such, the propagation path of the control sound that has been emitted from the control speaker 181 reaching the control point (the installation position of the noise cancellation effect detection microphone 191) can be shortened; hence, a high noise cancellation effect is obtained.

[0096] Further, since the indoor unit 100 allows the fan 20 to be disposed on the upstream side of the heat exchanger 50, it will be possible to dispose the fan 20, which becomes a noise source, to the upper portion in the casing 1. Accordingly, it will be possible to make the propagation path, to where the noise from the fan 20 is emitted from the outlet port 3, long. As such, by disposing the control speaker 181 on the downstream side of the heat exchanger 50, the distance between the noise detection microphone 161 and the control speaker 181 can be made long. That is, the computing time to generate the control sound corresponding to the sound detected with the noise detection microphone 161 can be longer; hence, there will be no need to make the computing speed high. Accordingly, since the indoor unit 100 according to Embodiment 1 can reduce the specification of each of the A/D converter 152 and the digital signal processor that performs signal processing, cost can be reduced.

[0097] Note that in a case in which the noise detection microphone 161, the control speaker 181, and the noise cancellation effect detection microphone 191 are provided on the downstream side of the heat exchanger 50, there is a possibility of occurrence of dew condensation due to being directly in contact with the cold air; hence, ones applied with waterproofing may be used.

[0098] As above, in the indoor unit 100 according to Embodiment 3, among the components of the noise cancellation mechanism, at least the control speaker 181 and the noise cancellation effect detection microphone 191 are provided on the downstream side of the heat exchanger 50. Accordingly, in the indoor unit 100, influence of the turbulent airflow generated by the fan 20 exerted to the noise cancellation effect detection microphone 191 can be reduced, and the route of the control sound generated from the control speaker 181 reaching the control point (the installation position of the noise cancellation effect detection microphone 191) can be shortened. As such, the indoor unit 100 can perform high-precision noise control with the noise cancellation mechanism.

[0099] Further, in the indoor unit 100 according to Embodiment 3, the noise detection microphone 161 is also disposed on the downstream side of the heat exchanger 50. Accordingly, influence of the turbulent airflow generated by the fan 20 exerted to the noise detection microphone 161 and the noise cancellation effect detection microphone 191 can be reduced, and coherence between the two microphones is increased; hence, a high noise cancellation effect can be obtained.

[0100] Further, in the indoor unit 100 according to Embodiment 3, the fan 20 can be provided on the upstream side of the heat exchanger 50 and to the upper portion in the casing 1. Accordingly, the length of the propagation path of the noise from the fan 20 can be made long, and the distance between the noise detection microphone 161 and the control speaker 181 can be made long. As such, there will be no need to make the speed of the arithmetic processing high and cost of the indoor unit 100 can be reduced.

Embodiment 4

[0101] The same noise cancellation effect as that of Embodiment 3 can be obtained by using a noise cancellation mechanism described below. Note that, in Embodiment 4, like reference numerals refer to like functions and configurations in Embodiment 1 to Embodiment 3 unless otherwise indicated.

[0102] Fig. 17 is a longitudinal sectional view of the indoor unit according to Embodiment 4 of the invention. The difference between the indoor unit 100 according to Embodiment 4 and the indoor unit 100 according to Embodiment 3 is the microphone used in the active noise reduction. More specifically, the indoor unit 100 according to Embodiment 3 uses two microphones (the noise detection microphone 161 and the noise cancellation effect detection microphone 191) and generates the control sound in the signal processing device 201. On the other hand, the indoor unit 100 according to Embodiment 4, the noise detection microphone 161 and the noise cancellation effect detection microphone 191 are replaced with one microphone, that is, the noise/noise cancellation effect detection microphone 211. Further, the signal processing methods are different since the microphones used for the dynamic noise reduction are different; hence, the indoor unit 100 of Embodiment 4 uses a signal processing device 204 that is different from the signal processing device 201 of the indoor unit 100 according to Embodiment 3.

[0103] That is, the noise cancellation mechanism of the indoor unit 100 according to Embodiment 4 includes the control speaker 181, the noise/noise cancellation effect detection microphone 211, and the signal processing device 204.

[0104] More specifically, the noise/noise cancellation effect detection microphone 211 is mounted in the vicinity of the outlet port 3 (for example, the portion of the nozzle 6 forming the outlet port 3) that is downstream of the heat exchanger 50. This noise/noise cancellation effect detection microphone 211 detects a resultant sound after interference of the operation sound (noise) of the indoor unit 100 including the blast noise of the fan 20 to the control sound that has been emitted from the control speaker 181. Further, the control speaker 181, which outputs the control sound corresponding to the noise, is provided on the side of the casing 1 (more specifically, below the heat exchanger 50 and near the noise/noise cancellation effect detection microphone 211). Furthermore, the control speaker 181 and the noise/noise cancellation effect detection microphone 211 are disposed below the heat exchanger 50 to face the middle of the air passage from the wall of the casing 1.

[0105] Furthermore, the installation position of the noise/noise cancellation effect detection microphone 211 is not limited to the upper portion of the outlet port 3, and may be anywhere in the opening portion of the outlet port 3. For example, the noise/noise cancellation effect detection microphone 211 may be mounted to a lower portion or to the side of the outlet port 3. Further, although in Embodiment 4, the control speaker 181 is mounted to the side of the casing 1, the control speaker 181 may be mounted to the front side or the rear side of the casing 1.

[0106] The output signal of the noise/noise cancellation effect detection microphone 211 is input to the signal processing device 204 that generates a signal (control sound) which controls the control speaker 181. Note that the configuration of the signal processing device 204 is exactly the same as that of the indoor unit 100 according to Embodiment 2.

[0107] Now, in order for the noise cancellation mechanism according to Embodiment 4 to obtain a high noise cancellation effect, it is required that the noise detected by the noise/noise cancellation effect detection microphone 211 is not one that has detected the pressure fluctuation components generated by the turbulent airflow.

[0108] Accordingly, in the indoor unit 100 according to Embodiment 4, the noise/noise cancellation effect detection microphone 211 is disposed on the downstream side of the heat exchanger 50. Since the fan 20 is disposed on the upstream side of the heat exchanger 50 in the indoor unit 100, it is possible to dispose the heat exchanger 50 between the noise/noise cancellation effect detection microphone 211 and the fan 20. When the noise/noise cancellation effect detection microphone 211 is disposed as above, the turbulent airflow generated in the fan 20 is suppressed by passing through the fins 56 of the heat exchanger 50. Accordingly, influence exerted to the noise/noise cancellation effect detection microphone 211 by the turbulent airflow can be reduced; hence, a high noise cancellation effect can be obtained.

[0109] Further, the noise cancellation effect is also influenced by the distance from the installation position of the control speaker 181 to the installation position (control point) of the noise/noise cancellation effect detection microphone 211. That is, the noise cancellation effect is also influenced by the length of the propagation path of the control sound that has been emitted from the control speaker 181 reaching the control point (the installation position of the noise/noise cancellation effect detection microphone 211). More specifically, the amplitude characteristics and the phase characteristics of the control sound that has been emitted from the control speaker 181 changes in the propagation path before reaching the control point (the installation position of the noise/noise cancellation effect detection microphone 211). If the amplitude characteristics and the phase characteristics are changed in the propagation path turning the control sound into one without the same amplitude as and a phase opposite to the noise, the noise cancellation effect is reduced.

[0110] In order to suppress such reduction of the noise cancellation effect caused by the propagation path, a common filtered-X algorithm resolves the above described problem by acquiring the propagation path of the control sound in advance and applying a correction in the course of generating the control sound. However, when the propagation path becomes long, the number of filter taps becomes large resulting in increase in arithmetic processing. Further, in a case of change in the sound velocity due to change in air temperature and the like, if the propagation path is long, the error between the acquired propagation path and the actual propagation path becomes large, and the noise cancellation effect is reduced.

[0111] Accordingly, in order to suppress reduction in the noise cancellation effect caused by the propagation path, it is preferable to dispose the control speaker 181 and the noise/noise cancellation effect detection microphone 211 close to each other. By disposing the control speaker 181 and the noise/noise cancellation effect detection microphone 211 as such, it will be possible to shorten the propagation distance of the control sound, and, thus, it will be possible to keep the change in the amplitude characteristics and the phase characteristics to be small. That is, by disposing the control speaker 181 and the noise/noise cancellation effect detection microphone 211 close to each other, it will be possible to superpose sound with high precision; hence, a high noise cancellation effect is obtained.

[0112] Accordingly, in the indoor unit 100 according to Embodiment 4, the control speaker 181 is provided on the downstream side of the heat exchanger 50 that is the installation position of the noise/noise cancellation effect detection microphone 211. As such, the propagation path of the control sound that has been emitted from the control speaker 181 reaching the control point (the installation position of the noise/noise cancellation effect detection microphone 211) can be shortened; hence, a high noise cancellation effect is obtained.

[0113] Note that in a case in which the control speaker 181 and the noise/noise cancellation effect detection microphone 211 are provided on the downstream side of the heat exchanger 50, there is a possibility of occurrence of dew condensation due to being directly in contact with the cold air; hence, ones applied with waterproofing may be used.

[0114] As above, in the indoor unit 100 according to Embodiment 4, the heat exchanger 50 is provided on the downstream side of the fan 20. Further, in the indoor unit 100, among the components of the noise cancellation mechanism, at least the control speaker 181 and the noise/noise cancellation effect detection microphone 211 are provided on the downstream side of the heat exchanger 50. Accordingly, in the indoor unit 100, influence of the turbulent airflow generated by the fan 20 exerted to the noise/noise cancellation effect detection microphone 211 can be reduced, and the route of the control sound generated from the control speaker 181 reaching the control point (the installation position of the noise/noise cancellation effect detection microphone 211) can be shortened. As such, the indoor unit 100 can perform high-precision noise control with the noise cancellation mechanism.

Embodiment 5

(Disposing Noise Detection Microphone to Boss)

[0115] Further, the noise cancellation mechanism can be disposed at a position described below, for example. Note that, in Embodiment 5, like functions and configurations to Embodiments 1 to 4 are denoted by like reference signs.

[0116] Fig. 18 is a longitudinal sectional view of the indoor unit according to Embodiment 5 of the invention. In Fig. 18, the right side of the drawing is the front side of the indoor unit 100.

[0117] In the indoor unit 100 according to Embodiment 5, the heat exchanger 50 is secured in the casing 1 with a heat exchanger fitting 58. As shown by the hollow arrows of Fig. 18, when the fan 20 is activated, the fan 20 suctions the air from a room through the inlet port 2 into the air passage inside the indoor unit 100, cools or heats the suction air with the heat exchanger 50 disposed under the fan 20, and blows the air from the outlet port 3 into the room.

[0118] Fig. 19 is a bottom view of the fan (as viewed from a bottom of Fig. 18) according to Embodiment 5 of the invention. Further, Fig. 20 is a cross-sectional view of the fan 20 taken along a cross-sectional plane M shown in Fig. 19.

In Embodiment 5, a modular fan including the fan 20, the fan motor, the bell mouth, the motor stay 16, and the like is used. This is because, if the modular fan is structured to be detachable from the casing 1, it will be possible to improve ease of maintenance and improve the precision of the tip clearance of the fan. The fan 20 includes the impeller 25 called a rotor blade. The fan motor serving as the power source of the impeller 25 is disposed inside the fixing member 17 of the motor stay 16. Further, the fixing member 17 is connected to the housing or the like of the modular fan through the supporting member 18. The cross-hatched area shown in Fig. 19 indicates a portion that corresponds to inner peripheries of the blades of the fan 20 (i.e., an inscribed circle tangential to inner peripheral portions of the blades of the impeller 25). Note that the supporting member 18 may be blade shaped or plate shaped to give the member a stator blade effect.

[0119] The fan motor serving as the power source of the impeller 25 and a boss 21 of the impeller 25 are connected to each other by the rotation shaft 20a. Thus, rotation of the fan motor is transmitted through the rotation shaft 20a to the impeller 25, so that the impeller 25 rotates. The rotation of the impeller 25 causes the air to flow (to be sent) in the direction indicated by the hollow arrows of Fig. 20. Note that the area with diagonal lines in Fig. 20 indicates portions that rotate when the fan 20 is in operation. On the other hand, the areas without diagonal lines indicate portions that do not rotate even when the fan 20 is in operation (i.e., immobile members). Further, the portion corresponding to the inner peripheries of the blades of the fan 20 (i.e., the inscribed circle tangential to the inner peripheral portions of the blades of the impeller 25) corresponds to an outer peripheral portion of the boss 21. Note that, in Embodiment 5, the fixing member 17 is formed to have substantially the same diameter as the diameter of the boss 21.

[0120] Referring again to Fig. 18, a noise detection microphone 161 serving as a noise detection device that detects an operation sound (noise) of the indoor unit 100, including a blast noise of the fan 20, is mounted to the fixing member 17 that corresponds to the inner peripheries of the blades of the fan 20. That is, the noise detection microphone 161 is arranged in a cylindrical region (hereinafter referred to as a cylindrical region S) defined by extending the inscribed circle tangential to the inner peripheral portions of the blades of the impeller 25 to the direction of the rotation axis of the impeller 25. Note that the fixing member 17 is independent from the rotatable impeller 25 as shown in Fig. 20, and is configured not to rotate when the fan 20 is in operation. Accordingly, the noise detection microphone 161 does not rotate either, when the fan 20 is in operation. Further, a control speaker 181 serving as a control sound output device that outputs a control sound corresponding to the noise is arranged below the noise detection microphone 161 so as to face the center of the air passage from a wall of the housing.

[0121] Further, at a lower end of a wall of the indoor unit 100, the noise cancellation effect detection microphone 191 serving as a noise cancellation effect detection device, which detects noise coming out from the outlet port 3 and detects a noise cancellation effect, is mounted to, for example, an upper portion of the outlet port 3. This noise cancellation effect detection microphone 191 is mounted to face a direction away from the flow passage. Note that the installation position of the noise cancellation effect detection microphone 191 is not limited to the upper portion of the outlet port 3, and may be any portion of the opening portion of the outlet port 3. For example, the noise cancellation effect detection microphone 191 may be mounted to a lower portion or to the side of the outlet port 3. Further, the noise cancellation effect detection microphone 191 does not need to be disposed so as to accurately be in a direction away from the flow passage. It is only required that the noise cancellation effect detection microphone 191 is disposed to face the outside of the indoor unit 100 (casing). That is, the noise cancellation effect detection microphone 191 may be installed at any position where noise emitted into the room can be detected.

[0122] Further, output signals of the noise detection microphone 161 and the noise cancellation effect detection microphone 191 are input to a signal processing device 207 serving as a control sound generation device that generates a signal (control sound) which controls the control speaker 181. The noise reduction mechanism of the indoor unit 100 includes the noise detection microphone 161, the control speaker 181, the noise cancellation effect detection microphone 191, and the signal processing device 207.

[0123] Next, a description is given on operations of the indoor unit 100. When the indoor unit 100 is operated, the impeller 25 of the fan 20 rotates. Then, the air in the room is suctioned from the upper side of the fan 20 and is sent to the lower side of the fan 20, thereby generating airflow. Accordingly, an operation sound (noise) is generated in the vicinity of the outlet port of the fan 20, and the sound is propagated to the downstream side.

[0124] In the vicinity of the outlet port 3 of the fan 20, turbulent airflow is generated by the rotation of the impeller 25. Further, since the air blown out from the fan 20 is blown out from the outlet port of the fan 20 toward the outside, the air impinges against the sidewall of the casing 1 of the indoor unit 100, and turbulence of airflow is further generated. Therefore, a pressure fluctuation due to the turbulent airflow is increased on the sidewall of the casing 1. In contrast, in the region inside the inner peripheries of the blades of the fan 20 (cylindrical region S), the turbulent airflow is smaller, and the pressure fluctuation due to the airflow is smaller.

[0125] In order to support this, the result of an experiment in which airflow blown out from the fan 20 has been visualized is shown in Fig. 22. Fig. 22 is a photograph taken when the fan 20 is operated after mounting the fan 20 to a right end of a duct-shaped tube and accumulating white smoke inside the duct. Focusing on the vicinity of the outlet port of the fan 20, it can be observed that in the region other than the vicinity of the fixing member 17 and the cylindrical region S, the accumulated white smoke has turned thin, which indicates that the white smoke is being carried by the airflow. On the other hand, in the vicinity of the fixing member 17 of the fan 20 and in the cylindrical region S, the white smoke remains accumulated, and influence exerted by the airflow is small. That is, it is found that the vicinity of the fixing member 17 of the fan 20 and the cylindrical region S are less affected by the airflow, and pressure fluctuation due to turbulent airflow is small.

[0126] The air sent from the fan 20 passes through the air passage and is sent to the heat exchanger 50. For example, during a cooling operation, a refrigerant is supplied to the heat exchanger 50 from a refrigerant pipe connected to an outdoor unit (not shown). The air that has been sent to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 so as to become cold air, and is directly released from the outlet port 3 into the room.

[0127] Next, a description will be given on a method suppressing of the operation sound of the indoor unit 100. Fig. 21 is a block diagram of the signal processing device according to Embodiment 5.

The operation sound (noise) of the indoor unit 100 including the blast noise of the fan 20 is detected by the noise detection microphone 161 mounted to the fixing member 17 of the fan 20. The noise detected by the noise detection microphone 161 is transmitted through the microphone amplifier 151 and the A/D converter 152 so as to be converted into a digital signal, and is input to the FIR filter 158 and the LMS algorithm 159.

[0128] The tap coefficient of the FIR filter 158 is successively updated by the LMS algorithm 159. In the LMS algorithm 159, the optimum tap coefficient is updated such that an error signal "e" approaches zero in accordance with Equation 1, which is the same equation as that of Embodiment 1, (h (n+1) = h (n) + 2● μ ● e (n) ● x (n)).

[0129] In this way, the digital signal that has passed through the FIR filter 158, the tap coefficient of which has been updated by the LMS algorithm 159, is converted into an analog signal by the D/A converter 154, is amplified by the amplifier 155, and is emitted as a control sound from the control speaker 181 into the air passage inside the indoor unit 100.

[0130] On the other hand, the noise cancellation effect detection microphone 191 which is mounted to the upper portion of the outlet port 3 of the indoor unit 100 to face a direction away from the flow passage detects a resultant sound after interference of the noise, which has propagated through the air passage from the fan 20 and has been emitted from the outlet port 3 into the room, and the control sound emitted from the control speaker 181. A signal detected by the noise cancellation effect detection microphone 191 is converted into a digital signal, and is averaged by the weighting means 153.

[0131] Fig. 23 is a block diagram illustrating a circuit of the weighting means according to Embodiment 5 of the invention. The weighting means 153 is an integrator including a multiplier 121 that multiplies the input signal by the weighting coefficient, an adder 122, a one-sample delay element 123, and a multiplier 124.

[0132] In Embodiment 5, the weighting coefficient of the multiplier 121 can be externally set in accordance with the installation environment.
For example, in an environment where disturbance is large and operations are unstable, the weighting coefficient of the multiplier 121 may be reduced. Conversely, in an environment with little disturbance, the weighting coefficient of the multiplier 121 may be increased. In this way, the sensitivity to environmental changes can be altered. In this case, the averaging operation by the weighting means 153 may not be performed until the LMS algorithm 159 becomes stable. This is because the noise is not sufficiently reduced while the LMS algorithm 159 is not stable, and runaway of the output value of the weighting means 153 may occur. Further, the output value of the weighting means 153 may be reset if the output value of the weighting means 13 exceeds a certain value.

[0133] The signal averaged in this way is treated as the above-described error signal "e" of the LMS algorithm 159. Then, feedback control is performed such that the error signal "e" approaches zero, and the tap coefficient of the FIR filter 158 is updated as appropriate. As a result, the noise in the vicinity of the outlet port 3 can be suppressed by the control sound that has passed through the FIR filter 158.

[0134] Since the noise of the indoor unit 100 that is perceived by a person is one that has been emitted from the outlet port 3 into the room, the noise being emitted into the room can be detected by orienting the noise cancellation effect detection microphone 191 to face the inside of the room that is a direction away from the flow passage. That is, sound having high coherence with the noise that has been emitted into the room can be detected by attaching the noise cancellation effect detection microphone 191 at the upper portion of the outlet port 3 to face a direction away from the flow passage. Further, since the noise cancellation effect detection microphone 191 is not directly hit by the airflow, the noise cancellation effect detection microphone 191 does not detect wind noise caused by the airflow. On the other hand, if the noise cancellation effect detection microphone 191 is oriented toward the flow passage, noise inside the flow passage will be detected. Therefore, since the noise cancellation effect detection microphone 191 cannot detect the change in the sound properties at the outlet port where the sound is emitted, the sound detected by the noise cancellation effect detection microphone 191 will have properties different from those of the noise in the room. Accordingly, the coherence between the sound detected by the noise cancellation effect detection microphone 191 and the sound emitted into the room is reduced. Moreover, since the noise cancellation effect detection microphone 191 is directly hit by the airflow, the noise cancellation effect detection microphone 191 will detect wind noise, which leads to further reduction in coherence.

[0135] Further, sounds other than the noise generated from the fan 20 are abundantly present in the room, and these sounds other than the noise undermine the stability of the feedback control. To address this problem, the sounds other than the noise are averaged by providing the weighting means 153 at a step preceding the feedback control. This allows components of the uncorrelated sound other than the noise to be canceled, and allows the feedback control to be operated stably. That is, the coherence between the noise detection microphone 161 and the noise cancellation effect detection microphone 191 can be increased.

[0136] Further, in Embodiment 5, since the noise detection microphone 161 is mounted to the fixing member 17 of the fan 20, the airflow does not directly hit the noise detection microphone 161. Therefore, detection of pressure fluctuation components generated by the turbulent airflow with the noise detection microphone 161 can be reduced. Accordingly, the noise detection microphone 161 can detect sound having high coherence with the noise, that is, the operation sound of the fan 20. Further, since the noise cancellation effect detection microphone 191 is mounted to the upper portion of the outlet port 3 to face a direction away from the flow passage, the noise cancellation effect detection microphone 191 is not directly hit by the airflow; hence, the noise cancellation effect detection microphone 191 is not affected by the airflow. Further, since the noise cancellation effect detection microphone 191 is allowed to detect only the noise emitted into the room, noise having high coherence with the actual noise heard by a person in the room can be detected by the noise cancellation effect detection microphone 191. Further, since the sound detected by the noise cancellation effect detection microphone 191 is averaged by the weighting means 153 and feedback control is performed, components other than the noise from the indoor unit 100 included in the sound detected by the noise cancellation effect detection microphone 191 can be averaged and canceled. Therefore, it is possible to obtain high coherence between the detected sound of the noise detection microphone 161 and the noise cancellation effect detection microphone 191. Accordingly, it is possible to obtain high coherence among the noise generated from the fan 20, the detected sound of the noise detection microphone 161, the detected sound of the noise cancellation effect detection microphone 191, and noise in the room emitted from the indoor unit 100; hence, a high noise cancellation effect can be obtained.

[0137] A description will be given on the result of an experiment in which coherence between the noise detection microphone 161 and the noise cancellation effect detection microphone 191 was measured in a case where the noise detection microphone 161 was actually mounted inside the inner peripheries of the blades of the fan 20 (the cylindrical region S).

[0138] Fig. 24 is a chart illustrating coherence properties between a detected sound of a noise detection microphone 161 and a detected sound of a noise cancellation effect detection microphone 191 when the fan 20 was operated while the noise detection microphone 161 was disposed outside the cylindrical region S. Next, Fig. 25 is a chart illustrating coherence properties between a detected sound of the noise detection microphone 161 and a detected sound of the noise cancellation effect detection microphone 191 when the fan 20 was operated in a case where the noise detection microphone 6 was disposed inside the cylindrical region S. It can be seen that by comparing Fig. 24 with Fig. 25, the coherence is obviously high in the case where the noise detection microphone 161 was disposed inside the cylindrical region S.

[0139] Further, since the noise detection microphone 161 is mounted to the fixing member 17 of the fan 20, the noise detection microphone 161 can be easily mounted without increasing the parts count, and the need for a precise mounting mechanism is eliminated. Further, since the noise detection microphone 161 is mounted to the fixing member 17 of the fan 20, the distance between the fan 20 and the noise detection microphone 161 can be reduced, which allows the height of the indoor unit 100 to be reduced.

[0140] Note that, in Embodiment 5, the noise detection microphone 161 is disposed on the fixing member 17. Accordingly, unique mechanical vibration associated with rotation of the fan 20 may be transmitted to the fixing member 17, and the noise detection microphone 161 may detect the vibration. In this case, the coherence between the noise detection microphone 161 and the noise cancellation effect detection microphone 191 may locally be reduced. In such a case, the noise detection microphone 161 may be disposed inside the cylindrical region S in a position other than that of the fixing member 17. For example, as shown in Fig. 26, the noise detection microphone 161 may be disposed on the heat exchanger 50 in the area inside the cylindrical region S. Further, for example, as shown in Fig. 27, the noise detection microphone 161 may be disposed under the heat exchanger fitting 58 in the area inside the cylindrical region S. By disposing the noise detection microphone 161 as described above, the coherence between the noise detection microphone 161 and the noise cancellation effect detection microphone 191 can be further increased compared with the case in which the noise detection microphone 161 is disposed on the fixing member 17, and a higher noise cancellation effect can be obtained.

[0141] Further, as shown in Fig. 28, the noise detection microphone 161 may be covered with a wall member 270. Since the wall member can block the airflow, the noise detection microphone 161 is further less affected by the airflow, and a higher noise cancellation effect can be obtained. In Fig. 28, the wall member 270 is formed in a substantially cylindrical shape. However, the wall member 270 may be formed in any shape.
Similarly, the noise detection microphone 161 may be covered with the wall member 270 in a case where the noise detection microphone 161 is mounted to the heat exchanger 50 or the heat exchanger fitting 58. The noise detection microphone 161 is further less affected by the airflow, and a higher noise cancellation effect can be obtained.
Further, the noise cancellation effect detection microphone 191 mounted to the upper portion of the outlet port 3 to face a direction away from the flow passage may be covered with a wall member. Since the wall member can block the airflow, the noise cancellation effect detection microphone 191 is not affected by the airflow, and a higher noise cancellation effect can be obtained.

[0142] Further, in Embodiment 5, the FIR filter 158 and the LMS algorithm 159 are used in the signal processing device 207. However, any adaptive signal processing circuit that makes the sound detected by the noise cancellation effect detection microphone 191 approach zero may be used, and may be one using a filtered-X algorithm that is commonly employed by active noise reduction methods. Further, the weighting means 153 does not need to be an integrator, and may be any means that can perform an averaging operation. Further, the signal processing device 207 does not need to be configured to perform adaptive signal processing, and may be configured to generate a control sound using a fixed tap coefficient. Furthermore, the signal processing device 207 does not need to be a digital signal processing circuit, and may be an analog signal processing circuit.

[0143] As described above, in the indoor unit 100 according to Embodiment 5, the noise detection microphone 161 serving as a noise detection device is disposed inside the cylindrical region S and on an immobile member of the fan 20. Therefore, it is possible to reduce the influence of the airflow from the outlet port of the fan 20, and thus to detect sound having high coherence with the noise. Accordingly, active noise reduction can be performed with high accuracy. Further, since the noise detection microphone 161 can be installed without changing the mechanism of the fan 20 and without increasing the parts count of the indoor unit 100, the indoor unit 100 can provide a high degree of installation freedom.

Note that the immobile member of the fan 20 is not limited to the fixing member 17. If, among the components of the fan 20, there is an immobile member in which at least a portion thereof is arranged inside the cylindrical region S, the noise detection microphone 161 may be disposed in the area of the immobile member inside the cylindrical region S.

[0144] Further, in the indoor unit 100 according to Embodiment 5, the noise detection microphone 161 serving as a noise detection device is disposed inside the cylindrical region S and on the downstream side of the fan 20. Therefore, it is possible to reduce the influence of the airflow from the outlet port of the fan 20, and thus to detect sound having high coherence with the noise. Accordingly, active noise reduction can be performed with high accuracy. Further, since the noise detection microphone 161 can be installed without changing the mechanism of the fan 20 and without increasing the parts count of the indoor unit 100, the indoor unit 100 can provide a high degree of installation freedom. Further, since the unique mechanical vibration associated with rotation of the fan 20 is not detected by the noise detection microphone 161, active noise reduction can be performed with higher accuracy than that in the case in which the noise detection microphone 161 is disposed on an immobile member of the fan 20.

[0145] Note that, in the case where the noise detection microphone 161 is disposed on the downstream side of the fan 20, components on which the noise detection microphone 161 are disposed are not limited to the heat exchanger 50 and the heat exchanger fitting 58. If there is a component in which at least a portion thereof is arranged inside the cylindrical region S and is disposed on the downstream side of the fan 20, the noise detection microphone 161 may be disposed in the area of the component inside the cylindrical region S.

[0146] Further, in the indoor unit 100 according to Embodiment 5, the noise cancellation effect detection microphone 191 serving as a noise cancellation effect detection device is disposed in the opening portion of the outlet port 3, and is arranged so as to face the outside of the indoor unit 100. Therefore, the noise cancellation effect detection microphone 191 can detect the noise emitted into the room without being affected by the airflow. Accordingly, it is possible to obtain high coherence between the noise emitted into the room from the indoor unit 100 and the detected sound of the noise cancellation effect detection microphone 191. Therefore, active noise reduction can be performed with high accuracy to the noise emitted into the room from the indoor unit 100.

[0147] Further, in the indoor unit 100 according to Embodiment 5, the signal processing device 207 serving as a control sound generation device is provided with a circuit that applies weight to a detection result detected by the noise cancellation effect detection microphone 191 serving as a noise cancellation effect detection device, and that performs feedback control. Therefore, sound other than the noise of the indoor unit 100 detected by the noise cancellation effect detection microphone 191 can be canceled by averaging the sound. Accordingly, sound having high coherence with each other can be detected by the noise detection microphone 161 and the noise cancellation effect detection microphone 191; hence, active noise reduction can be performed with higher accuracy.

[0148] Further, in the indoor unit 100 according to Embodiment 5, the noise detection microphone 161 is disposed on the fixing member 17 of the fan 20 in an area inside the cylindrical region S. Therefore, it is possible to reduce influence of the airflow from the outlet port of the fan 20, and thus to detect sound having high coherence with the noise. Accordingly, active noise reduction can be performed with high accuracy. Further, since the noise detection microphone 161 can be installed without changing the mechanism of the fan 20 and without increasing the parts count of the air-conditioning apparatus, the indoor unit 100 can provide a high degree of installation freedom.

[0149] Further, in the indoor unit 100 according to Embodiment 5, the noise detection microphone 161 is disposed on the heat exchanger 50 in an area inside the cylindrical region S. Therefore, it is possible to reduce influence of the airflow from the outlet port of the fan 20, and thus to detect sound having high coherence with the noise. Accordingly, active noise reduction can be performed with high accuracy. Further, since the noise detection microphone 161 can be installed without changing the mechanism of the fan 20 and without increasing the parts count of the air-conditioning apparatus, the indoor unit 100 can provide a high degree of installation freedom. Further, since the unique mechanical vibration associated with rotation of the fan 20 is not detected by the noise detection microphone 161, active noise reduction can be performed with an accuracy higher than that in the case in which the noise detection microphone 161 is disposed on an immobile member of the fan 20.

[0150] Further, in the indoor unit 100 according to Embodiment 5, the noise detection microphone 161 is disposed on the heat exchanger fitting 58 in an area inside the cylindrical region S. Therefore, it is possible to reduce influence of the airflow from the outlet port of the fan 20, and thus to detect sound having high coherence with the noise. Accordingly, active noise reduction can be performed with high accuracy. Further, since the noise detection microphone 161 can be installed without changing the mechanism of the fan 20 and without increasing the parts count of the air-conditioning apparatus, the indoor unit 100 can provide a high degree of installation freedom. Further, since the unique mechanical vibration associated with rotation of the fan 20 is not detected by the noise detection microphone 161, active noise reduction can be performed with an accuracy higher than that in the case in which the noise detection microphone 161 is disposed on an immobile member of the fan 20.

[0151] Further, in the indoor unit 100 according to Embodiment 5, the noise detection microphone 161 is covered with the wall member 270. Since the wall member 270 blocks the airflow, the noise detection microphone 161 is further less affected by the airflow and a higher noise cancellation effect can be obtained.

[0152] Further, in the indoor unit 100 according to Embodiment 5, the noise cancellation effect detection microphone 191 is covered with a wall member. Since the wall member blocks the airflow, the noise cancellation effect detection microphone 191 is further less affected by the airflow and a higher noise cancellation effect can be obtained.

Embodiment 6

[0153] In Embodiment 6, a description is given on the indoor unit 100 in which the noise/noise cancellation effect detection microphone 211 is provided as a noise/noise cancellation effect detection device into which the noise detection microphone 161 and the noise cancellation effect detection microphone 191 of Embodiment 5 are integrated. Note that, in Embodiment 6, items not specifically described are the same as those of Embodiment 5, and like functions and configurations are denoted by like reference signs.

[0154] Fig. 29 is a longitudinal sectional view of the indoor unit according to Embodiment 6 of the invention. In Fig. 29, the right side of the drawing is the front side of the indoor unit 100.

[0155] In the indoor unit 100 according to Embodiment 6, the heat exchanger 50 is secured in the casing 1 with a heat exchanger fitting 58. As shown by the hollow arrows of Fig. 29, when the fan 20 is activated, the fan 20 suctions the air from a room through the inlet port 2 into the air passage inside the indoor unit 100, cools or heats the suction air with the heat exchanger 50 disposed under the fan 20, and blows the air from the outlet port 3 into the room.

[0156] The differences between the indoor unit 100 according to Embodiment 6 and the indoor unit 100 according to Embodiment 5 are as follows. That is, the indoor unit 100 according to Embodiment 5 uses two microphones for performing active noise reduction, namely the noise detection microphone 161 and the noise cancellation effect detection microphone 191, in order to generate the control sound in the signal processing device 207. On the other hand, the indoor unit 100 according to Embodiment 6 replaces these with a single microphone, namely the noise/noise cancellation effect detection microphone 211. Further, due to this, the signal processing method differs, and therefore the content of the signal processing device 204 differs. On the sidewall of the casing 1 of the indoor unit 100, the control speaker 181, which outputs the control sound corresponding to the noise, is arranged to face the center of the air passage from the wall. Further, on the fixing member 17 in an area inside the cylindrical region S, the noise/noise cancellation effect detection microphone 211 is disposed that detects the resultant sound after interference of the operation sound (noise) of the indoor unit 100 including the blast noise of the fan 20 and the control sound emitted from the control speaker 181.

[0157] Note that the fixing member 17 is independent from the impeller 25, and is configured not to rotate when the fan 20 is in operation. Accordingly, the noise/noise cancellation effect detection microphone 211 does not rotate either, when the fan 20 is in operation. An output signal of the noise/noise cancellation effect detection microphone 211 is input to the signal processing device 204 serving as a control sound generation device that generates a signal (control sound) which controls the control speaker 181. The noise reduction mechanism of the indoor unit 100 includes the noise/noise cancellation effect detection microphone 211, the control speaker 181, and the signal processing device 204. The configuration of the signal processing device 204 is exactly the same as that of Fig. 11 described in Embodiment 2.

[0158] Next, a description is given on operations of the indoor unit 100. When the indoor unit 100 is operated, the impeller 25 of the fan 20 rotates. Then, the air in the room is suctioned from the upper side of the fan 20 and is sent to the lower side of the fan 20, thereby generating airflow. Accordingly, an operation sound (noise) is generated in the vicinity of the outlet port of the fan 20, and the sound is propagated to the downstream side. As in the case of Embodiment 5, turbulent airflow is generated by rotation of the impeller 25 in the vicinity of the outlet port of the fan 20. Further, since the air blown out from the fan 20 blows from the outlet port of the fan 20 toward the outside, the air impinges against the sidewall of the housing of the indoor unit 100, and turbulence of air flow is further generated. Therefore, a pressure fluctuation due to the turbulent airflow is increased on the sidewall of the indoor unit 100. In contrast, in the region inside the inner peripheries of the blades of the fan 20 (cylindrical region S), the turbulent airflow is smaller, and the pressure fluctuation due to the airflow is smaller.

[0159] The air sent from the fan 20 passes through the air passage and is sent to the heat exchanger 50. For example, during a cooling operation, the refrigerant is supplied to the heat exchanger 50 from a refrigerant pipe connected to the outdoor unit (not shown). The air that has been sent to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 so as to become cold air, and is directly released from the outlet port 3 into the room.

[0160] The method of suppressing the operation sound of the indoor unit 100 is completely the same as that described in Embodiment 2, that is, it is operated such that the control sound is output to make the noise detected by the noise/noise cancellation effect detection microphone 211 approach zero, resulting in suppression of noise to the noise/noise cancellation effect detection microphone 211.

[0161] As described above, in Embodiment 6, in the indoor unit 100 in which the active noise reduction method is employed, since the noise/noise cancellation effect detection microphone 211 is mounted on the fixing member 17 in the area inside the cylindrical region S, the airflow does not directly hit the noise/noise cancellation effect detection microphone 16. This makes it possible to reduce detection of pressure fluctuation components generated by the turbulent airflow. Therefore, it is possible to detect sound having high coherence with the noise, that is, the operation sound of the fan 20, and thus to obtain a high noise cancellation effect.

[0162] Further, since the noise/noise cancellation effect detection microphone 211 is mounted to the fixing member 17 of the fan 20, the noise/noise cancellation effect detection microphone 211 can be easily mounted without increasing the parts count, and the need for a precise mounting mechanism is eliminated. Further, since the noise/noise cancellation effect detection microphone 211 is mounted to the fixing member 17 of the fan 20, the distance between the fan 20 and the noise/noise cancellation effect detection microphone 211 can be reduced, which allows the height of the indoor unit 100 to be reduced.

[0163] Note that, in Embodiment 6, the noise/noise cancellation effect detection microphone 211 is disposed on the fixing member 17. Therefore, unique mechanical vibration associated with rotation of the fan 20 may be transmitted to the noise/noise cancellation effect detection microphone 211, and the noise/noise cancellation effect detection microphone 211 may detect the vibration. This may reduce the noise cancellation effect. In such a case, the noise/noise cancellation effect detection microphone 211 may be disposed inside the cylindrical region S in a position other than that of the fixing member 17. For example, as shown in Fig. 30, the noise/noise cancellation effect detection microphone 211 may be disposed on the heat exchanger 50 in the area inside the cylindrical region S. Further, for example, as shown in Fig. 31, the noise/noise cancellation effect detection microphone 211 may be disposed under the heat exchanger fitting 58 in the area inside the cylindrical region S. In the case where the noise/noise cancellation effect detection microphone 211 is disposed as described above, a higher noise cancellation effect can be obtained compared with the case in which the noise/noise cancellation effect detection microphone 211 is disposed on the fixing member 17.

[0164] Further, as shown in Fig. 32, the noise/noise cancellation effect detection microphone 211 may be covered with the wall member 270. Since the wall member 270 can block the airflow, the noise/noise cancellation effect detection microphone 211 is further less affected by the airflow, and a higher noise cancellation effect can be obtained. In Fig. 32, the wall member 270 is formed in a substantially cylindrical shape. However, the wall member 270 may be formed in any shape. Similarly, the noise/noise cancellation effect detection microphone 211 may be covered with the wall member 270 in a case where the noise/noise cancellation effect detection microphone 211 is mounted to the heat exchanger 50 or the heat exchanger fitting 58. The noise/noise cancellation effect detection microphone 211 is further less affected by the airflow, and a higher noise cancellation effect can be obtained.

[0165] As described above, in the indoor unit 100 according to Embodiment 6, the noise/noise cancellation effect detection microphone 211 serving as a noise/noise cancellation effect detection device is disposed inside the cylindrical region S and on an immobile member of the fan 20. Therefore, it is possible to reduce influence of the airflow from the outlet port of the fan 20, and thus to detect sound having high coherence with the noise. Accordingly, active noise reduction can be performed with high accuracy. Further, since the noise/noise cancellation effect detection microphone 211 can be installed without increasing the parts count of the indoor unit 100, the indoor unit 100 can provide a high degree of installation freedom.

[0166] Further, in Embodiment 6, the FIR filter 158 and the LMS algorithm 159 are used in the signal processing device 204. However, any adaptive signal processing circuit that makes the sound detected by the noise/noise cancellation effect detection microphone 211 approach zero may be used, and may be one using a filtered-X algorithm that is commonly employed by active noise reduction methods. Further, the signal processing device 204 does not need to be configured to perform adaptive signal processing, and may be configured to generate a control sound using a fixed tap coefficient. Furthermore, the signal processing device 204 does not need to be a digital signal processing circuit, and may be an analog signal processing circuit.

[0167] Further, in the indoor unit 100 according to Embodiment 6, the noise/noise cancellation effect detection microphone 211 serving as a noise/noise cancellation effect detection device is disposed inside the cylindrical region S and on the downstream side of the fan 20. Therefore, it is possible to reduce influence of the airflow from the outlet port of the fan 20, and thus to detect sound having high coherence with the noise. Accordingly, active noise reduction can be performed with high accuracy. Further, since the noise/noise cancellation effect detection microphone 211 can be installed without changing the mechanism of the fan 20 and without increasing the parts count of the indoor unit 100, the indoor unit 100 can provide a high degree of installation freedom. Further, since the unique mechanical vibration associated with rotation of the fan 20 is not detected by the noise/noise cancellation effect detection microphone 211, active noise reduction can be performed with an accuracy higher than that in the case in which the noise/noise cancellation effect detection microphone 211 is disposed on an immobile member of the fan 20.

[0168] Further, in the indoor unit 100 according to Embodiment 6, the noise/noise cancellation effect detection microphone 211 is disposed on the fixing member 17 of the fan 20 in an area inside the cylindrical region S. Therefore, it is possible to reduce influence of the airflow from the outlet port of the fan 20, and thus to detect sound having high coherence with the noise. Accordingly, active noise reduction can be performed with high accuracy. Further, since the noise/noise cancellation effect detection microphone 211 can be installed without changing the mechanism of the fan 20 and without increasing the parts count of the air-conditioning apparatus, the indoor unit 100 can provide a high degree of installation freedom.

[0169] Further, in the indoor unit 100 according to Embodiment 6, the noise/noise cancellation effect detection microphone 211 is disposed on the heat exchanger 50 in an area inside the cylindrical region S. Therefore, it is possible to reduce influence of the airflow from the outlet port of the fan 20, and thus to detect sound having high coherence with the noise. Accordingly, active noise reduction can be performed with high accuracy. Further, since the noise/noise cancellation effect detection microphone 211 can be installed without changing the mechanism of the fan 20 and without increasing the parts count of the air-conditioning apparatus, the indoor unit 100 can provide a high degree of installation freedom. Further, since the unique mechanical vibration associated with rotation of the fan 20 is not detected by the noise/noise cancellation effect detection microphone 211, active noise reduction can be performed with an accuracy higher than that in the case in which the noise/noise cancellation effect detection microphone 211 is disposed on an immobile member of the fan 20.

[0170] Further, in the indoor unit 100 according to Embodiment 6, the noise/noise cancellation effect detection microphone 211 is disposed on the heat exchanger fitting 58 in an area inside the cylindrical region S. Therefore, it is possible to reduce influence of the airflow from the outlet port of the fan 20, and thus to detect sound having high coherence with the noise. Accordingly, active noise reduction can be performed with high accuracy. Further, since the noise/noise cancellation effect detection microphone 211 can be installed without changing the mechanism of the fan 20 and without increasing the parts count of the air-conditioning apparatus, the indoor unit 100 can provide a high degree of installation freedom. Further, since the unique mechanical vibration associated with rotation of the fan 20 is not detected by the noise/noise cancellation effect detection microphone 211, active noise reduction can be performed with an accuracy higher than that in the case in which the noise/noise cancellation effect detection microphone 211 is disposed on an immobile member of the fan 20.

[0171] Further, in the indoor unit 100 according to Embodiment 6, the noise/noise cancellation effect detection microphone 211 is covered with the wall member 270. Since the wall member blocks the airflow, the noise/noise cancellation effect detection microphone 211 is further less affected by the airflow and a higher noise cancellation effect can be obtained.

Embodiment 7

[0172] In Embodiment 7, a description is given on an indoor unit 100 in which the noise/noise cancellation effect detection microphone 211 is disposed at the upper portion of the outlet port 3 to face a direction away from the flow passage. Note that, in Embodiment 7, items not specifically described are the same as those of Embodiment 5 or Embodiment 6, like functions and configurations are denoted by like reference signs.

[0173] Fig. 33 is a longitudinal sectional view of the indoor unit according to Embodiment 7 of the invention. In Fig. 33, the right side of the drawing is the front side of the indoor unit 100.

[0174] The indoor unit 100 according to Embodiment 7 is different from the indoor unit 100 according to Embodiment 6 in that the noise/noise cancellation effect detection microphone 211 is disposed at the upper portion of the outlet port 3 to face a direction away from the flow passage. Accordingly, the configuration of a signal processing device 208 also differs from that of Embodiment 6. As in the case of Embodiment 6, in the case where the noise/noise cancellation effect detection microphone 211 is mounted to the upper portion of the outlet port 3 to face a direction away from the flow passage, the noise/noise cancellation effect detection microphone 211 can be easily mounted without increasing the parts count, and the need for a precise mounting mechanism is eliminated. On the sidewall of the casing 1 of the indoor unit 100, the control speaker 181, which outputs the control sound corresponding to the noise, is arranged to face the center of the air passage from the wall. Further, the noise/noise cancellation effect detection microphone 211, which detects the resultant sound after interference of the operation sound (noise) of the indoor unit 100 including the blast noise of the fan 20 and the control sound emitted from the control speaker 181, is disposed at the upper portion of the outlet port 3 to face a direction away from the flow passage. An output signal of the noise/noise cancellation effect detection microphone 211 is input to the signal processing device 208 serving as a control sound generation device that generates a signal (control sound) which controls the control speaker 181.

[0175] Fig. 34 is a block diagram of the signal processing device 208. The difference from the signal processing device 204 shown in Fig. 11 is that the weighting means 153 is disposed between the output of the A/D converter 152 and the input of the LMS algorithm 159. The configurations other than that are the same as those of the signal processing device 204 of Embodiment 2.

[0176] Next, a description is given on operations of the indoor unit 100. When the indoor unit 100 is operated, the impeller 25 of the fan 20 rotates. Then, the air in the room is suctioned from the upper side of the fan 20 and is sent to the lower side of the fan 20, thereby generating airflow. Accordingly, an operation sound (noise) is generated in the vicinity of the outlet port of the fan 20, and the sound is propagated to the downstream side. As in the cases of Embodiments 5 and 6, turbulent airflow is generated by rotation of the impeller 25 in the vicinity of the outlet port of the fan 20. Further, since the air blown out from the fan 20 blows from the outlet port of the fan 20 toward the outside, the air impinges against the sidewall of the housing of the indoor unit 100, and turbulence of air flow is further generated. Therefore, a pressure fluctuation due to the turbulent airflow is increased on the sidewall of the indoor unit 100.

[0177] However, in Embodiment 7, the noise/noise cancellation effect detection microphone 211 is disposed at the upper portion of the outlet port 3 to face a direction away from the flow passage. Compared with the vicinity of the fan 20, the vicinity of the outlet port 3 is separated by a sufficiently large distance from the outlet port of the fan 20 where there is large turbulent airflow. Further, in the vicinity of the outlet port 3, the turbulent airflow is rectified to some extent by the heat exchanger 50. Therefore, the turbulent airflow is smaller in the vicinity of the noise/noise cancellation effect detection microphone 211. Furthermore, since the airflow does not directly hit the area where the noise/noise cancellation effect detection microphone 211 is disposed, the noise/noise cancellation effect detection microphone 211 is hardly affected by the turbulent airflow. Since the noise of the indoor unit 100 that is perceived by a person is one that has been emitted from the outlet port 3 into the room, the noise being emitted into the room can be detected by orienting the noise/noise cancellation effect detection microphone 211 to face the inside of the room that is a direction away from the flow passage. That is, sound having high coherence with the noise that has been emitted into the room can be detected by mounting the noise/noise cancellation effect detection microphone 211 to the upper portion of the outlet port 3 to face a direction away from the flow passage.

[0178] Next, a description will be given on a method of suppressing the operation sound of the indoor unit 100. The control sound generating method of Embodiment 7 is similar to the method described in Embodiment 2. The control sound generating method of Embodiment 7 differs from the method described in Embodiment 2 in that the signal input as an error signal to the LMS algorithm 159 is averaged by the weighting means 153. In the case where the noise/noise cancellation effect detection microphone 211 is disposed at the upper portion of the outlet port 3 to face a direction away from the flow passage, the noise detected by the noise/noise cancellation effect detection microphone 211 abundantly contains sound other than the noise generated from the fan 20. Thus, these sound other than the noise undermine the stability of the feedback control. To address this problem, in Embodiment 7, the sounds other than the noise are averaged by providing the weighting means 153 at a preceding step of the feedback control. This allows components of the uncorrelated sound other than the noise to be canceled, and allows the feedback control to be operated stably. That is, the coherence between the noise output from the outlet port 3 into the room and the noise/noise cancellation effect detection microphone 211 can be increased.

[0179] Note that, as in the case of Embodiment 5, the averaging operation by the weighting means 153 may not be performed until the LMS algorithm 159 becomes stable. This is because the noise is not sufficiently reduced while the LMS algorithm 159 is not stable, and runaway of the output value of the weighting means 153 may occur. Further, the output value of the weighting means 153 may be reset if the output value of the weighting means 13 exceeds a certain value. Further, in order to further reduce influence of the airflow, the noise/noise cancellation effect detection microphone 211 may be covered with the wall member 270. Since the wall member can block the airflow, the noise/noise cancellation effect detection microphone 211 is further less affected by the airflow, and a higher noise cancellation effect can be obtained.

[0180] Furthermore, the installation position of the noise/noise cancellation effect detection microphone 211 is not limited to the upper portion of the outlet port 3, and may be anywhere in the opening portion of the outlet port 3. For example, the noise/noise cancellation effect detection microphone 211 may be mounted to a lower portion or to the side of the outlet port 3. Further, the noise/noise cancellation effect detection microphone 211 does not need to be disposed so as to accurately face a direction away from the flow passage. It is only required that the noise/noise cancellation effect detection microphone 211 is disposed to face the outside of the indoor unit 100 (housing). That is, the noise/noise cancellation effect detection microphone 211 may be installed at any position where noise emitted into the room can be detected.

[0181] Further, in Embodiment 7, the FIR filter 158 and the LMS algorithm 159 are used in the signal processing device 208. However, any adaptive signal processing circuit that makes the sound detected by the noise/noise cancellation effect detection microphone 211 approach zero may be used, and may be one using a filtered-X algorithm that is commonly employed by active noise reduction methods. Further, the weighting means 153 does not need to be an integrator, and may be any means that can perform an averaging operation. Further, the signal processing device 208 does not need to be configured to perform adaptive signal processing, and may be configured to generate a control sound using a fixed tap coefficient. Furthermore, the signal processing device 208 does not need to be a digital signal processing circuit, and may be an analog signal processing circuit.

[0182] As described above, in the indoor unit 100 according to Embodiment 7, the noise/noise cancellation effect detection microphone 211 serving as a noise/noise cancellation effect detection device is disposed in the opening portion of the outlet port 3, and is arranged to face the outside of the indoor unit 100. Therefore, the noise/noise cancellation effect detection microphone 211 can detect the noise emitted into the room without being affected by the airflow. Accordingly, it is possible to obtain high coherence between the noise emitted into the room from the indoor unit 100 and the detected sound of the noise/noise cancellation effect detection microphone 211. Therefore, active noise reduction can be performed with high accuracy to the noise emitted into the room from the indoor unit 100.

[0183] Further, in the indoor unit 100 according to Embodiment 7, the signal processing device 208 serving as a control sound generation device is provided with a circuit that applies weight to a detection result detected by the noise/noise cancellation effect detection microphone 211 serving as a noise/noise cancellation effect detection device, and that performs feedback control. Therefore, sound other than the noise of the indoor unit 100 detected by the noise/noise cancellation effect detection microphone 211 can be canceled by averaging the sound. Accordingly, active noise reduction can be performed with higher accuracy. Further, in the indoor unit 100 according to Embodiment 7, the noise/noise cancellation effect detection microphone 211 is covered with the wall member 270. Since the wall member blocks the airflow, the noise/noise cancellation effect detection microphone 211 is further less affected by the airflow and a higher noise cancellation effect can be obtained.

Embodiment 8

(Individual Control of Fan)

[0184] The noise cancellation effect of the active noise cancellation mechanism can be further improved by individually controlling the rotation speed of each fan 20 provided in the indoor unit 100. Note that, in Embodiment 8, like functions and configurations to Embodiments 1 and 7 are denoted by like reference signs.

[0185] Fig. 35 is a front view of the indoor unit according to Embodiment 8 of the invention. Fig. 36 is a side view of the indoor unit illustrated in Fig. 35. Note that Fig. 36 is a diagram of the indoor unit 100 of Fig. 35 viewed from the diagonally-shaded-arrow direction in Fig. 35 and illustrates a view when the sidewall of the casing 1 of the indoor unit 100 is seen through. Note that in Fig. 36, a remote control 280, the controller 281, and motor drivers 282A to 282C illustrated in Fig. 35 are not shown.

[0186] In the indoor unit 100 shown in Figs. 35 and 36, the inlet ports 2 are openly formed in the upper portion of the indoor unit 100 (more specifically, the casing 1 of the indoor unit 100) and the outlet port 3 is openly formed at the lower end of the indoor unit 100 (more specifically, the casing 1 of the indoor unit 100). That is, an air passage communicating the inlet ports 2 and the outlet port 3 is formed in the indoor unit 100. In the air passage below the inlet ports 2, multiple fans 20 with impellers 25 are provided along the left-right direction (longitudinal direction). Note that in Embodiment 8, three fans (fans 20A to 20Ca) are provided. In the fans 20A to 20C, the center of the rotation shaft of each impeller 25 is provided in a substantially vertical direction. The fans 20A to 20C are connected to blower fan control means 171 of the controller 281 through their respective motor drivers 282A to 282C. Note that further details of the controller 281 will be described below.

[0187] Further, the heat exchanger 50 that cools or heats air by exchanging heat is arranged under the fans 20A to 20C. As shown by the hollow arrows of Fig. 35, when the fans 20A to 20C are activated, the fans 20A to 20C suction the air from a room through the inlet ports 2 into the air passage inside the indoor unit 100, cools or heats the suction air with the heat exchanger 50 disposed under the fans 20A to 20C, and blows the air from the outlet port 3 into the room.

[0188] Further, the indoor unit 100 according to Embodiment 8 is disposed with a noise cancellation mechanism used in the active noise reduction. The noise cancellation mechanism of the indoor unit 100 according to Embodiment 8 includes noise detection microphones 161 and 162, control speakers 181 and 182, noise cancellation effect detection microphones 191 and 192, and signal processing devices 201 and 202. That is, the noise cancellation mechanism of the indoor unit 100 according to Embodiment 8 includes two noise detection microphones, two control speakers, and two noise cancellation effect detection microphones. The noise cancellation mechanism including the noise detection microphone 161, the control speaker 181, the noise cancellation effect detection microphone 191, and the signal processing device 201 is, hereinafter, referred to as a noise cancellation mechanism A. Further, the noise cancellation mechanism including the noise detection microphone 162, the control speaker 182, the noise cancellation effect detection microphone 192, and the signal processing device 202 is, hereinafter, referred to as a noise cancellation mechanism B.

[0189] The noise detection microphones 161 and 162 are noise detection devices that detect the operation sound (noise) of the indoor unit 100 including the blast noise of the fans 20A to 20C (noise emitted from the fans 20A to 20C). The noise detection microphones 161 and 162 are provided at positions on the downstream side of the fans 20A to 20C (for example, between the fans 20A to 20C and the heat exchanger 50). Further, the noise detection microphone 161 is provided on the left side of the indoor unit 100 and the noise detection microphone 162 is provided on the right side of the indoor unit 100.

[0190] The control speakers 181 and 182 are control sound output devices that each outputs a control sound corresponding to the noise. The control speakers 181 and 182 are disposed at positions on the downstream side of the noise detection microphones 161 and 162, respectively, (for example, on the downstream side of the heat exchanger 50). Further, the control speaker 181 is provided on the left side of the indoor unit 100 and the control speaker 182 is provided on the right side of the indoor unit 100. Furthermore, the control speakers 181 and 182 are disposed to face the middle of the air passage from the wall of the casing 1.

[0191] The noise cancellation effect detection microphones 191 and 192 are noise cancellation effect detection devices that detect the noise cancellation effect of the control sound. The noise cancellation effect detection microphones 191 and 192 are disposed at positions on the downstream side of the control speakers 181 and 182, respectively. Further, the noise cancellation effect detection microphone 191 is disposed substantially on the extended line of the rotation shaft of the fan 20A, for example, and the noise cancellation effect detection microphone 192 is disposed substantially on the extended line of the rotation shaft of the fan 20C, for example. Note that in Embodiment 8, the noise cancellation effect detection microphones 191 and 192 are disposed on the nozzle 6 that forms the outlet port 3. That is, the noise cancellation effect detection microphones 191 and 192 detect the noise coming out from the outlet port 3 to detect the noise cancellation effect.

[0192] The configurations of the signal processing devices 201 and 202 are exactly the same as the configuration illustrated in Fig. 8 described in Embodiment 1.

[0193] Fig. 37 is a block diagram illustrating the controller according to Embodiment 8 of the invention.

Each of the operations and means described below are implemented by executing a program that is embedded in the controller 281 that is provided in the indoor unit 100. The controller 281 mainly includes an input unit 130 that inputs a signal from an external input device such as the remote control 280, and the like; a CPU 131 that carries out computing in accordance with the embedded program; and a memory 132 that stores data and the program. Further, the CPU 131 includes blower fan control means 171.

[0194] The blower fan control means 171 includes uniform-rotation-speed determination means 133, individual-fan-control rotation-speed determination means 134, and SW 135 in plural number (the same number as that of the fans 20). The uniform-rotation-speed determination means 133 determines the rotation speed of the fans 20A to 20C when all of the fans are to be operated with the same rotation speed, on the basis of operating information input from the remote control 280. Operation information input from the remote control 280 is, for example, operation mode information such as a cooling operation mode, a heating operation mode, and a dehumidifying operation mode; and air volume information such as high, medium, and low. The individual-fan-control rotation-speed determination means 134 determines the rotation speed of each fan when the fans 20A to 20C are to be controlled individually. The SWs 135 switch the rotation control signals of the fans 20A to 20C that are transmitted to motor drivers 282A to 282C, on the basis of the signal input from the remote control 280, for example. That is, the SWs 135 switch between having the fans 20A to 20C to operate with the same rotation speed and having each of the fans 20A to 20C to operate with individual rotation speeds.

[0195] Next, a description is given on operations of the indoor unit 100.

When the indoor unit 100 is operated, the impeller of each of the fans 20A to 20C rotates. Then, the air in the room is suctioned from the upper side of the fans 20A to 20C and is sent to the lower side of the fans 20A to 20C, thereby generating airflow. Accordingly, operation sounds (noise) are generated in the vicinity of the outlet ports of the fans 20A to 20C, and the sounds are propagated to the downstream side. The air sent from the fans 20A to 20C passes through the air passage and is sent to the heat exchanger 50. For example, during a cooling operation, a low-temperature refrigerant is supplied to the heat exchanger 50 from a pipe connected to the outdoor unit (not shown). The air that has been sent to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 so as to become cold air, and is directly released from the outlet port 3 into the room.

[0196] The operations of the noise cancellation mechanism A and the noise cancellation mechanism B are completely the same as that described in Embodiment 1 and are operated so that the control sounds are output to make the noise detected by the noise cancellation effect detection microphones 191 and 192 approach zero, resulting in suppression of noise to the noise cancellation effect detection microphones 191 and 192.

In the active noise reduction method, control sounds that have opposite phases with the noise at the disposed positions (control points) of the noise cancellation effect detection microphones 191 and 192 are output from the control speakers 181 and 182. Accordingly, the noise cancellation effect near each of the noise cancellation effect detection microphones 191 and 192 is high; however, when the distance from each point increases, the phase of the control sound changes. Therefore, at positions with distance from the noise cancellation effect detection microphones 191 and 192, the phase shift between the noise and the control sound becomes large and the noise cancellation effect becomes low.

[0197] A control method of individually controlling the fans 20A to 20C (hereinafter, also referred to as an "individual fan control") will be described next.

Operating information selected with the remote control 280 is input to the controller 281. Operating information is operation mode information such as, for example, a cooling operation mode, a heating operation mode, and a dehumidifying operation mode. Further, air volume information such as high, medium, and low are also input to the controller 281 from the remote control 280 as operating information. The operating information input to the controller 281 is input to the uniform-rotation-speed determination means 133 through the input unit 130. Being input with the operating information, the uniform-rotation-speed determination means 133 determines the rotation speed of the fans 20A to 20C when all of the fans are to be operated with the same rotation speed, on the basis of the input operating information. When the individual fan control is not carried out, the fans 20A to 20C are all controlled with the same rotation speed (hereinafter, also referred to as a "uniform-rotation-speed control").

[0198] Information of the rotation speed (the rotation speed during the uniform-rotation-speed control) determined by the uniform-rotation-speed determination means 133 is input to the individual-fan-control rotation-speed determination means 134. Meanwhile, in the individual-fan-control rotation-speed determination means 134, blower fan information that has been pre-stored in the memory at shipping of the product is read out. The blower fan information is information of the fan 20 that is emitting noise showing a high noise cancellation effect with the interfering control sound. That is, the blower fan information is information of the fans 20 that are highly related to the noise cancellation effect detection microphones 191 and 192. The identification number of each fan 20 is allocated to the corresponding noise cancellation effect detection microphone. In Embodiment 8, the identification numbers of the fans 20 that have the shortest distance (highly related) to the noise cancellation effect detection microphones 191 and 192 are used as the blower fan information. Specifically, the identification numbers are the identification number of the fan 20A that has the shortest distance to the noise cancellation effect detection microphone 191 and the identification number of the fan 20C that has the shortest distance to the noise cancellation effect detection microphone 192.

[0199] The individual-fan-control rotation-speed determination means 134 determines the rotation speed of each fan 20 when the individual fan control is to be carried out, on the basis of the rotation speed information determined by the uniform-rotation-speed determination means 133 and the blower fan information read out from the memory 132. Specifically, the individual-fan-control rotation-speed determination means 134 increases the rotation speed of the fans 20A and 20C that are the most closest to the noise cancellation effect detection microphones 191 and 192 and reduces the rotation speed of the fan 20B that has the most distance from the noise cancellation effect detection microphones 191 and 192. The rotation speed of each of the fans 20A to 20C may be determined such that the air volume obtained when carrying out the individual fan control is the same as that when carrying out the uniform-rotation-speed control. Since the air volume and the rotation speed have a proportionality relation, for example, when with the configuration of Fig. 35, in the case where the rotation speed of the fans 20A and 20C are each increased by 10%, the air volume will be the same if the rotation speed of the fan 20B is decreased by 20%.

[0200] When an operating information signal (for example, such as a signal for a silent mode) is input from the remote control 280 indicating that the individual fan control is to be carried out, by switching the SWs 135, the rotation control signal of the uniform-rotation-speed control is switched to the rotation control signals for the individual fan control. These rotation control signals are output from the controller 281 to the fans 20A to 20c. The rotation control signals output from the controller 281 are input to the motor drivers 282A to 282C and the fans 20A to 20C are controlled to have rotation speeds in accordance with the rotation control signals.

[0201] As described above, when active noise reduction is carried out, although the noise cancellation effect are high at and around each of the noise cancellation effect detection microphones 191 and 192 that are control points of the noise control, the noise cancellation effect is low at positions far from the control points since the phase shift between the noise and the control sound that has been emitted from the control speakers 181 and 182 becomes large. However, in Embodiment 8, by configuring the indoor unit 100 to have the plural fans 20A to 20C, the rotation speed of the fans 20A and 20C that are close in distance to the noise cancellation effect detection microphones 191 and 192 and that show high noise cancellation effects (the fans that emit noise showing high noise cancellation effects) can be increased, and the rotation speed of the fan 20B that is far in distance to the noise cancellation effect detection microphones 191 and 192 (the fan that emits noise showing a low noise cancellation effect) can be reduced.

[0202] As a result, in the indoor unit 100 according to Embodiment 8, since the noise cancellation effect becomes further higher in a region with a high noise cancellation effect and the noise becomes smaller in a region with a low noise cancellation effect, the noise emitted from the entire outlet port 3 can be reduced compared to that of an indoor unit that uses a single fan or to that of an indoor unit that does not perform individual fan control. Further, the above can be achieved without deterioration of aerodynamic performance by controlling the rotation speed of each of the plural fans 20A to 20C so that the air volume is constant.

[0203] Furthermore, as shown in Figs. 38 and 39, by dividing the air passage of the indoor unit 100 into a plurality of regions, the noise cancellation effect can be further increased.

[0204] Fig. 38 is a front view of another exemplary indoor unit according to Embodiment 8 of the invention.

Fig. 39 is a left side view of the indoor unit illustrated in Fig. 38. Note that in Fig. 39, the sidewall of the casing 1 of the indoor unit 100 is seen through. In the indoor unit 100 illustrated in Figs. 38 and 39, by dividing the air passage with the partition plates 90 and 90a, the air passage is separated into a region where the air blown out by the fan 20A passes, a region where the air blown out by the fan 20B passes, and a region where the air blown out by the fan 20C passes. Further, the noise detection microphone 161, the control speaker 181, and the noise cancellation effect detection microphone 191 of the noise cancellation mechanism A are disposed in the region where the air blown out by the fan 20A passes. Furthermore, the noise detection microphone 162, the control speaker 182, and the noise cancellation effect detection microphone 192 of the noise cancellation mechanism B are disposed in the region where the air blown out by the fan 20C passes.

[0205] By configuring the indoor unit 100 as above, the noise emitted by each of the fans 20A to 20C can be separated in their respective areas such that the noise cancellation mechanism A only reduces the noise emitted from the fan 20A and the noise cancellation mechanism B only reduces the noise emitted from the fan 20C. Accordingly, it will be possible to prevent the noise emitted from the fan 20B from being detected by the noise detection microphones 161 and 162 and the noise cancellation effect detection microphones 191 and 192; hence, crosstalk noise components of the noise detection microphones 161 and 162 and the noise cancellation effect detection microphones 191 and 192 are reduced.

[0206] Further, since the air passage is made close to a duct structure, the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, the noise cancellation effect becomes higher still. Meanwhile, by reducing the rotation speed of the fan 20B that is not provided with the noise cancellation mechanism, the noise is made small in the region where there is no noise cancellation mechanism. Accordingly, by configuring the indoor unit 100 as Figs. 38 and 39, noise can be further reduced compared to that of the configuration of Fig. 35. Note that in Figs. 38 and 39, each partition plate is inserted through the entire region of the air passage; however, the partition plate may separate only a portion of the air passage, such that only the upstream side of the heat exchanger 50 or only the downstream side of the heat exchanger 50 is separated, for example.

[0207] Note that in Embodiment 8, the noise detection microphones 161 and 162 are disposed on the two sides of the indoor unit 100; however, the noise detection microphones 161 and 162 may be disposed at any position that are on the upstream side of the control speakers 181 and 182, respectively. Further, in Embodiment 8, the control speakers 181 and 182 are disposed on the two sides of the indoor unit 100; however, the control speakers 181 and 182 may be disposed at any position that are on the downstream side of the noise detection microphones 161 and 162, respectively, and on the upstream side of the noise cancellation effect detection microphones 191 and 192, respectively. Furthermore, in Embodiment 8, the noise cancellation effect detection microphones 191 and 192 are disposed substantially on the extended lines of the rotation shafts of the fans 20A and 20C, respectively; however, the noise cancellation effect detection microphones 191 and 192 may be disposed at any position that are on the downstream side of the control speakers 181 and 182, respectively. Additionally, in Embodiment 8, although two of each of the noise detection microphone, the control speaker, the noise cancellation effect detection microphone, and the signal processing device are disposed, the invention is not limited to this.

[0208] Further, in Embodiment 8, although the blower fan control means 171 is configured in the CPU 131 inside the controller 281, the blower fan control means 171 may be configured by hardware such as a Large Scale Integration (LSI) or a Field Programmable Gate Array (FPGA). Furthermore, the configuration of the blower fan control means 171 is not limited to the configuration illustrated in Fig. 37.

[0209] Moreover, Embodiment 8 is configured such that the blower fan control means 171 increases the rotation speed of the fans 20A and 20C that are close in distance to the noise cancellation effect detection microphones 191 and 192, and reduces the rotation speed of the fan 20B that is far in distance; however, the configuration may be such that either one is performed.

[0210] As described above, in the indoor unit 100 according to Embodiment 8, the plurality of fans 20A to 20C are disposed and a controller 281 (more specifically, blower fan control means 171) that individually controls the rotation speed of each of the fans 20A to 20C is provided. The blower fan control means 171 performs rotation speed control such that the rotation speed of the fans 20A and 20C that are sending air to the regions close to the noise cancellation effect detection microphones 191 and 192, which are regions with high noise cancellation effects, are controlled to be increased and the rotation speed of the fan 20B that is sending air to the region that is far in distance to the noise cancellation effect detection microphones 191 and 192, which is the region with low noise cancellation effect, is controlled to be decreased. Accordingly, the noise cancellation effect becomes further higher in a region with a high noise cancellation effect and the noise becomes smaller in a region with a low noise cancellation effect. Thus, compared to an indoor unit that uses a single fan or to an indoor unit that does not perform individual fan control, having a noise cancellation mechanism with the same configuration, a higher noise reduction effect can be obtained.

[0211] Further, since the blower fan control means 171 controls the rotation speed of each of the fans 20A to 20C so that the air volume emitted from the outlet port 3 is the same between when the individual fan control is performed and when the uniform-rotation-speed control is performed, it is possible to reduce noise without deteriorating the aerodynamic performance.

[0212] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated such that the noise cancellation mechanism A only reduces the noise emitted from the fan 20A and the noise cancellation mechanism B only reduces the noise emitted from the fan 20C. Accordingly, the crosstalk noise components due to the noise emitted from the fan 20B becomes smaller.

[0213] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the air passage is made close to a duct structure and the noise is captured in one dimension. Accordingly, since the phase of the noise propagating through the indoor unit 100 becomes uniform, phase error with the interfering control sound becomes small. Furthermore, by reducing the rotation speed of the fan 20B that is not provided with the noise cancellation mechanism, the noise in the region where there is no noise cancellation mechanism becomes small, and, compared to the configuration of Fig. 35, it will be possible to obtain a further higher noise reduction effect.

Embodiment 9

[0214] Not limited to the configuration of Fig. 8, the individual fan control may be performed on the basis of the noise cancellation effect detected by the noise cancellation effect detection microphone. Note that, in Embodiment 9, points different from that of Embodiment 8 described above will be mainly described and same parts as Embodiment 8 will be referred to with the same reference numerals.

[0215] Fig. 40 is a front view of the indoor unit according to Embodiment 9 of the invention.
The indoor unit 100 according to Embodiment 9 is different from the indoor unit 100 according to Embodiment 8 in that the indoor unit 100 according to Embodiment 9 is provided with a noise cancellation mechanism C (a noise detection microphone 163, a control speaker 183, a noise cancellation effect detection microphone 193, and a signal processing device 203). The configuration of the signal processing device 203 is completely the same as those of the signal processing devices 201 and 202. Note that the mounting positions of the noise detection microphone 163, the control speaker 183, and the noise cancellation effect detection microphone 193 are, similar to that of Embodiment 8, and it is only sufficient that the noise detection microphone 163, the control speaker 183, and the noise cancellation effect detection microphone 193 are disposed from the downstream side of the fan 20B in this order.

[0216] Further, the indoor unit 100 of Embodiment 9 is different from the indoor unit 100 of Embodiment 8 in that signal lines (signal lines to transmit signals S1, S2, and S3) that are connected from the signal processing devices 201 to 203 to blower fan control means 172 are provided. Accordingly, the configuration of the blower fan control means 172 is different from the configuration of the blower fan control means 171 according to Embodiment 8. Specifically, the signals S1, S2, and S3 that are transmitted to the blower fan control means 172 from the signal processing devices 201 to 203 are signals that has been input from the noise cancellation effect detection microphones 191 to 193, that has passed through the microphone amplifier 151, and that has been digitally converted by the A/D converter 152. That is, the signals S1, S2, and S3 are digital values of the sound pressure levels detected by the noise cancellation effect detection microphones 191 to 193.

[0217] The configuration of the blower fan control means 172 will be described next.
Fig. 41 is a block diagram illustrating the controller according to Embodiment 9 of the invention. Each of the operations and means described below are implemented by executing a program that is built-in in the controller 281 provided in the indoor unit 100. Similar to the configuration described in Embodiment 8, the controller 281 mainly includes the input unit 130 that inputs a signal from an external input device such as the remote control 280, and the like; the CPU 131 that carries out computing in accordance with the embedded program; and the memory 132 that stores data and the program. Further, the CPU 131 includes the blower fan control means 172.

[0218] The blower fan control means 172 includes the uniform-rotation-speed determination means 133, averaging means 136 in plural number (the same number as that of the noise cancellation effect detection microphones) individual-fan-control rotation-speed determination means 134A, and the SW 135 in plural number (the same number as that of the fans 20). The uniform-rotation-speed determination means 133 determines the rotation speed of the fans 20A to 20C when all of the fans are to be operated with the same rotation speed, on the basis of the operating information input from the remote control 280. Operation information input from the remote control 280 is, for example, operation mode information such as a cooling operation mode, a heating operation mode, and a dehumidifying operation mode; and air volume information such as high, medium, and low. The averaging means 136 are input with digital values S1, S2, and S3 of the sound pressure levels detected by the noise cancellation effect detection microphones 191 to 193. The averaging means 136 average these signals S1, S2, and S3 for a set time.

[0219] The individual-fan-control rotation-speed determination means 134A determines the rotation speed of each fan when the fans 20A to 20C are to be controlled individually, on the basis of the averaged signals of S1, S2, and S3, which has been averaged by the averaging means 136, and the rotation speed information input from the uniform-rotation-speed determination means 133. The SWs 135 switch the rotation control signals of the fans 20A to 20C that are transmitted to the motor drivers

282A to 282C, on the basis of the signal input from the remote control 280, for example. That is, the SWs 135 switch between having the fans 20A to 20C to operate with the same rotation speed (to perform the uniform-rotation-speed control) and having each of the fans 20A to 20C to operate with individual rotation speeds (to perform the individual fan control).

[0220] Next, a description is given on operations of the indoor unit 100.

Similar to Embodiment 8, when the indoor unit 100 is operated, the impeller of each of the fans 20A to 20C rotates. Then, the air in the room is suctioned from the upper side of the fans 20A to 20C and is sent to the lower side of the fans 20A to 20C, thereby generating airflow. Accordingly, operation sounds (noise) are generated in the vicinity of the outlet ports of the fans 20A to 20C, and the sounds are propagated to the downstream side. The air sent from the fans 20A to 20C passes through the air passage and is sent to the heat exchanger 50. For example, during a cooling operation, a low-temperature refrigerant is supplied to the heat exchanger 50 from a pipe connected to the outdoor unit (not shown). The air that has been sent to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 so as to become cold air, and is directly released from the outlet port 3 into the room.

[0221] Further, the operations of the noise cancellation mechanisms A to C are also completely the same as that described in Embodiment 8 and are operated so that the control sounds are output to make the noise detected by the noise cancellation effect detection microphones 191 to 193 approach zero, resulting in suppression of noise to the noise cancellation effect detection microphones 191 to 193.

[0222] Note that in the indoor unit 100 according to Embodiment 9, other than the noise emitted from the fan 20B, the noise cancellation effect detection microphone 193 picks up noise that are emitted from the neighboring fans 20A and 20C (crosstalk noise components). On the other hand, the crosstalk noise components that are detected by the noise cancellation effect detection microphones 191 and 192 are smaller than the crosstalk noise components that are detected by the noise cancellation effect detection microphone 193. This is because the noise cancellation effect detection microphones 191 and 192 each have only one neighboring fan 20 (fan 20B). Accordingly, the noise cancellation effect of the noise cancellation mechanisms A and B are higher compared to that of the noise cancellation mechanism C.

[0223] Individual fan control of the fans 20A to 20C according to Embodiment 9 will be described next.

Operating information selected with the remote control 280 is input to the controller 281. As described above, the operating information is operation mode information such as, for example, a cooling operation mode, a heating operation mode, and a dehumidifying operation mode. Further, air volume information such as high, medium, and low are also input to the controller 281 from the remote control 280 as operating information. The operating information input to the controller 281 is input to the uniform-rotation-speed determination means 133 through the input unit 130. Being input with the operating information, the uniform-rotation-speed determination means 133 determines the rotation speed of the fans 20A to 20C when uniform-rotation-speed control is to be performed, on the basis of the input operating information.

[0224] Meanwhile, the S1 to S3 (digital values of the sound pressure levels that has been detected by the noise cancellation effect detection microphones 191 to 193) input to the averaging means 136 from the signal processing devices 201 to 203 are averaged for a set time in the averaging means 136.

[0225] Information of the averaged sound pressure level value of each of S1 to S3 and information of the rotation speed (the rotation speed during the uniform-rotation-speed control) determined by the uniform-rotation-speed determination means 133 are input to the individual-fan-control rotation-speed determination means 134A. The individual-fan-control rotation-speed determination means 134A determines the rotation speed of each fan 20 when individual fan control is to be performed, on the basis of these information. Specifically, the rotation speed of the fan is determined such that the rotation speed of the fan that is close in distance (highly related) to the noise cancellation effect detection microphone that has a small averaged sound pressure level value is increased and the rotation speed of the fan that is close in distance (highly related) to the noise cancellation effect detection microphone that has a large averaged sound pressure level value is reduced. The rotation speed of each of the fans 20A to 20C may be determined such that the air volume obtained when carrying out the individual fan control is the same as that when carrying out the uniform-rotation-speed control.

[0226] For example, in the indoor unit 100 according to Embodiment 9, when the mean value of the noise level detected by the noise cancellation effect detection microphone 191 is 45 dB, the mean value of the noise level detected by the noise cancellation effect detection microphone 192 is 45 dB, and the mean value of the noise level detected by the noise cancellation effect detection microphone 193 is 50 dB, then the individual-fan-control rotation-speed determination means 134A determines the rotation speed of each fan 20 such that the rotation speed of the fans 20A and 20C are increased and the rotation speed of the fan 20B is reduced. Since the air volume and the rotation speed have a proportionality relation, for example, when with the configuration of Fig. 40, in the case where the rotation speed of the fans 20A and 20C are each increased by 10%, the air volume will be the same if the rotation speed of the fan 20B is decreased by 20%.

[0227] Note that the above-described determination method of the rotation speed of the fans 20A to 20C is exemplary and explanatory only. For example, when the mean value of the noise level detected by the noise cancellation effect detection microphone 191 is 45 dB, the mean value of the noise level detected by the noise cancellation effect detection microphone 192 is 47 dB, and the mean value of the noise level detected by the noise cancellation effect detection microphone 193 is 50 dB, then the rotation speed of each fan 20 may be determined such that the rotation speed of the fan 20A is increased, the rotation speed of the fan 20B is reduced, and the rotation speed of the fan 20C is kept the same. That is, the rotation speed of each fan 20 may be determined such that the rotation speed of the fan 20A that is close in distance to the noise cancellation effect detection microphone 191 that has the smallest detected noise level is increased, the rotation speed of the fan 20B that is close in distance to the noise cancellation effect detection microphone 193 that has the largest detected noise level is reduced, and the rotation speed of the fan 20C that is neither of the above is kept the same.

[0228] When an operating information signal (for example, such as a signal for a silent mode) is input from the remote control 280 indicating that the individual fan control is to be carried out, by switching the SWs 135, the rotation control signal of the uniform-rotation-speed control is switched to the rotation control signals for the individual fan control. These rotation control signals are output from the controller 281 to the fans 20A to 20c. The rotation control signals output from the controller 281 are input to the motor drivers 282A to 282C and the fans 20A to 20C are controlled to have rotation speeds in accordance with the rotation control signals.

[0229] Here, as described above, in the case of the indoor unit 100 according to Embodiment 9, compared to the noise cancellation effect in the region in the vicinity of the noise cancellation effect detection microphone 193, the noise cancellation effect in the regions in the vicinity of the noise cancellation effect detection microphones 191 and 192 are higher in accordance with the size of the crosstalk noise components from the neighboring fan(s). That is, in the case of the indoor unit 100 according to Embodiment 9, the detected noise levels are smaller in the region in the vicinity of the noise cancellation effect detection microphones 191 and 192 compared to that in the region in the vicinity of the noise cancellation effect detection microphone 193. Meanwhile, the noise cancellation effect in the region in the vicinity of the noise cancellation effect detection microphone 193 becomes lower. Now, as regards the indoor unit 100 according to Embodiment 9 provided with plural fans 20A to 20C, the rotation speed of the fans 20A and 20C that are close in distance to the noise cancellation effect detection microphones 191 and 192 that have small mean values of the detected noise level values, among the mean values of the noise level values detected by the noise cancellation effect detection microphones 191 to 193, are increased, and the rotation speed of the fan 20B that is close in distance to the noise cancellation effect detection microphone 193 that has a large mean value of the detected noise level values, among the mean values of the noise level values detected by the noise cancellation effect detection microphones 191 to 193, is reduced.

[0230] As a result, in the indoor unit 100 according to Embodiment 9, since the noise cancellation effect becomes further higher in a region with a high noise cancellation effect and the noise becomes smaller in a region with a low noise cancellation effect, the noise emitted from the entire outlet port 3 can be reduced compared to that of an indoor unit that uses a single fan or to that of an indoor unit that does not perform individual fan control.

[0231] Furthermore, as shown in Figs. 42 and 43, by dividing the air passage of the indoor unit 100 into a plurality of regions, the noise cancellation effect can be further increased.

[0232] Fig. 42 is a front view of another exemplary indoor unit according to Embodiment 9 of the invention. Fig. 43 is a left side view of the indoor unit illustrated in Fig. 42. Note that in Fig. 43, a view is illustrated while the sidewall of the casing 1 of the indoor unit 100 is seen through. In the indoor unit 100 illustrated in Figs. 42 and 43, by dividing the air passage with the partition plates 90 and 90a, the air passage is separated into a region where the air blown out by the fan 20A passes, a region where the air blown out by the fan 20B passes, and a region where the air blown out by the fan 20C passes. Further, the noise detection microphone 161, the control speaker 181, and the noise cancellation effect detection microphone 191 of the noise cancellation mechanism A are disposed in the region where the air blown out by the fan 20A passes. Furthermore, the noise detection microphone 162, the control speaker 182, and the noise cancellation effect detection microphone 192 of the noise cancellation mechanism B are disposed in the region where the air blown out by the fan 20C passes. Still further, the noise detection microphone 163, the control speaker 183, and the noise cancellation effect detection microphone 193 of the noise cancellation mechanism C are disposed in the region where the air blown out by the fan 20B passes.

[0233] By configuring the indoor unit 100 as above, the noise emitted by each of the fans 20A to 20C can be separated in their respective areas such that the noise cancellation mechanism A only reduces the noise emitted from the fan 20A, the noise cancellation mechanism B only reduces the noise emitted from the fan 20C, and the noise cancellation mechanism C only reduces the noise emitted from the fan 20B. Accordingly, the crosstalk noise components (noise emitted from the fan(s) provided in the neighboring passage(s)) detected by the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193 become smaller.

[0234] Further, since the air passage is made close to a duct structure, the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, the noise cancellation effect becomes higher still. Accordingly, by configuring the indoor unit 100 as Figs. 42 and 43, noise can be further reduced compared to that of the configuration of Fig. 40. Note that in Figs. 42 and 43, the partition plates are inserted through the entire air passage regions; however, the partition plates may separate only a portion of the air passages, such that only the upstream side of the heat exchanger 50 or only the downstream side of the heat exchanger 50 is separated, for example. Further, similar to Embodiment 8, even in a case such as the one of Fig. 44 in which there is a fan 20 provided with no noise cancellation mechanisms (in Fig. 44, the noise cancellation mechanism C is not provided to the fan 20B), a similar noise cancellation effect can be obtained by reducing the rotation speed of the fan 20 so that the noise in the region that is not provided with any noise cancellation mechanism is reduced.

[0235] Note that the installation position of each of the noise detection microphones 161 to 163 may be any position that is on the upstream side of the corresponding control speakers 181 to 183. Further, the installation position of each of the control speakers 181 to 183 may be any position that is on the downstream side of the corresponding noise detection microphones 161 to 163 and on the upstream side of the corresponding noise cancellation effect detection microphones 191 to 193. Furthermore, in Embodiment 9, the noise cancellation effect detection microphones 191 to 193 are disposed substantially on the extended lines of the rotation shafts of the fans 20A to 20C, respectively; however, the noise cancellation effect detection microphones 191 to 193 may be disposed at any position that are on the downstream side of the control speakers 181 to 183, respectively. Additionally, in Embodiment 9, although two to three of each of the noise detection microphone, the control speaker, the noise cancellation effect detection microphone, and the signal processing device are disposed, the invention is not limited to this.

[0236] Further, in Embodiment 9, although the blower fan control means 172 is configured in the CPU 131 inside the controller 281, it may be configured by hardware such as a Large Scale Integration (LSI) or a Field Programmable Gate Array (FPGA). Furthermore, the configuration of the blower fan control means 172 is not limited to the configuration illustrated in Fig. 41.

[0237] Moreover, Embodiment 9 is configured such that the blower fan control means 172 increases the rotation speed of the fans 20A and 20C that are close in distance to the noise cancellation effect detection microphones 191 and 192 having small noise levels, and reduces the rotation speed of the fan 20B that is close in distance to the noise cancellation effect detection microphone 193 having a large noise level; however, the configuration may be such that either one is performed.

[0238] As described above, the indoor unit 100 according to Embodiment 9 is disposed with the plural fans 20A to 20C and is provided with the controller 281 (more specifically, the blower fan control means 172) that individually controls the rotation speed of each of the fans 20A to 20C. The blower fan control means 172 performs rotation speed control such that the rotation speed of the fan that is close in distance to the noise cancellation effect detection microphone that has detected a small noise level, among the mean values of the noise level detected by the noise cancellation effect detection microphones 191 to 193, is increased, and the rotation speed of the fan close in distance to the noise cancellation effect detection microphone that has detected a large noise level, among the mean values of the noise level detected by the noise cancellation effect detection microphones 191 to 193, is reduced. Accordingly, the noise cancellation effect becomes further higher in the region with a high noise cancellation effect (that is, the region with small noise level) and the noise becomes smaller in the region with a low noise cancellation effect (that is, the region with large noise level). Thus, compared to an indoor unit that uses a single fan or to an indoor unit that does not perform individual fan control, having a noise cancellation mechanism with the same configuration, the noise can be further reduced.

[0239] Further, since the blower fan control means 172 controls the rotation speed of each of the fans 20A to 20C so that the air volume emitted from the outlet port 3 is the same between when the individual fan control is performed and when the uniform-rotation-speed control is performed, it is possible to reduce noise without deteriorating the aerodynamic performance.

[0240] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated such that the noise cancellation mechanism A only reduces the noise emitted from the fan 20A, the noise cancellation mechanism B only reduces the noise emitted from the fan 20C, and the noise cancellation mechanism C only reduces the noise emitted from the fan 20B. Accordingly, in each of the regions, the crosstalk noise components due to the noise emitted from the neighboring region(s) becomes smaller.

[0241] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the air passage is made close to a duct structure and the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, compared to the configuration of Fig. 40, a higher noise cancellation effect can be obtained. Further, even in a case such as the one of Fig. 44 in which there is a fan 20 provided with no noise cancellation mechanisms, a similar noise cancellation effect can be obtained by reducing the rotation speed of the fan 20 so that the noise in the region that is not provided with any noise cancellation mechanism is reduced.

Embodiment 10

[0242] When the individual fan control is performed on the basis of the noise cancellation effect detected by the noise cancellation effect detection microphone, the individual fan control may be performed as below, for example. Note that, in Embodiment 10, points different from that of Embodiment 8 or Embodiment 9 described above will be mainly described, and same parts as Embodiment 8 or Embodiment 9 will be referred to with the same reference numerals.

[0243] Fig. 45 is a front view of the indoor unit according to Embodiment 10 of the invention.

The indoor unit 100 according to Embodiment 10 is different from the indoor unit 100 according to Embodiment 9 in that the indoor unit 100 according to Embodiment 10 is further provided with signal lines (signal lines to transmit signals T1, T2, and T3) that are connected to the blower fan control means 173 from the signal processing devices 201 to 203. Accordingly, the configuration of the blower fan control means 173 is different from the configuration of the blower fan control means 172 according to Embodiment 9. Specifically, similar to Embodiment 9, the signals S1, S2, and S3 that are transmitted to the blower fan control means 173 from the signal processing devices 201 to 203 are signals that has been input from the noise cancellation effect detection microphones 191 to 193, that has passed through the microphone amplifier 151, and that has been digitally converted by the A/D converter 152. That is, the signals S1, S2, and S3 are digital values of the sound pressure levels detected by the noise cancellation effect detection microphones 191 to 193. Further, the newly added signals T1, T2, and T3 are digital signals that are signals input from the noise detection microphones 161 to 163, that has passed through the microphone amplifier 151, and that has been digitally converted by the A/D converter 152. That is, the signals T1, T2, and T3 are digital values of the sound pressure levels detected by the noise detection microphones 161 to 163.

[0244] The configuration of the blower fan control means 173 will be described next.

Fig. 46 is a block diagram illustrating a controller according to Embodiment 10 of the invention. Each of the operations and means described below are implemented by executing a program that is built-in in the controller 281 provided in the indoor unit 100. Similar to the configuration described in Embodiment 9, the controller 281 mainly includes the input unit 130 that inputs a signal from an external input device such as the remote control 280, and the like; the CPU 131 that carries out computing in accordance with the embedded program; and the memory 132 that stores data and the program. Further, the CPU 131 includes the blower fan control means 173.

[0245] The blower fan control means 173 includes the uniform-rotation-speed determination means 133, coherence computing means 137 in plural number (the same number as that of the noise cancellation effect detection microphones) individual-fan-control rotation-speed determination means 134B, and the SW 135 in plural number (the same number as that of the fans 20). The uniform-rotation-speed determination means 133 determines the rotation speed of the fans 20A to 20C when all of the fans are to be operated with the same rotation speed, on the basis of the operating information input from the remote control 280. Operation information input from the remote control 280 is, for example, operation mode information such as a cooling operation mode, a heating operation mode, and a dehumidifying operation mode; and air volume information such as high, medium, and low. The coherence computing means 137 are input with digital values S1, S2, and S3 of the sound pressure levels detected by the noise cancellation effect detection microphones 191 to 193 and with digital values T1, T2, and T3 of the sound pressure levels detected by the noise detection microphones 161 to 163. The coherence computing means 137 calculate the coherence between S1 and T1, S2 and T2, and S3 and T3.

[0246] The individual-fan-control rotation-speed determination means 134B determines the rotation speed of each fan when the fans 20A to 20C are to be controlled individually, on the basis of the coherence values computed by the coherence computing means 137 and the rotation speed information input from the uniform-rotation-speed determination means 133. The SWs 135 switch the rotation control signals of the fans 20A to 20C that are transmitted to the motor drivers 282A to 282C, on the basis of the signal input from the remote control 280, for example. That is, the SWs 135 switch between having the fans 20A to 20C to operate with the same rotation speed (to perform the uniform-rotation-speed control) and having each of the fans 20A to 20C to operate with individual rotation speeds (to perform the individual fan control).

[0247] Next, a description is given on operations of the indoor unit 100.

Similar to Embodiment 9, when the indoor unit 100 is operated, the impeller of each of the fans 20A to 20C rotates. Then, the air in the room is suctioned from the upper side of the fans 20A to 20C and is sent to the lower side of the fans 20A to 20C, thereby generating airflow. Accordingly, operation sounds (noise) are generated in the vicinity of the outlet ports of the fans 20A to 20C, and the sounds are propagated to the downstream side. The air sent from the fans 20A to 20C passes through the air passage and is sent to the heat exchanger 50. For example, during a cooling operation, a low-temperature refrigerant is supplied to the heat exchanger 50 from a pipe connected to the outdoor unit (not shown). The air that has been sent to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 so as to become cold air, and is directly released from the outlet port 3 into the room.

[0248] Further, the operations of the noise cancellation mechanisms A to C are also completely the same as that described in Embodiment 9 and are operated so that the control sounds are output to make the noise detected by the noise cancellation effect detection microphones 191 to 193 approach zero, resulting in suppression of noise to the noise cancellation effect detection microphones 191 to 193.

[0249] Generally, the coherence values between the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193 greatly influence the noise cancellation effect of the active noise reduction. That is, unless the coherence between the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193 is high, noise cancellation effect cannot be expected. Conversely, the noise cancellation effect can be estimated by coherence values between the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193.

[0250] Accordingly, on the basis of the coherence values between the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193, the indoor unit 100 (more specifically, the blower fan control means 173 of the controller 281) according to Embodiment 10 controls the rotation speed of the fans 20A to 20C such that the rotation speed of a fan in a region estimated to have a high noise cancellation effect is increased and the rotation speed of a fan in a region estimated to have a low noise cancellation effect is reduced.

[0251] Individual fan control of the fans 20A to 20C according to Embodiment 10 will be described next.
Operating information selected with the remote control 280 is input to the controller 281. As described above, the operating information is operation mode information such as, for example, a cooling operation mode, a heating operation mode, and a dehumidifying operation mode. Further, air volume information such as high, medium, and low are also input to the controller 281 from the remote control 280 as operating information. The operating information input to the controller 281 is input to the uniform-rotation-speed determination means 133 through the input unit 130. Being input with the operating information, the uniform-rotation-speed determination means 133 determines the rotation speed of the fans 20A to 20C when uniform-rotation-speed control is to be performed, on the basis of the input operating information.

[0252] Meanwhile, the coherence values between the corresponding microphones, that is, the coherence values between the digital values S1 to S3 of the sound pressure levels that has been detected by the noise cancellation effect detection microphones 191 to 193 and the digital values T1, T2, and T3 of the sound pressure levels detected by the noise detection microphones 161 to 163, which are input from the signal processing devices 201 to 203, are obtained by the coherence computing means 137.

[0253] Information of the coherence values computed by the coherence computing means 137 and information of the rotation speed (the rotation speed during the uniform-rotation-speed control) determined by the uniform-rotation-speed determination means 133 is input to the individual-fan-control rotation-speed determination means 134B. The individual-fan-control rotation-speed determination means 134B determines the rotation speed of each fan when individual fan control is to be performed, on the basis of these information. Specifically, the rotation speed of the fan is determined such that the rotation speed of the fan that is close in distance (highly related) to the noise cancellation effect detection microphone having a high coherence value is increased and the rotation speed of the fan that is close in distance (highly related) to the noise cancellation effect detection microphone having a low coherence value is reduced. The rotation speed of each of the fans 20A to 20C may be determined such that the air volume obtained when carrying out the individual fan control is the same as that when carrying out the uniform-rotation-speed control.

[0254] For example, in the indoor unit 100 according to Embodiment 10, when the coherence value between the noise detection microphone 161 and the noise cancellation effect detection microphone 191 is 0.8, the coherence value between the noise detection microphone 162 and the noise cancellation effect detection microphone 192 is 0.8, and the coherence value between the noise detection microphone 163 and the noise cancellation effect detection microphone 193 is 0.5, then the individual-fan-control rotation-speed determination means 134B determines the rotation speed of each fan such that the rotation speed of the fans 20A and 20C are increased and the rotation speed of the fan 20B is reduced. Since the air volume and the rotation speed have a proportionality relation, for example, when with the configuration of Fig. 45, in the case where the rotation speed of the fans 20A and 20C are each increased by 10%, the air volume will be the same if the rotation speed of the fan 20B is decreased by 20%.

[0255] Note that the above-described determination method of the rotation speed of the fans 20A to 20C is exemplary and explanatory only. For example, when the coherence value between the noise detection microphone 161 and the noise cancellation effect detection microphone 191 is 0.8, the coherence value between the noise detection microphone 162 and the noise cancellation effect detection microphone 192 is 0.7, and the coherence value between the noise detection microphone 163 and the noise cancellation effect detection microphone 193 is 0.5, then the rotation speed of each fan may be determined such that the rotation speed of the fan 20A is increased, the rotation speed of the fan 20B is reduced, and the rotation speed of the fan 20C is kept the same. That is, the rotation speed of each fan may be determined such that the rotation speed of the fan 20A that is close in distance to the noise cancellation effect detection microphone 191 having the highest coherence value is increased, the rotation speed of the fan 20B that is close in distance to the noise cancellation effect detection microphone 193 having the lowest coherence value is reduced, and the rotation speed of the fan 20C that is neither of the above is kept the same.

[0256] When an operating information signal (for example, such as a signal for a silent mode) is input from the remote control 280 indicating that the individual fan control is to be carried out, by switching the SWs 135, the rotation control signal of the uniform-rotation-speed control is switched to the rotation control signals for the individual fan control. These rotation control signals are output from the controller 281 to the fans 20A to 20c. The rotation control signals output from the controller 281 are input to the motor drivers 282A to 282C and the fans 20A to 20C are controlled to have rotation speeds in accordance with the rotation control signals.

[0257] As described above, when using active noise reduction, the expected noise cancellation effect differs depending on the coherence values between the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193. That is, it can be estimated that the noise cancellation effect detection microphone with a high coherence value has a high noise cancellation effect and that the noise cancellation effect detection microphone with a low coherence value has a low noise cancellation effect. Now, as regards the indoor unit 100 according to Embodiment 10 provided with plural fans 20A to 20C, the rotation speed of the fan that is close in distance to the noise cancellation effect detection microphone having a high coherence value is increased and the rotation speed of the fan that is closed in distance to the noise cancellation effect detection microphone having a low coherence value is decreased.

[0258] As a result, in the indoor unit 100 according to Embodiment 10, the noise cancellation effect becomes further higher in a region estimated to have a high noise cancellation effect and the noise becomes smaller in the region estimated to have a low noise cancellation effect. Thus, compared to an indoor unit that uses a single fan or to an indoor unit that does not perform individual fan control, the noise emitted from the entire outlet port 3 can be reduced. Further, in the indoor unit 100 according to Embodiment 10, deterioration of aerodynamic performance can be suppressed by individually controlling the rotation speed of the plural fans 20A to 20C so that the air volume is uniform to the air volume when uniform-rotation-speed control is performed.

[0259] Furthermore, as shown in Figs. 42 and 43 of Embodiment 9, by dividing the air passage of the indoor unit 100 into a plurality of regions, the noise cancellation effect can be further increased. That is, the noise emitted by each of the fans 20A to 20C can be separated in their respective areas such that the noise cancellation mechanism A only reduces the noise emitted from the fan 20A, the noise cancellation mechanism B only reduces the noise emitted from the fan 20C, and the noise cancellation mechanism C only reduces the noise emitted from the fan 20B. Accordingly, noise, the crosstalk noise components (noise emitted from the fan(s) provided in the neighboring passage(s)) detected by the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193 become smaller.

[0260] Further, since the air passage is made close to a duct structure, the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, the noise cancellation effect becomes higher still. Accordingly, by dividing the air passage of the indoor unit 100 into a plurality of regions, noise can be further reduced compared to that of the configuration of Fig. 45. Note that, similar to Fig. 44 of Embodiment 9 in a case in which there is a fan provided with no noise cancellation mechanisms, a similar noise cancellation effect can be obtained by reducing the rotation speed of the fan 20 so that the noise in the region that is not provided with any noise cancellation mechanism is reduced.

[0261] Note that the installation position of each of the noise detection microphones 161 to 163 according to Embodiment 10 may be any position that is on the upstream side of the corresponding control speakers 181 to 183. Further, the installation position of each of the control speakers 181 to 183 may be any position that is on the downstream side of the corresponding noise detection microphones 161 to 163 and on the upstream side of the corresponding noise cancellation effect detection microphones 191 to 193. Furthermore, in Embodiment 10, the noise cancellation effect detection microphones 191 to 193 are disposed substantially on the extended lines of the rotation shafts of the fans 20A to 20C, respectively; however, the noise cancellation effect detection microphones 191 to 193 may be disposed at any position that are on the downstream side of the control speakers 181 to 183, respectively. Additionally, in Embodiment 10, although three of each of the noise detection microphone, the control speaker, the noise cancellation effect detection microphone, and the signal processing device are disposed, the invention is not limited to this.

[0262] Further, in Embodiment 10, although the blower fan control means 173 is configured in the CPU 131 inside the controller 281, it may be configured by hardware such as a Large Scale Integration (LSI) or a Field Programmable Gate Array (FPGA). Furthermore, the configuration of the blower fan control means 173 is not limited to the configuration illustrated in Fig. 46.

[0263] Moreover, Embodiment 10 is configured such that the blower fan control means 173 increases the rotation speed of the fans 20A and 20C that are close in distance to the noise cancellation effect detection microphones 191 and 192 having high coherence values, and reduces the rotation speed of the fan 20B that is close in distance to the noise cancellation effect detection microphone 193 having a low coherence value; however, the configuration may be such that either one is performed.

[0264] As described above, the indoor unit 100 according to Embodiment 10 is disposed with the plural fans 20A to 20C and is provided with the controller 281 (more specifically, the blower fan control means 173) that individually controls the rotation speed of each of the fans 20A to 20C. The blower fan control means 173 performs rotation speed control such that, after calculating the coherence values between the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193, the rotation speed of the fan that is close in distance to the noise cancellation effect detection microphone having a high coherence value with the noise detection microphone is increased, and the rotation speed of the fan close in distance to the noise cancellation effect detection microphone having a low coherence value with the noise detection microphone is reduced. As a result, the noise cancellation effect becomes further higher in a region where a high noise cancellation effect can be expected and the noise becomes smaller in the region where a noise cancellation effect cannot be expected. Thus, compared to an indoor unit that uses a single fan or to an indoor unit that does not perform individual fan control, having a noise cancellation mechanism with the same configuration, the noise can be further reduced.

[0265] Further, since the blower fan control means 173 controls the rotation speed of each of the fans 20A to 20C so that the air volume emitted from the outlet port 3 is the same between when the individual fan control is performed and when the uniform-rotation-speed control is performed, it is possible to reduce noise without deteriorating the aerodynamic performance.

[0266] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated such that the noise cancellation mechanism A only reduces the noise emitted from the fan 20A, the noise cancellation mechanism B only reduces the noise emitted from the fan 20C, and the noise cancellation mechanism C only reduces the noise emitted from the fan 20B. Accordingly, in each of the regions, the crosstalk noise components due to the noise emitted from the neighboring region(s) becomes smaller.

[0267] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the air passage is made close to a duct structure and the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, compared to the configuration of Fig. 45, a higher noise cancellation effect can be obtained. Further, even in a case in which there is a fan 20 provided with no noise cancellation mechanisms, a similar noise cancellation effect can be obtained by reducing the rotation speed of the fan 20 so that the noise in the region that is not provided with any noise cancellation mechanism is reduced.

[0268] Furthermore, in the indoor unit 100 according to Embodiment 10, rotation speed control is performed on the basis of the coherence values between the noise detection microphones and the noise cancellation effect detection microphones. Since the theoretical noise cancellation effect can be estimated from the coherence values, it is possible to control the rotation speed of the fans more optimally and finely on the basis of the coherence values of each of the noise cancellation effect detection microphones. Accordingly, the indoor unit 100 according to Embodiment 10 can further obtain a higher noise cancellation effect compared to those of the configurations of Embodiments 8 and 9.

Embodiment 11

[0269] The noise cancellation mechanism embodying the invention is not limited to the noise cancellation mechanisms illustrated in Embodiments 8 to 10. For example, even when a noise cancellation mechanism that is different from those described above is used, an air-conditioning apparatus with the same advantageous effects of Embodiments 8 to 10 can be obtained. Note that in Embodiment 11, description is given of an exemplary case in which a different noise cancellation mechanism is applied to the air-conditioning apparatus according to Embodiment 8. Further, in Embodiment 11, points different from those of Embodiment 8 to Embodiment 10 described above will be mainly described, and same parts as Embodiment 8 to Embodiment 10 will be referred to with the same reference numerals.

[0270] Fig. 47 is a front view of the indoor unit according to Embodiment 11 of the invention.

The difference between the indoor unit 100 according to Embodiment 11 and the indoor unit 100 of Embodiment 8 is the configuration of the noise cancellation mechanism. Specifically, the noise cancellation mechanism A of the indoor unit 100 according to Embodiment 8 uses two microphones (the noise detection microphone 161 and the noise cancellation effect detection microphone 191) to perform active noise reduction. On the other hand, a noise cancellation mechanism D of the indoor unit 100 according to Embodiment 11 serving as the noise cancellation mechanism corresponding to the noise cancellation mechanism A replaces the two microphones (the noise detection microphone 161 and the noise cancellation effect detection microphone 191) of the noise cancellation mechanism A with a single microphone (the noise/noise cancellation effect detection microphone 211). Similarly, the noise cancellation mechanism B of the indoor unit 100 according to Embodiment 8 uses two microphones (the noise detection microphone 162 and the noise cancellation effect detection microphone 192) to perform active noise reduction. On the other hand, a noise cancellation mechanism E of the indoor unit 100 according to Embodiment 11 serving as the noise cancellation mechanism corresponding to the noise cancellation mechanism B replaces the two microphones (the noise detection microphone 162 and the noise cancellation effect detection microphone 192) of the noise cancellation mechanism B with a single microphone (the noise/noise cancellation effect detection microphone

212). Further, due to this, the signal processing method differs; hence, the indoor unit 100 according to Embodiment 11 is provided with signal processing devices 204 and 205 replacing the signal processing devices 201 and 202. Note that the configurations of the signal processing devices 204 and 205 are exactly the same as the configurations described in Embodiment 2.

[0271] Next, a description is given on operations of the indoor unit 100.

Similar to Embodiment 8, when the indoor unit 100 is operated, the impeller of each of the fans 20A to 20C rotates. Then, the air in the room is suctioned from the upper side of the fans 20A to 20C and is sent to the lower side of the fans 20A to 20C, thereby generating airflow. Accordingly, operation sounds (noise) are generated in the vicinity of the outlet ports of the fans 20A to 20C, and the sounds are propagated to the downstream side. The air sent from the fans 20A to 20C passes through the air passage and is sent to the heat exchanger 50. For example, during a cooling operation, a low-temperature refrigerant is supplied to the heat exchanger 50 from a pipe connected to the outdoor unit (not shown). The air that has been sent to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 so as to become cold air, and is directly released from the outlet port 3 into the room.

[0272] Note that the method of suppressing the operation sound of the indoor unit 100 is completely the same as that of Embodiment 2, that is, it is operated such that the control sounds are output to make the noise detected by the noise/noise cancellation effect detection microphone 211 and 212 approach zero, resulting in suppression of noise to the noise/noise cancellation effect detection microphone 211 and 212.

[0273] As described in Embodiment 8, in the active noise reduction method, control sounds that have opposite phases with the noise at the disposed positions (control points) of the noise/noise cancellation effect detection microphones 211 and 212 are output from the control speakers 181 and 182. Accordingly, the noise cancellation effect near each of the noise/noise cancellation effect detection microphones 211 and 212 is high; however, when the distance from each point increases, the phase of the control sound changes. Therefore, at positions with distance from the noise/noise cancellation effect detection microphones 211 and 212, the phase shift between the noise and the control sound becomes large and the noise cancellation effect becomes low.

[0274] Note that the individual fan control of the fans 20A to 20C according to Embodiment 11 is same to the control of the blower fan control means 171 described in Embodiment 8.

[0275] Accordingly, in the indoor unit 100 provided with plural fans 20A to 20C, the rotation speed of the fans 20A and 20C that are close in distance to the noise/noise cancellation effect detection microphones 211 and 212 are increased and the fan 20B that is far in distance to the noise/noise cancellation effect detection microphones 211 and 212 is decreased; hence it will be possible to increase noise in the vicinity of the noise/noise cancellation effect detection microphones 211 and 212 where the noise cancellation effect of the active noise reduction are high and to decrease noise in the region that is far in distance to the noise/noise cancellation effect detection microphones 211 and 212 where the noise cancellation effect of the active noise reduction is low.

[0276] That is, as described above, when active noise reduction is carried out, although the noise cancellation effect are high at and around each of the noise/noise cancellation effect detection microphone 211 and 212 that are control points of the noise control, the noise cancellation effect is low at positions far from the control points since the phase shift between the noise and the control sound that has been emitted from the control speakers 181 and 182 becomes large. However, in Embodiment 11, by configuring the indoor unit 100 to have the plural fans 20A to 20C, the rotation speed of the fans 20A and 20C (the fans that emit noise showing high noise cancellation effects) that are close in distance to the noise/noise cancellation effect detection microphones 211 and 212 can be increased, and the rotation speed of the fan 20B (the fan that emits noise showing a low noise cancellation effect) that is far in distance to the noise/noise cancellation effect detection microphones 211 and 212 can be reduced.

[0277] As a result, in the indoor unit 100 according to Embodiment 11, since the noise cancellation effect becomes further higher in a region with a high noise cancellation effect and the noise becomes smaller in a region with a low noise cancellation effect, the noise emitted from the entire outlet port 3 can be reduced compared to that of an indoor unit that uses a single fan or to that of an indoor unit that does not perform individual fan control. Further, in the indoor unit 100 according to Embodiment 11, deterioration of aerodynamic performance can be suppressed by individually controlling the rotation speed of the plural fans 20A to 20C so that the air volume is uniform to the air volume when uniform-rotation-speed control is performed.

[0278] Furthermore, as shown in Figs. 48 and 49, by dividing the air passage of the indoor unit 100 into a plurality of regions, the noise cancellation effect can be further increased.

[0279] Fig. 48 is a front view of another exemplary indoor unit according to Embodiment 11 of the invention. Fig. 49 is a left side view of the indoor unit illustrated in Fig. 48. Note that in Fig. 49, a view is illustrated while the sidewall of the casing 1 of the indoor unit 100 is seen through. In the indoor unit 100 illustrated in Figs. 48 and 49, by dividing the air passage with the partition plates 90 and 90a, the air passage is separated into a region where the air blown out by the fan 20A passes, a region where the air blown out by the fan 20B passes, and a region where the air blown out by the fan 20C passes. Further, the control speaker 181 and the noise/noise cancellation effect detection microphone 211 of the noise cancellation mechanism D are disposed in the region where the air blown out by the fan 20A passes. Furthermore, the control speaker 182 and the noise/noise cancellation effect detection microphone 212 of the noise cancellation mechanism E are disposed in the region where the air blown out by the fan 20C passes.

[0280] By configuring the indoor unit 100 as above, the noise emitted by each of the fans 20A to 20C can be separated in their respective areas such that the noise cancellation mechanism D only reduces the noise emitted from the fan 20A and the noise cancellation mechanism E only reduces the noise emitted from the fan 20C. Accordingly, it will be possible to prevent the noise emitted from the fan 20B from being detected by the noise/noise cancellation effect detection microphones 211 and 212; hence, crosstalk noise components of the noise/noise cancellation effect detection microphones 211 and 212 are reduced.

[0281] Further, since the air passage is made close to a duct structure, the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, the noise cancellation effect becomes higher still. Accordingly, by configuring the indoor unit 100 as Figs. 48 and 49, noise can be further reduced compared to that of the configuration of Fig. 47. Note that in Figs. 48 and 49, the partition plates are inserted through the entire air passage regions; however, the partition plates may separate only a portion of the air passages, such that only the upstream side of the heat exchanger 50 or only the downstream side of the heat exchanger 50 is separated, for example.

[0282] Note that in Embodiment 11, the noise/noise cancellation effect detection microphones 211 and 212 are disposed on the downstream side of the control speakers 181 and 182; however, the noise/noise cancellation effect detection microphones 211 and 212 may be disposed on the upstream side of the control speakers 181 and 182. Additionally, in Embodiment 11, although two of each of the control speaker, the noise/noise cancellation effect detection microphone, and the signal processing device are disposed, the invention is not limited to this.

[0283] Further, in Embodiment 11, although the blower fan control means 171 is configured in the CPU 131 inside the controller 281, it may be configured by hardware such as a Large Scale Integration (LSI) or a Field Programmable Gate Array (FPGA). Furthermore, similar to Embodiment 8, the configuration of the blower fan control means 171 is not limited to the configuration illustrated in Fig. 37.

[0284] Moreover, Embodiment 11 is configured such that the blower fan control means 171 increases the rotation speed of the fans 20A and 20C that are close in distance to the noise/noise cancellation effect detection microphones 211 and 212, and reduces the rotation speed of the fan 20B that is far in distance; however, the configuration may be such that either one is performed.

[0285] As described above, the indoor unit 100 according to Embodiment 11 is disposed with the plural fans 20A to 20C and is provided with the controller 281 (more specifically, the blower fan control means 171) that individually controls the rotation speed of each of the fans 20A to 20C. The blower fan control means 171 performs rotation speed control such that the rotation speed of the fans 20A and 20C that are sending air to the regions close to the noise/noise cancellation effect detection microphones 211 and 212, which are regions with high noise cancellation effects, are controlled to be increased and the rotation speed of the fan 20B that is sending air to the region that is far in distance to the noise cancellation effect detection microphones 211 and 212, which is the region with a low noise cancellation effect, is controlled to be decreased. Accordingly, the noise cancellation effect becomes further higher in a region with a high noise cancellation effect and the noise becomes smaller in a region with a low noise cancellation effect. Thus, compared to an indoor unit that uses a single fan or to an indoor unit that does not perform individual fan control, having a noise cancellation mechanism with the same configuration, the noise can be further reduced.

[0286] Further, since the blower fan control means 171 controls the rotation speed of the fans 20A to 20C so that the air volume emitted from the outlet port 3 is the same between when the individual fan control is performed and when the uniform-rotation-speed control is performed, it is possible to reduce noise without deteriorating the aerodynamic performance.

[0287] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated such that the noise cancellation mechanism D only reduces the noise emitted from the fan 20A and the noise cancellation mechanism E only reduces the noise emitted from the fan 20C. Accordingly, the crosstalk noise components due to the noise emitted from the fan 20B becomes smaller.

[0288] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the air passage is made close to a duct structure and the noise is captured in one dimension. Accordingly, since the phase of the noise propagating through the indoor unit 100 becomes uniform, phase error with the interfering control sound becomes small. Furthermore, by reducing the rotation speed of the fan 20B that is not provided with the noise cancellation mechanism, the noise in the region where there is no noise cancellation mechanism becomes small, and, compared to the configuration of Fig. 47, it will be possible to obtain a higher noise reduction effect.

[0289] Additionally, in Embodiment 11, since the noise detection microphones 161 and 162 and the noise cancellation effect detection microphones 191 and 192 are integrated into the noise/noise cancellation effect detection microphones 211 and 212, the number of microphones can be reduced and parts count can be reduced; hence, cost can be further reduced.

Embodiment 12

[0290] Naturally, the noise cancellation mechanism illustrated in Embodiment 11 may be used in the indoor unit illustrated in Embodiment 9. Note that, in Embodiment 12, points different from those of Embodiment 8 to Embodiment 11 described above will be mainly described and same parts as Embodiment 8 to Embodiment 11 will be referred to with the same reference numerals.

[0291] Fig. 50 is a front view of the indoor unit according to Embodiment 12 of the invention.

The indoor unit 100 according to Embodiment 12 is different from the indoor unit 100 according to Embodiment 11 in that the indoor unit 100 according to Embodiment 12 is provided with a noise cancellation mechanism F (the control speaker 183, a noise/noise cancellation effect detection microphone 213, and a signal processing device 206). The configuration of the signal processing device 206 is completely the same as those of the signal processing devices 204 and 205.

[0292] Further, similar to Embodiment 9, the indoor unit 100 of Embodiment 12 is different from the indoor unit 100 of Embodiment 11 in that signal lines (signal lines to transmit signals S1, S2, and S3) that are connected from the signal processing devices 204 to 206 to the blower fan control means 172 are provided. The signals S1, S2, and S3 that are transmitted to the blower fan control means 172 from the signal processing devices 204 to 206 are signals that has been input from the noise/noise cancellation effect detection microphones 211 to 213, that has passed through the microphone amplifier 151, and that has been digitally converted by the A/D converter 152. That is, the signals S1, S2, and S3 are digital values of the sound pressure levels detected by the noise/noise cancellation effect detection microphones 211 to 213.

[0293] The configuration of the blower fan control means 172 is the same as that described in Embodiment 9 and is configured as illustrated in Fig. 41. The blower fan control means 172 includes the uniform-rotation-speed determination means 133, averaging means 136 in plural number (the same number as that of the noise cancellation effect detection microphones), individual-fan-control rotation-speed determination means 134A, and the SW 135 in plural number (the same number as that of the fans 20). The uniform-rotation-speed determination means 133 determines the rotation speed of the fans 20A to 20C when all of the fans are to be operated with the same rotation speed, on the basis of the operating information input from the remote control 280. Operation information input from the remote control 280 is, for example, operation mode information such as a cooling operation mode, a heating operation mode, and a dehumidifying operation mode; and air volume information such as high, medium, and low. The averaging means 136 are input with the digital values S1, S2, and S3 of the sound pressure levels detected by the noise cancellation effect detection microphones 191 to 193. The averaging means 136 average these signals S1, S2, and S3 for a set time.

[0294] The individual-fan-control rotation-speed determination means 134A determines the rotation speed of each fan when the fans 20A to 20C are to be controlled individually, on the basis of the signals of S1, S2, and S3, which has been averaged by the averaging means 136, and the rotation speed information input from the uniform-rotation-speed determination means 133. The SWs 135 switch the rotation control signals of the fans 20A to 20C that are transmitted to the motor drivers 282A to 282C, on the basis of the signal input from the remote control 280, for example. That is, the SWs 135 switch between having the fans 20A to 20C to operate with the same rotation speed (to perform the uniform-rotation-speed control) and having each of the fans 20A to 20C to operate with individual rotation speeds (to perform the individual fan control).

[0295] Next, a description is given on operations of the indoor unit 100.

The difference between Embodiment 12 and Embodiment 11 is only the operation of the blower fan control means 172. Further, the operation of the blower fan control means 172 is as described in Embodiment 9. That is, the digital values S1 to S3 of the sound pressure level that has been detected by the noise/noise cancellation effect detection microphones 211 to 213 are averaged for a set time in the averaging means 136. On the basis of these averaged sound pressure level values and the rotation speed determined by the uniform-rotation-speed determination means 133, the individual-fan-control rotation-speed determination means 134A determines the rotation speed of each fan when individual fan control is to be performed. Specifically, the rotation speed of the fan is determined such that the rotation speed of the fan that is close in distance (highly related) to the noise cancellation effect detection microphone that has a small averaged sound pressure level value is increased and the rotation speed of the fan that is close in distance (highly related) to the noise cancellation effect detection microphone that has a large averaged sound pressure level value is reduced. The rotation speed of each of the fans 20A to 20C may be determined such that the air volume obtained when carrying out the individual fan control is the same as that when carrying out the uniform-rotation-speed control.

[0296] For example, in the indoor unit 100 according to Embodiment 12, when the mean value of the noise level detected by the noise/noise cancellation effect detection microphone 211 is 45 dB, the mean value of the noise level detected by the noise/noise cancellation effect detection microphone 212 is 45 dB, and the mean value of the noise level detected by the noise/noise cancellation effect detection microphone 213 is 50 dB, then the individual-fan-control rotation-speed determination means 134A determines the rotation speed of each fan

20 such that the rotation speed of the fans 20A and 20C are increased and the rotation speed of the fan 20B is reduced. Since the air volume and the rotation speed have a proportionality relation, for example, when with the configuration of Fig. 50, in the case where the rotation speed of the fans 20A and 20C are each increased by 10%, the air volume will be the same if the rotation speed of the fan 20B is decreased by 20%.

[0297] Note that the above-described determination method of the rotation speed of the fans 20A to 20C is exemplary and explanatory only. For example, when the mean value of the noise level detected by the noise/noise cancellation effect detection microphone 211 is 45 dB, the mean value of the noise level detected by the noise/noise cancellation effect detection microphone 212 is 47 dB, and the mean value of the noise level detected by the noise/noise cancellation effect detection microphone 213 is 50 dB, then the rotation speed of each fan 20 may be determined such that the rotation speed of the fan 20A is increased, the rotation speed of the fan 20B is reduced, and the rotation speed of the fan 20C is kept the same. That is, the rotation speed of each fan may be determined such that the rotation speed of the fan 20A that is close in distance to the noise/noise cancellation effect detection microphone 211 that has the smallest detected noise level is increased, the rotation speed of the fan 20B that is close in distance to the noise/noise cancellation effect detection microphone 213 that has the largest detected noise level is reduced, and the rotation speed of the fan 20C that is neither of the above is kept the same.

[0298] When an operating information signal (for example, such as a signal for a silent mode) is input from the remote control 280 indicating that the individual fan control is to be carried out, the rotation speed of each fan is controlled individually. That is, when the operating information signal (for example, such as a signal for a silent mode) is input from the remote control 280 indicating that the individual fan control is to be carried out, by switching the SWs 135, the rotation control signal of the uniform-rotation-speed control is switched to the rotation control signals for the individual fan control. These rotation control signals are output from the controller 281 to the fans 20A to 20c. The rotation control signals output from the controller 281 are input to the motor drivers 282A to 282C and the fans 20A to 20C are controlled to have rotation speeds in accordance with the rotation control signals.

[0299] Here, similar to Embodiment 9, in the case of the indoor unit 100 according to Embodiment 12, compared to the noise cancellation effect in the region in the vicinity of the noise/noise cancellation effect detection microphone 213, the noise cancellation effect in the regions in the vicinity of the noise/noise cancellation effect detection microphones 211 and 212 are higher, in accordance with the size of the crosstalk noise components from the neighboring fan(s). That is, the detected noise levels are smaller in the region in the vicinity of the noise/noise cancellation effect detection microphones 211 and 212 compared to that in the region in the vicinity of the noise/noise cancellation effect detection microphone 213. Meanwhile, the noise cancellation effect in the region in the vicinity of the noise/noise cancellation effect detection microphone 213 becomes lower. Now, as regards the indoor unit 100 according to Embodiment 12 provided with plural fans 20A to 20C, the rotation speed of the fans 20A and 20C that are close in distance to the noise/noise cancellation effect detection microphones 211 and 212 that have small mean values of the detected noise level values, among the mean values of the noise level values detected by the noise/noise cancellation effect detection microphones 211 to 213, are increased, and the rotation speed of the fan 20B that is close in distance to the noise/noise cancellation effect detection microphone 213 that has a large mean value of the detected noise level values, among the mean values of the noise level values detected by the noise/noise cancellation effect detection microphones 211 to 213, is reduced.

[0300] As a result, in the indoor unit 100 according to Embodiment 12, since the noise cancellation effect becomes further higher in a region with a high noise cancellation effect and the noise becomes smaller in a region with a low noise cancellation effect, the noise emitted from the entire outlet port 3 can be reduced compared to that of an indoor unit that uses a single fan or to that of an indoor unit that does not perform individual fan control. Further, in the indoor unit 100 according to Embodiment 12, deterioration of aerodynamic performance can be suppressed by individually controlling the rotation speed of the plural fans 20A to 20C so that the air volume is uniform to the air volume when uniform-rotation-speed control is performed.

[0301] Furthermore, as shown in Figs. 51 and 52, by dividing the air passage of the indoor unit 100 into a plurality of regions, the noise cancellation effect can be further increased.

[0302] Fig. 51 is a front view of another exemplary indoor unit according to Embodiment 12 of the invention. Fig. 52 is a left side view of the indoor unit illustrated in Fig. 51. Note that in Fig. 52, a view is illustrated while the sidewall of the casing 1 of the indoor unit 100 is seen through. In the indoor unit 100 illustrated in Figs. 51 and 52, by dividing the air passage with the partition plates 90 and 90a, the air passage is separated into a region where the air blown out by the fan 20A passes, a region where the air blown out by the fan 20B passes, and a region where the air blown out by the fan 20C passes. Further, the control speaker 181 and the noise/noise cancellation effect detection microphone 211 of the noise cancellation mechanism D are disposed in the region where the air blown out by the fan 20A passes. Furthermore, the control speaker 182 and the noise/noise cancellation effect detection microphone 212 of the noise cancellation mechanism E are disposed in the region where the air blown out by the fan 20C passes. Still further, the control speaker 183 and the noise/noise cancellation effect detection microphone 213 of the noise cancellation mechanism F are disposed in the region where the air blown out by the fan 20B passes.

[0303] By configuring the indoor unit 100 as above, the noise emitted by each of the fans 20A to 20C can be separated in their respective areas such that the noise cancellation mechanism D only reduces the noise emitted from the fan 20A, the noise cancellation mechanism E only reduces the noise emitted from the fan 20C, and the noise cancellation mechanism F only reduces the noise emitted from the fan 20B. Accordingly, the crosstalk noise components (noise emitted from the fan(s) provided in the neighboring passage(s)) detected by the noise/noise cancellation effect detection microphones 211 to 213 become smaller.

[0304] Further, since the air passage is made close to a duct structure, the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, the noise cancellation effect becomes higher still. Accordingly, by configuring the indoor unit 100 as Figs. 51 and 52, noise can be further reduced compared to that of the configuration of Fig. 50. Note that in Figs. 51 and 52, the partition plates are inserted through the entire air passage regions; however, the partition plates may separate only a portion of the air passages, such that only the upstream side of the heat exchanger 50 or only the downstream side of the heat exchanger 50 is separated, for example. Further, similar to Fig. 11, in a case such as the one of Fig. 53 where there is a fan provided with no noise cancellation mechanisms, a similar noise cancellation effect can be obtained by reducing the rotation speed of the fan 20 so that the noise in the region that is not provided with any noise cancellation mechanism is reduced.

[0305] Note that in Embodiment 12, the noise/noise cancellation effect detection microphones 211 to 213 are disposed on the downstream side of the control speakers 181 to 183; however, the noise/noise cancellation effect detection microphones 211 to 213 may be disposed on the upstream side of the control speakers 181 to 183. Additionally, in Embodiment 12, although two to three of each of the control speaker, the noise/noise cancellation effect detection microphone, and the signal processing device are disposed, the invention is not limited to this.

[0306] Further, in Embodiment 12, although the blower fan control means 172 is configured in the CPU 131 inside the controller 281, it may be configured by hardware such as a Large Scale Integration (LSI) or a Field Programmable Gate Array (FPGA). Furthermore, similar to Embodiment 9, the configuration of the blower fan control means 172 is not limited to the configuration illustrated in Fig. 41.

[0307] Moreover, Embodiment 12 is configured such that the blower fan control means 172 increases the rotation speed of the fan that is close in distance to the noise/noise cancellation effect detection microphone having a small noise level, and reduces the rotation speed of the fan that is close in distance to the noise/noise cancellation effect detection microphone having a large noise level; however, the configuration may be such that either one is performed.

[0308] As described above, the indoor unit 100 according to Embodiment 12 is disposed with the plural fans 20A to 20C and is provided with the controller 281 (more specifically, the blower fan control means 172) that individually controls the rotation speed of each of the fans 20A to 20C. The blower fan control means 172 performs rotation speed control such that the rotation speed of the fan that is close in distance to the noise/noise cancellation effect detection microphone that has detected a small noise level, among the mean values of the noise level detected by the noise/noise cancellation effect detection microphones 211 to 213, is increased, and the rotation speed of the fan close in distance to the noise/noise cancellation effect detection microphone that has detected a large noise level, among the mean values of the noise level detected by the noise/noise cancellation effect detection microphones 211 to 213, is reduced. Accordingly, the noise cancellation effect becomes further higher in a region with a high noise cancellation effect (that is, the region with small noise level) and the noise becomes smaller in a region with a low noise cancellation effect (that is, the region with large noise level). Thus, compared to an indoor unit that uses a single fan or to an indoor unit that does not perform individual fan control, having a noise cancellation mechanism with the same configuration, the noise can be further reduced.

[0309] Further, since the blower fan control means 172 controls the rotation speed of the fans 20A to 20C so that the air volume emitted from the outlet port 3 is the same between when the individual fan control is performed and when the uniform-rotation-speed control is performed, it is possible to reduce noise without deteriorating the aerodynamic performance.

[0310] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated such that the noise cancellation mechanism D only reduces the noise emitted from the fan 20A, the noise cancellation mechanism E only reduces the noise emitted from the fan 20C, and the noise cancellation mechanism F only reduces the noise emitted from the fan 20B. Accordingly, in each of the regions, the crosstalk noise components due to the noise emitted from the neighboring region(s) becomes smaller.

[0311] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the air passage is made close to a duct structure and the noise is captured in one dimension. Accordingly, since the phase of the noise propagating through the indoor unit 100 becomes uniform, phase error with the interfering control sound becomes small. Thus, the noise cancellation effect of the noise/noise cancellation effect detection microphones 211 to 213 becomes high, and it will be possible to further reduce noise compared to that of the configuration of Fig. 51. Further, even in a case in which there is a fan 20 provided with no noise cancellation mechanisms, a similar noise cancellation effect can be obtained by reducing the rotation speed of the fan 20 so that the noise in the region that is not provided with any noise cancellation mechanism is reduced.

[0312] Additionally, in Embodiment 12, since the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193 are integrated into the noise/noise cancellation effect detection microphones 211 to 213, the number of microphones can be reduced and, accordingly, the parts count is reduced; hence, cost can be further reduced.

Embodiment 13

[0313] In Embodiments 8 to 12, the fan that emits noise that is highly related to the noise cancellation effect detection microphone or the noise/noise cancellation effect detection microphone (that is, the fan that emits noise to which the noise cancellation effect detection microphone or the noise/noise cancellation effect detection microphone can easily exert its noise cancellation effect) is the fan that is close in distance to the noise cancellation effect detection microphone or the noise/noise cancellation effect detection microphone. Not limited to the above, the fan that emits noise that is highly related to the noise cancellation effect detection microphone or the noise/ noise cancellation effect detection microphone (that is, the fan that emits noise to which the noise cancellation effect detection microphone or the noise/noise cancellation effect detection microphone can easily exert its noise cancellation effect) may be the following fan. Note that, in Embodiment 13, description is given using the air-conditioning apparatus according to Embodiment 8. Further, in Embodiment 13, points different from those of Embodiment 8 to Embodiment 12 described above will be mainly described, and same parts as Embodiment 8 to Embodiment 12 will be referred to with the same reference numerals.

[0314] As described above, the basic configuration of the indoor unit 100 according to Embodiment 13 is similar to that of Fig. 35 described in Embodiment 8. The difference between the indoor unit 100 according to Embodiment 13 and the indoor unit 100 according to Embodiment 8 is the blower fan information that is input to the memory 132 of the controller 281. That is, the difference between the indoor unit 100 according to Embodiment 13 and the indoor unit 100 according to Embodiment 8 is the blower fan information that is input to the individual-fan-control rotation-speed determination means 134 from the memory 132.

[0315] Further, in Embodiment 8, the detailed installation configuration of the control speakers 181 and 182 to the sides of the indoor unit 100 is not described. In Embodiment 13, the control speakers 181 and 182 are disposed on the sides of the indoor unit 100 as follows. Since the control speakers 181 and 182 have a certain degree of thickness, if the speakers are disposed on the front side or the rear side of the indoor unit 100, the air passage will be blocked and will disadvantageously result in deterioration of aerodynamic performance. Accordingly, in Embodiment 13, the control speakers 181 and 182 are disposed in machine boxes (boxes that each house a control circuit and the like, not shown) that are provided to the two side portions of the casing 1. By disposing the control speakers 181 and 182 as above, it will be possible to prevent the control speakers 181 and 182 from jutting out into the air passage.

[0316] More specifically, in Embodiment 8, the identification numbers of the fans 20 that are close in distance to the noise cancellation effect detection microphones 191 and 192 are referred to as the blower fan information. On the other hand, in Embodiment 13, the identification numbers of the fans 20 that are disposed at the two ends of the casing 1 of the indoor unit 100 are referred to as the blower fan information. That is, as it can be understood from Fig. 35, the blower fan information of Embodiment 13 is the identification numbers of the fan 20A and the fan 20C.

[0317] The operation of the indoor unit 100 is similar to that described in Embodiment 8. Accordingly, the individual fan control of the fans 20A to 20C will be described below.

[0318] Similar to Embodiment 8, the individual-fan-control rotation-speed determination means 134 of the blower fan control means 171 determines the rotation speed of each fan 20 when the individual fan control is to be carried out, on the basis of the rotation speed information determined by the uniform-rotation-speed determination means 133 and the blower fan information read out from the memory 132. Specifically, the individual-fan-control rotation-speed determination means 134 increases the rotation speed of the fans 20A and 20C, of which their identification numbers are input to the memory 132, and reduces the rotation speed of the fan 20B, of which its identification number has not been input to the memory 132. As a result, the individual-fan-control rotation-speed determination means 134 increases the rotation speed of the fans 20A and 20C that are disposed at the two ends of the casing 1 of the indoor unit 100 and reduces the rotation speed of the fan 20B that is disposed at a position other than the two ends of the casing 1 of the indoor unit 100. Note that the rotation speed of each of the fans 20A to 20C may be determined such that the air volume obtained when carrying out the individual fan control is the same as that when carrying out the uniform-rotation-speed control.

[0319] When an operating information signal (for example, such as a signal for a silent mode) is input from the remote control 280 indicating that the individual fan control is to be carried out, by switching the SWs 135, the rotation control signal of the uniform-rotation-speed control is switched to the rotation control signals for the individual fan control. These rotation control signals are output from the controller 281 to the fans 20A to 20c. The rotation control signals output from the controller 281 are input to the motor drivers 282A to 282C and the fans 20A to 20C are controlled to have rotation speeds in accordance with the rotation control signals.

[0320] The crosstalk noise components differ when the noise of the fans are detected between a case in which the noise emitted by the fans 20A and 20C at the two ends are actively canceled and a case in which the noise emitted by the fan 20B at a position other than the two ends are actively canceled. This is because, when noise emitted from the fan 20B is detected, the noise emitted from the neighboring fans 20A and 20C are also picked up as crosstalk noise components. Accordingly, in Embodiment 13, the indoor unit 100 is configured with plural fans 20A to 20C, the rotation speed of the fans 20A and 20C at the two ends with small crosstalk noise components when the noise are detected are increased, and the rotation speed of the fan at a position other than the two ends, where the crosstalk components are large when the noise is detected, is reduced.

[0321] As a result, in the indoor unit 100 according to Embodiment 13, since the noise cancellation effect becomes further higher in a region with a high noise cancellation effect and the noise becomes smaller in a region with a low noise cancellation effect, the noise emitted from the entire outlet port 3 can be reduced compared to that of an indoor unit that uses a single fan or to that of an indoor unit that does not perform individual fan control. Further, in the indoor unit 100 according to Embodiment 13, deterioration of aerodynamic performance can be suppressed by individually controlling the rotation speed of the plural fans 20A to 20C so that the air volume is uniform to the air volume when uniform-rotation-speed control is performed.

[0322] Furthermore, in Embodiment 13, the control speakers 181 and 182 are disposed on the two sides of the indoor unit 100 so that the control speakers 181 and 182 do not jut out into the air passage. Accordingly, pressure loss caused by the jutting out of the control speakers 181 and 182 into the air passage can be prevented and, thus, deterioration of aerodynamic performance can be prevented.

[0323] Additionally, similar to the indoor unit 100 illustrated in Figs. 38 and 39 of Embodiment 8, the indoor unit 100 according to Embodiment 13 also divides the air passage of the indoor unit 100 into a plurality of regions such that the noise cancellation effect can be further increased.

[0324] That is, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated in their respective areas such that the noise cancellation mechanism A only reduces the noise emitted from the fan 20A and the noise cancellation mechanism B only reduces the noise emitted from the fan 20C. Accordingly, it will be possible to prevent the noise emitted from the fan 20B from being detected by the noise detection microphones 161 and 162 and the noise cancellation effect detection microphones 191 and 192; hence, crosstalk noise components of the noise detection microphones 161 and 162 and the noise cancellation effect detection microphones 191 and 192 are reduced.

[0325] Further, since the air passage is made close to a duct structure, the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, the noise cancellation effect becomes higher still. Meanwhile, by reducing the rotation speed of the fan 20B that is not provided with the noise cancellation mechanism, the noise in the region where there is no noise cancellation mechanism can be made small. Accordingly, in the indoor unit 100 according to Embodiment 13 as well, by dividing the air passage of the indoor unit 100 into a plurality of regions, noise can be further reduced compared to that of the configuration of Fig. 35. Note that the partition plates do not have to be provided through the entire air passage regions, and the partition plates may separate only a portion of the air passages, such that only the upstream side of the heat exchanger 50 or only the downstream side of the heat exchanger 50 is separated, for example.

[0326] Note that in Embodiment 13, the noise detection microphones 161 and 162 are disposed on the two sides of the indoor unit 100; however, the installation position of the noise detection microphones 161 and 162 may be any position that is on the upstream side of the control speakers 181 and 182. Furthermore, in Embodiment 13, the noise cancellation effect detection microphones 191 and 192 are disposed substantially on the extended lines of the rotation shafts of the fans 20A and 20C, respectively; however, the noise cancellation effect detection microphones 191 and 192 may be disposed at any position that are on the downstream side of the control speakers 181 and 182, respectively. Additionally, in Embodiment 13, although two of each of the noise detection microphone, the control speaker, the noise cancellation effect detection microphone, and the signal processing device are disposed, the invention is not limited to this.

[0327] Further, in Embodiment 13, although the blower fan control means 171 is configured in the CPU 131 inside the controller 281, the blower fan control means 171 may be configured by hardware such as a Large Scale Integration (LSI) or a Field Programmable Gate Array (FPGA). Furthermore, the configuration of the blower fan control means 171 is not limited to the configuration illustrated in Fig. 37.

[0328] Moreover, Embodiment 13 is configured such that the blower fan control means 171 increases the rotation speed of the fans 20A and 20C at the two ends of the indoor unit 100 and reduces the rotation speed of the fan 20B at a position other than the two ends; however, the configuration may be such that either one is performed.

[0329] As described above, the indoor unit 100 according to Embodiment 13 is disposed with the plural fans 20A to 20C and is provided with the blower fan control means 171 that individually controls the rotation speed of each of the fans 20A to 20C. The blower fan control means 171 performs rotation speed control such that the rotation speed of the fans 20A and 20C that are disposed at the two ends of the indoor unit 100 are increased and the rotation speed of the fan 20B that is disposed at a position other than the two ends of the indoor unit 100 is reduced. Accordingly, the noise cancellation effect becomes further higher in a region with small crosstalk noise components from the neighboring fan(s) and with a high noise cancellation effect, and the noise becomes smaller in a region with large crosstalk noise components and with a low noise cancellation effect. Thus, compared to an indoor unit that uses a single fan or to an indoor unit that does not perform individual fan control, having a noise cancellation mechanism with the same configuration, a higher noise reduction effect can be obtained.

[0330] Further, since the blower fan control means 171 controls the rotation speed of each of the fans 20A to 20C so that the air volume emitted from the outlet port 3 is the same between when the individual fan control is performed and when the uniform-rotation-speed control is performed, it is possible to reduce noise without deteriorating the aerodynamic performance.

[0331] Furthermore, the control speakers 181 and 182 are disposed on the two sides of the indoor unit 100 so that the control speakers 181 and 182 do not jut out into the air passage. Accordingly, pressure loss caused by the jutting out of the control speakers 181 and 182 into the air passage can be prevented and, thus, deterioration of aerodynamic performance can be prevented.

[0332] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated such that the noise cancellation mechanism A only reduces the noise emitted from the fan 20A and the noise cancellation mechanism B only reduces the noise emitted from the fan 20C. Accordingly, the crosstalk noise components due to the noise emitted from the fan 20B becomes smaller.

[0333] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the air passage is made close to a duct structure and the noise is captured in one dimension. Accordingly, since the phase of the noise propagating through the indoor unit 100 becomes uniform, phase error with the interfering control sound becomes small. Furthermore, by reducing the rotation speed of the fan 20B that is not provided with the noise cancellation mechanism, the noise in the region where there is no noise cancellation mechanism becomes small, and, compared to the configuration of Fig. 35, it will be possible to obtain a further higher noise reduction effect.

Embodiment 14

[0334] Naturally, the blower fan information described in Embodiment 13 may be used in the indoor unit according to Embodiment 11. Note that, in Embodiment 14, points different from those of Embodiment 8 to Embodiment 13 described above will be mainly described and same parts as Embodiment 8 to Embodiment 13 will be referred to with the same reference numerals.

[0335] The basic configuration of the indoor unit 100 according to Embodiment 14 is similar to that of Fig. 47 described in Embodiment 11. The difference between the indoor unit 100 according to Embodiment 14 and the indoor unit 100 according to Embodiment 11 is the blower fan information that is input to the memory 132 of the controller 281. More specifically, in Embodiment 14, the identification numbers of the fans 20 that are disposed at the two ends of the casing 1 of the indoor unit 100 are referred to as the blower fan information. That is, as it can be understood from Fig. 47, the blower fan information of Embodiment 14 is the identification numbers of the fan 20A and the fan 20C.

[0336] Further, in Embodiment 11, the detailed installation configuration of the control speakers 181 and 182 to the sides of the indoor unit 100 has not been described. In Embodiment 14, the control speakers 181 and 182 are disposed on the sides of the indoor unit 100 as follows. Since the control speakers 181 and 182 have a certain degree of thickness, if the speakers are disposed on the front side or the rear side of the indoor unit 100, the air passage will be blocked and will disadvantageously result in deterioration of aerodynamic performance. Accordingly, in Embodiment 14, the control speakers 181 and 182 are disposed in machine boxes (boxes that each house a control circuit and the like, not shown) that are provided to the two side portions of the casing 1. By disposing the control speakers 181 and 182 as above, it will be possible to prevent the control speakers 181 and 182 from jutting out into the air passage.

[0337] The operation of the indoor unit 100 is similar to that described in Embodiment 11. Accordingly, the individual fan control of the fans 20A to 20C will be described below.

[0338] Similar to Embodiment 11, the individual-fan-control rotation-speed determination means 134 of the blower fan control means 171 determines the rotation speed of each fan when the individual fan control is to be carried out, on the basis of the rotation speed information determined by the uniform-rotation-speed determination means 133 and the blower fan information read out from the memory 132. Specifically, the individual-fan-control rotation-speed determination means 134 increases the rotation speed of the fans 20A and 20C, of which their identification numbers are input to the memory 132, and reduces the rotation speed of the fan 20B, of which its identification number has not been input to the memory 132. As a result, the individual-fan-control rotation-speed determination means 134 increases the rotation speed of the fans 20A and 20C that are disposed at the two ends of the casing 1 of the indoor unit 100 and reduces the rotation speed of the fan 20B that is disposed at a position other than the two ends of the casing 1 of the indoor unit 100. Note that the rotation speed of each of the fans 20A to 20C may be determined such that the air volume obtained when carrying out the individual fan control is the same as that when carrying out the uniform-rotation-speed control.

[0339] When an operating information signal (for example, such as a signal for a silent mode) is input from the remote control 280 indicating that the individual fan control is to be carried out, by switching the SWs 135, the rotation control signal of the uniform-rotation-speed control is switched to the rotation control signals for the individual fan control. These rotation control signals are output from the controller 281 to the fans 20A to 20c. The rotation control signals output from the controller 281 are input to the motor drivers 282A to 282C and the fans 20A to 20C are controlled to have rotation speeds in accordance with the rotation control signals.

[0340] The crosstalk noise components differ when the noise of the fans are detected between a case in which the noise emitted by the fans 20A and 20C at the two ends are actively canceled and a case in which the noise emitted by the fan 20B at a position other than the two ends are actively canceled. This is because, the noise emitted from the neighboring fans 20A and 20C are also picked up as crosstalk noise components when noise emitted from the fan 20B is detected. Accordingly, in Embodiment 14, the indoor unit 100 is configured with plural fans 20A to 20C, the rotation speed of the fans 20A and 20C at the two ends with small crosstalk noise components when the noise are detected are increased, and the rotation speed of the fan at a position other than the two ends, where the crosstalk components are large when the noise is detected, is reduced.

[0341] As a result, in the indoor unit 100 according to Embodiment 14, since the noise cancellation effect becomes further higher in a region with a high noise cancellation effect and the noise becomes smaller in a region with a low noise cancellation effect, the noise emitted from the entire outlet port 3 can be reduced compared to that of an indoor unit that uses a single fan or to that of an indoor unit that does not perform individual fan control. Further, in the indoor unit 100 according to Embodiment 14, deterioration of aerodynamic performance can be suppressed by individually controlling the rotation speed of the plural fans 20A to 20C so that the air volume is uniform to the air volume when uniform-rotation-speed control is performed.

[0342] Furthermore, in Embodiment 14, the control speakers 181 and 182 are disposed on the two sides of the indoor unit 100 so that the control speakers 181 and 182 do not jut out into the air passage. Accordingly, pressure loss caused by the jutting out of the control speakers 181 and 182 into the air passage can be prevented and, thus, deterioration of aerodynamic performance can be prevented.

[0343] Additionally, similar to the indoor unit 100 illustrated in Figs. 48 and 49 of Embodiment 11, the indoor unit 100 according to Embodiment 14 also divides the air passage of the indoor unit 100 into a plurality of regions such that the noise cancellation effect can be further increased.

[0344] That is, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated in their respective areas such that the noise cancellation mechanism D only reduces the noise emitted from the fan 20A and the noise cancellation mechanism E only reduces the noise emitted from the fan 20C. Accordingly, it will be possible to prevent the noise emitted from the fan 20B from being detected by the noise/noise cancellation effect detection microphones 211 and 212; hence, crosstalk noise components of the noise/noise cancellation effect detection microphones 211 and 212 are reduced.

[0345] Further, since the air passage is made close to a duct structure, the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, the noise cancellation effect becomes higher still. Meanwhile, by reducing the rotation speed of the fan 20B that is not provided with the noise cancellation mechanism, the noise in the region where there is no noise cancellation mechanism can be made small. Accordingly, in the indoor unit 100 according to Embodiment 14 as well, by dividing the air passage of the indoor unit 100 into a plurality of regions, noise can be further reduced compared to that of the configuration of Fig. 47. Note that the partition plates do not have to be provided through the entire air passage regions, and the partition plates may separate only a portion of the air passages, such that only the upstream side of the heat exchanger 50 or only the downstream side of the heat exchanger 50 is separated, for example.

[0346] Note that in Embodiment 14, the noise/noise cancellation effect detection microphones 211 and 212 are disposed on the downstream side of the control speakers 181 and 182; however, the noise/noise cancellation effect detection microphones 211 and 212 may be disposed on the upstream side of the control speakers 181 and 182. Additionally, in Embodiment 14, although two of each of the control speaker, the noise/noise cancellation effect detection microphone, and the signal processing device are disposed, the invention is not limited to this.

[0347] Further, in Embodiment 14, although the blower fan control means 171 is configured in the CPU 131 inside the controller 281, it may be configured by hardware such as a Large Scale Integration (LSI) or a Field Programmable Gate Array (FPGA). Furthermore, the configuration of the blower fan control means 171 is also not limited.

[0348] Moreover, Embodiment 14 is configured such that the blower fan control means 171 increases the rotation speed of the fans 20A and 20C at the two ends of the indoor unit 100 and reduces the rotation speed of the fan 20B at a position other than the two ends; however, the configuration may be such that either one is performed.

[0349] As described above, the indoor unit 100 according to Embodiment 14 is disposed with the plural fans 20A to 20C and is provided with the blower fan control means 171 that individually controls the rotation speed of each of the fans 20A to 20C. The blower fan control means 171 performs rotation speed control such that the rotation speed of the fans 20A and 20C that are disposed at the two ends of the indoor unit 100 are increased and the rotation speed of the fan 20B that is disposed at a position other than the two ends of the indoor unit 100 is reduced. Accordingly, the noise cancellation effect becomes further higher in a region with small crosstalk noise from the neighboring fan(s) and with a high noise cancellation effect, and the noise becomes smaller in a region with large crosstalk noise and with a low noise cancellation effect. Thus, compared to an indoor unit that uses a single fan or to an indoor unit that does not perform individual fan control, having a noise cancellation mechanism with the same configuration, the noise can be further reduced.

[0350] Further, since the blower fan control means 171 controls the rotation speed of each of the fans 20A to 20C so that the air volume emitted from the outlet port 3 is the same between when the individual fan control is performed and when the uniform-rotation-speed control is performed, it is possible to reduce noise without deteriorating the aerodynamic performance.

[0351] Furthermore, the control speakers 181 and 182 are disposed on the two sides of the indoor unit 100 so that the control speakers 181 and 182 do not jut out into the air passage. Accordingly, pressure loss caused by the jutting out of the control speakers 181 and 182 into the air passage can be prevented and, thus, deterioration of aerodynamic performance can be prevented.

[0352] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated such that the noise cancellation mechanism D only reduces the noise emitted from the fan 20A and the noise cancellation mechanism E only reduces the noise emitted from the fan 20C. Accordingly, the crosstalk noise components due to the noise emitted from the fan 20B becomes smaller.

[0353] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the air passage is made close to a duct structure and the noise is captured in one dimension. Accordingly, since the phase of the noise propagating through the indoor unit 100 becomes uniform, phase error with the interfering control sound becomes small. Furthermore, by reducing the rotation speed of the fan 20B that is not provided with the noise cancellation mechanism, the noise in the region where there is no noise cancellation mechanism becomes small, and, compared to the configuration of Fig. 47, it will be possible to obtain a further higher noise reduction effect.

[0354] Additionally, in Embodiment 14, since the noise detection microphones 161 and 162 and the noise cancellation effect detection microphones 191 and 192 are integrated into the noise/noise cancellation effect detection microphones 211 and 212, the number of microphones can be reduced and parts count can be reduced; hence, cost can be further reduced.

Embodiment 15

[0355] When the individual fan control is performed on the basis of the noise cancellation effect of the noise cancellation effect detection microphone or the noise/noise cancellation effect detection microphone, the individual fan control may be performed as below, for example. Note that, in Embodiment 15, points different from those of Embodiments 8 to Embodiment 14 described above will be mainly described and same parts as Embodiment 8 to Embodiment 14 will be referred to with the same reference numerals.

[0356] Fig. 54 is a front view of the indoor unit according to Embodiment 15 of the invention.
The difference between the indoor unit 100 according to Embodiment 15 and the indoor unit 100 of Embodiment 9 is only the configuration of a blower fan control means 174.

[0357] The configuration of the blower fan control means 174 according to Embodiment 15 will be described.
Fig. 55 is a block diagram illustrating a controller according to Embodiment 15 of the invention. Each of the operations and means described below are implemented by executing a program that is built-in in the controller 281 provided in the indoor unit 100. Similar to the configurations described in Embodiments 8 to 14, the controller 281 mainly includes the input unit 130 that inputs a signal from an external input device such as the remote control 280, and the like; the CPU 131 that carries out computing in accordance with the embedded program; and the memory 132 that stores data and the program. Further, the CPU 131 according to Embodiment 15 includes the blower fan control means 174.

[0358] The blower fan control means 174 includes the uniform-rotation-speed determination means 133, noise cancellation amount calculating means 138 in plural number (the same number as that of the noise cancellation effect detection microphones), individual-fan-control rotation-speed determination means 134C, and the plural SWs 135 (the same number as that of the fans 20).
The uniform-rotation-speed determination means 133 determines the rotation speed of the fans 20A to 20C when all of the fans are to be operated with the same rotation speed, on the basis of the operating information

input from the remote control 280. Operation information input from the remote control 280 is, for example, operation mode information such as a cooling operation mode, a heating operation mode, and a dehumidifying operation mode; and air volume information such as high, medium, and low. The noise cancellation amount calculating means 138 are input with the digital values S1, S2, and S3 of the sound pressure levels detected by the noise cancellation effect detection microphones 191 to 193. The noise cancellation amount calculating means 138 calculate the noise cancellation amounts from these signals S1, S2, and S3.

[0359] The individual-fan-control rotation-speed determination means 134C determines the rotation speed of each fan when the fans 20A to 20C are to be controlled individually, on the basis of the noise cancellation amount that has been calculated by the noise cancellation amount calculating means 138 and the blower fan information stored in the memory 132. The blower fan information is information of the fans 20 that are highly related to the noise cancellation effect detection microphones 191 to 193. The SWs 135 switch the rotation control signals of the fans 20A to 20C that are transmitted to the motor drivers 282A to 282C, on the basis of the signal input from the remote control 280, for example. That is, the SWs 135 switch between having the fans 20A to 20C to operate with the same rotation speed (to perform the uniform-rotation-speed control) and having each of the fans 20A to 20C to operate with individual rotation speeds (to perform the individual fan control).

[0360] Fig. 56 is a block diagram illustrating the noise cancellation amount calculating means according to Embodiment 15 of the invention.

Each noise cancellation amount calculating means 138 include averaging means 136 that averages the signal (S1, S2, or S3) that has been input thereto, pre-control sound-pressure-level storage means 139 that stores the sound pressure level before start of the active noise reduction control, and a difference device 140.

[0361] Next, a description is given on operations of the indoor unit 100.

Similar to Embodiment 9, when the indoor unit 100 is operated, the impeller of each of the fans 20A to 20C rotates. Then, the air in the room is suctioned from the upper side of the fans 20A to 20C and is sent to the lower side of the fans 20A to 20C, thereby generating airflow. Accordingly, operation sounds (noise) are generated in the vicinity of the outlet ports of the fans 20A to 20C, and the sounds are propagated to the downstream side. The air sent from the fans 20A to 20C passes through the air passage and is sent to the heat exchanger 50. For example, during a cooling operation, a low-temperature refrigerant is supplied to the heat exchanger 50 from a pipe connected to the outdoor unit (not shown). The air that has been sent to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 so as to become cold air, and is directly released from the outlet port 3 into the room.

[0362] Further, the operations of the noise cancellation mechanisms A to C are also completely the same as that described in Embodiment 9 and are operated so that the control sounds are output to make the noise detected by the noise cancellation effect detection microphones 191 to 193 approach zero, resulting in suppression of noise to the noise cancellation effect detection microphones 191 to 193.

[0363] In the indoor unit 100 according to Embodiment 15, other than the noise emitted from the fan 20B, the noise cancellation effect detection microphone 193 picks up noise that are emitted from the neighboring fans 20A and 20C (crosstalk noise components). On the other hand, the crosstalk noise components that are detected by the noise cancellation effect detection microphones 191 and 192 are smaller than the crosstalk noise components that are detected by the noise cancellation effect detection microphone 193. This is because the noise cancellation effect detection microphones 191 and 192 each have only one neighboring fan (fan 20B). Accordingly, the noise cancellation effect of the noise cancellation mechanisms A and B are higher compared to that of the noise cancellation mechanism C.

[0364] Individual fan control of the fans 20A to 20C according to Embodiment 15 will be described next.

Operating information selected with the remote control 280 is input to the controller 281. As described above, the operating information is operation mode information such as, for example, a cooling operation mode, a heating operation mode, and a dehumidifying operation mode. Further, air volume information such as high, medium, and low are also input to the controller 281 from the remote control 280 as operating information. The operating information input to the controller 281 is input to the uniform-rotation-speed determination means 133 through the input unit 130. Being input with the operating information, the uniform-rotation-speed determination means 133 determines the rotation speed of the fans 20A to 20C when uniform-rotation-speed control is to be performed, on the basis of the input operating information. When the individual fan control is not carried out, the fans 20A to 20C are all controlled with the same rotation speed.

[0365] Meanwhile, in the noise cancellation amount calculating means 138, S1 to S3 (the digital values of the sound pressure levels that have been detected by the noise cancellation effect detection microphones 191 to 193) are input to the averaging means 136 from the signal processing devices 201 to 203. Further, each noise cancellation amount calculating means 138 averages the sound pressure level, which has been detected by the corresponding one of the noise cancellation effect detection microphones 191 to 193 before the active noise reduction control is performed, with the corresponding averaging means 136 for a set time, and stores the averaged sound pressure level in the corresponding pre-control sound-pressure-level storage means 139. Next, the noise cancellation amount calculating means 138 averages the sound pressure level, which has been detected by the corresponding one of the noise cancellation effect detection microphones 191 to 193 during the active noise reduction control, with the corresponding averaging means 136 for a set time.

[0366] Then, the noise cancellation amount calculating means 138 calculates the noise cancellation amount from the difference between "the averaged sound pressure level of the sound pressure level that has been detected by the corresponding one of the noise cancellation effect detection microphones 191 to 193 during the active noise reduction control, in which the averaged sound pressure level is averaged for a set time by the corresponding averaging means 136" and "the averaged sound pressure level of the sound pressure level that has been detected by the corresponding one of the noise cancellation effect detection microphones 191 to 193 before the active noise reduction control is performed, in which the averaged sound pressure level is averaged for a set time by the corresponding averaging means 136" (the sound level that is stored in the corresponding pre-control sound-pressure-level storage means 139). The noise cancellation amounts that have been calculated by the noise cancellation amount calculating means 138 are input to the individual-fan-control rotation-speed determination means 134C.

[0367] Further, the blower fan information is stored in the memory 132. Each blower fan information is information of the fan 20 that emits noise that is most highly related to the noise detected by one of the noise cancellation effect detection microphones 191 to 193. The identification number for each fan is allocated to the corresponding noise cancellation effect detection microphone. In Embodiment 15, the identification numbers serving as the blower fan information are obtained as follows. For example, identification is made of which noise, among the noise emitted from the fans 20A to 20C, is most highly related to the sound that has been detected by the noise cancellation effect detection microphone 191. If the noise detected by the noise cancellation effect detection microphone 191 is most highly related to the noise emitted from the fan 20A, then the blower fan information corresponding to the noise cancellation effect detection microphone 191 will be the identification number indicating the fan 20A. Similarly, the blower fan information corresponding to the noise cancellation effect detection microphones 192 and 193 are determined and are stored in the memory 132 in advance.

[0368] The determination of the blower fan information may be carried out as below, for example. For example, before the shipment of the product, noise emitted from the fans 20A to 20C while the fans 20A and 20C are operated are detected by microphones that detect the noise accurately. Then, the coherence values between the sound detected by these microphones and the sound detected by the noise cancellation effect detection microphone 191 are measured. After that, the microphone with the detection value having the highest coherence value with the detection value of the noise cancellation effect detection microphone 191 is determined. The identification number of the fan 20 that is emitting the noise detected by this microphone is the blower fan information corresponding to the noise cancellation effect detection microphone 191. The blower fan information corresponding to the noise cancellation effect detection microphones 192 and 193 may be determined similarly.

[0369] Further, the determination of the blower fan information may also be carried out as below, for example. The coherence computing means 137 described in Embodiment 10 are mounted on the blower fan control means 174 or the like of the indoor unit 100. Then, during its operation after the shipment of the product, the coherence values between the detection values of the noise detection microphones 161 and 163 and the detection value of the noise cancellation effect detection microphones 191 to 193 are measured. After that, the blower fan information of each of the noise cancellation effect detection microphones 191 to 193 may be the identification number of the fan 20 that is close in distance to the noise detection microphone that has the highest coherence value with the relevant one of the noise cancellation effect detection microphones 191 to 193.

[0370] Note that the methods of determining the blower fan information are not limited to the methods described above. The method can be any method that can specify the fan emitting noise that is most highly related to the detection sound of the relevant one of the noise cancellation effect detection microphones 191 to 193.

[0371] The noise cancellation amount calculated by the noise cancellation amount calculating means 138 and the blower fan information stored in the memory 132 are input to the individual-fan-control rotation-speed determination means 134C. The individual-fan-control rotation-speed determination means 134C determines the rotation speed of each fan when individual fan control is to be performed, on the basis of these information. Specifically, the rotation speed of the fan is determined such that the rotation speed of the fan that is highly related to the noise detected by the noise cancellation effect detection microphone having a large noise cancellation amount is increased and the rotation speed of the fan that is highly related to the noise detected by the noise cancellation effect detection microphone having a small noise cancellation amount is reduced. The rotation speed of each of the fans 20A to 20C may be determined such that the air volume obtained when carrying out the individual fan control is the same as that when carrying out the uniform-rotation-speed control.

[0372] For example, in the indoor unit 100 according to Embodiment 15, assume that the fan emitting noise that is most highly related to the sound detected by the noise cancellation effect detection microphone 191 is fan 20A, the fan emitting noise that is most highly related to the sound detected by the noise cancellation effect detection microphone 192 is 20C, and the fan emitting noise that is most highly related to the sound detected by the noise cancellation effect detection microphone 193 is fan

20B. Further, assume that the noise cancellation amount at the noise cancellation effect detection microphone 191 is -5 dB, the noise cancellation amount at the noise cancellation effect detection microphone 192 is -5 dB, and the noise cancellation amount at the noise cancellation effect detection microphone 193 is -2 db. In the above case, the individual-fan-control rotation-speed determination means 134C determines the rotation speed of each fan such that the rotation speed of the fans 20A and 20C are increased and the rotation speed of the fan 20B is reduced. Since the air volume and the rotation speed have a proportionality relation, for example, when with the configuration of Fig. 54, in the case where the rotation speed of the fans 20A and 20C are each increased by 10%, the air volume will be the same if the rotation speed of the fan 20B is decreased by 20%.

[0373] Note that the above-described determination method of the rotation speed of the fans 20A to 20C is exemplary and explanatory only. For example, in the indoor unit 100 according to Embodiment 15, assume that the fan emitting noise that is most highly related to the sound detected by the noise cancellation effect detection microphone 191 is fan 20A, the fan emitting noise that is most highly related to the sound detected by the noise cancellation effect detection microphone 192 is 20C, and the fan emitting noise that is most highly related to the sound detected by the noise cancellation effect detection microphone 193 is fan 20B. Further, assume that the noise cancellation amount at the noise cancellation effect detection microphone 191 is -5 dB, the noise cancellation amount at the noise cancellation effect detection microphone 192 is -3 dB, and the noise cancellation amount at the noise cancellation effect detection microphone 193 is -2 db. In the above case, the rotation speed of each fan may be determined such that the rotation speed of the fan 20A is increased, the rotation speed of the fan 20B is reduced, and the rotation speed of the fan 20C is kept the same. That is, the rotation speed of each fan may be determined such that the rotation speed of the fan 20A that is highly related to the noise cancellation effect detection microphone 191 having the largest noise cancellation amount is increased, the rotation speed of the fan 20B that is highly related to the noise cancellation effect detection microphone 193 having the smallest noise cancellation amount is reduced, and the rotation speed of the fan 20C that is neither of the above is kept the same.

[0374] When an operating information signal (for example, such as a signal for a silent mode) is input from the remote control 280 indicating that the individual fan control is to be carried out, by switching the SWs 135, the rotation control signal of the uniform-rotation-speed control is switched to the rotation control signals for the individual fan control. These rotation control signals are output from the controller 281 to the fans 20A to 20c. The rotation control signals output from the controller 281 are input to the motor drivers 282A to 282C and the fans 20A to 20C are controlled to have rotation speeds in accordance with the rotation control signals.

[0375] Here, as described above, in the case of the indoor unit 100 according to Embodiment 15, compared to the noise cancellation amount in the region in the vicinity of the noise cancellation effect detection microphone 193, the noise cancellation amount in the regions in the vicinity of the noise cancellation effect detection microphones 191 and 192 are larger, in accordance with the size of the crosstalk noise components from the neighboring fan(s). Meanwhile, the noise cancellation amount in the region in the vicinity of the noise cancellation effect detection microphone 193 is smaller. Now, as regards the indoor unit 100 according to Embodiment 15 provided with plural fans 20A to 20C, the rotation speed of the fans 20A and 20C that are emitting noise that are highly related to the noise cancellation effect detection microphones 191 and 192 having high noise cancellation amounts are increased and the rotation speed of the fan 20B that is emitting noise that is highly related to the noise cancellation effect detection microphone 193 having a small noise cancellation amount is reduced.

[0376] As a result, in the indoor unit 100 according to Embodiment 15, since the noise cancellation effect becomes further higher in a region with a high noise cancellation effect and the noise becomes smaller in a region with a low noise cancellation effect, the noise emitted from the entire outlet port 3 can be reduced compared to that of an indoor unit that uses a single fan or to that of an indoor unit that does not perform individual fan control. Further, in the indoor unit 100 according to Embodiment 15, deterioration of aerodynamic performance can be suppressed by individually controlling the rotation speed of the plural fans 20A to 20C so that the air volume is uniform to the air volume when uniform-rotation-speed control is performed.

[0377] Additionally, similar to the indoor unit 100 illustrated in Figs. 42 and 43 of Embodiment 9, the indoor unit 100 according to Embodiment 15 also divides the air passage of the indoor unit 100 into a plurality of regions such that the noise cancellation effect can be further increased.

[0378] That is, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated in their respective areas such that the noise cancellation mechanism A only reduces the noise emitted from the fan 20A, the noise cancellation mechanism B only reduces the noise emitted from the fan 20C, and the noise cancellation mechanism C only reduces the noise emitted from the fan 20B. Accordingly, the crosstalk noise components (noise emitted from the fan(s) provided in the neighboring passage(s)) detected by the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193 become smaller.

[0379] Further, since the air passage is made close to a duct structure, the noise is captured in one dimension.

Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, the noise cancellation effect becomes higher still. Accordingly, in the indoor unit 100 according to Embodiment 15 as well, by dividing the air passage of the indoor unit 100 into a plurality of regions, noise can be further reduced compared to that of the configuration of Fig. 54. On the other hand, even in a case in which there is a fan provided with no noise cancellation mechanisms, a similar effect can be obtained by reducing the rotation speed of the fan 20 so that the noise in the region that is not provided with any noise cancellation mechanism is reduced. Further, in Figs. 42 and 43, the partition plates are inserted through the entire air passage regions; however, the partition plates may separate only a portion of the air passages, such that only the upstream side of the heat exchanger 50 or only the downstream side of the heat exchanger 50 is separated, for example.

[0380] Note that, in Embodiment 15, the noise cancellation effect detection microphones 191 to 193 are disposed substantially on the extended lines of the rotation shafts of the fans 20A to 20C, respectively; however, the noise cancellation effect detection microphones 191 to 193 may be disposed at any position that are on the downstream side of the control speakers 181 to 183, respectively. Additionally, in Embodiment 15, although three of each of the noise detection microphone, the control speaker, the noise cancellation effect detection microphone, and the signal processing device are disposed, the invention is not limited to this.

[0381] Further, in Embodiment 15, although the blower fan control means 174 is configured in the CPU 131 inside the controller 281, it may be configured by hardware such as a Large Scale Integration (LSI) or a Field Programmable Gate Array (FPGA). Furthermore, the configuration of the blower fan control means 174 is not limited to the configurations illustrated in Figs. 55 and 56.

[0382] Moreover, Embodiment 15 is configured such that the blower fan control means 174 increases the rotation speed of a fan that is emitting a noise that is highly related to the noise cancellation effect detection microphone having a high noise cancellation amount, and reduces the rotation speed of the fan that is emitting a noise that is highly related to the noise cancellation effect detection microphone having a low noise cancellation amount; however, the configuration may be such that either one is performed.

[0383] Further, in Embodiment 15, the noise cancellation amounts of the noise cancellation effect detection microphones 191 to 193 are used as parameters for controlling the rotation speed of the fans; however, it goes without saying that other parameters may be used for controlling the rotation speed of the fan. For example, the mean value of the sound pressure level detected by each of the noise cancellation effect detection microphones 191 to 193 may be calculated, and the rotation speed of the fan that is emitting noise that is highly related to the sound detected by the noise cancellation effect detection microphone with the highest mean value of the noise pressure level may be reduced. Further, for example, the mean value of the sound pressure level detected by each of the noise cancellation effect detection microphones 191 to 193 may be calculated, and the rotation speed of the fan that is emitting noise that is highly related to the sound detected by the noise cancellation effect detection microphone with the lowest mean value of the noise pressure level may be increased. Naturally, both of the above may be performed.

[0384] Furthermore, as parameters for controlling the rotation speed of the fans, coherence values between the noise detection microphone 161 and the noise cancellation effect detection microphone 191, the noise detection microphone 162 and the noise cancellation effect detection microphone 192, and the noise detection microphone 163 and the noise cancellation effect detection microphone 193 may be used. For example, the rotation speed of the fan that is emitting noise that is highly related to the sound detected by the noise cancellation effect detection microphone with the smallest coherence value may be reduced. Further, for example, the rotation speed of the fan that is emitting noise that is highly related to the sound detected by the noise cancellation effect detection microphone with the largest coherence value may be increased. Naturally, both of the above may be performed.

[0385] As described above, the indoor unit 100 according to Embodiment 15 is disposed with the plural fans 20A to 20C and is provided with the controller 281 (more specifically, the blower fan control means 174) that individually controls the rotation speed of each of the fans 20A to 20C. The blower fan control means 174 performs rotation speed control such that the rotation speed of a fan that is emitting a noise that is highly related to the noise cancellation effect detection microphone having a high noise cancellation amount, among the noise cancellation amounts at the noise cancellation effect detection microphones 191 to 193, is increased, and the rotation speed of the fan that is emitting a noise that is highly related to the noise cancellation effect detection microphone having a low noise cancellation amount, among the noise cancellation amounts at the noise cancellation effect detection microphones 191 to 193, is reduced. Accordingly, by increasing the rotation speed in a region with a large noise cancellation amount, the noise cancellation effect is further increased, and by reducing the rotation speed in the region with a small noise cancellation amount, noise is further reduced in that region. Thus, compared to an indoor unit that uses a single fan or to an indoor unit that does not perform individual fan control, having a noise cancellation mechanism with the same configuration, the noise can be further reduced.

[0386] Further, in the indoor unit 100 according to Embodiment 15, since the fan that is emitting noise that is highly related to the noise detected by the noise cancellation effect detection microphone with a large noise cancellation amount is specified, it is possible to perform precise rotation speed control even if plural fans 20A to 20C that emit different sound pressure levels are used.

[0387] Furthermore, since the blower fan control means 174 controls the rotation speed of each of the fans 20A to 20C so that the air volume emitted from the outlet port 3 is the same between when the individual fan control is performed and when the uniform-rotation-speed control is performed, it is possible to reduce noise without deteriorating the aerodynamic performance.

[0388] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated such that the noise cancellation mechanism A only reduces the noise emitted from the fan 20A, the noise cancellation mechanism B only reduces the noise emitted from the fan 20C, and the noise cancellation mechanism C only reduces the noise emitted from the fan 20B. Accordingly, in each of the regions, the crosstalk noise components due to the noise emitted from the neighboring region(s) becomes smaller.

[0389] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the air passage is made close to a duct structure and the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, compared to the configuration of Fig. 54, a higher noise cancellation effect can be obtained. On the other hand, even in a case in which there is a region with no noise cancellation mechanisms, a similar effect can be obtained by reducing the rotation speed of the fan that is not provided with any noise cancellation mechanism such that the noise in the region is reduced.

Embodiment 16

[0390] The individual fan control (individual fan control that uses information of the fans 20 that are highly related to the noise cancellation effect detection microphones) described in Embodiment 15 can be carried out in an air-conditioning apparatus provided with a different noise cancellation mechanism than that of Embodiment 15. Note that description will be given below of a case in which the individual fan control illustrated in Embodiment 15 is employed to the indoor unit according to Embodiment 12. Further, in Embodiment 16, points different from those of Embodiment 8 to Embodiment 15 described above will be mainly described, and same parts as Embodiment 8 to Embodiment 15 will be referred to with the same reference numerals.

[0391] Fig. 57 is a front view of the indoor unit according to Embodiment 16 of the invention.
The difference between the indoor unit 100 according to Embodiment 16 and the indoor unit 100 of Embodiment 12 is only the configuration of the blower fan control means 174. Note that the configuration of the blower fan control means 174 are exactly the same as the configuration illustrated in Fig. 55 of Embodiment 15.

[0392] Next, a description is given on operations of the indoor unit 100.
Similar to Embodiment 12, when the indoor unit 100 is operated, the impeller of each of the fans 20A to 20C rotates. Then, the air in the room is suctioned from the upper side of the fans 20A to 20C and is sent to the lower side of the fans 20A to 20C, thereby generating airflow. Accordingly, operation sounds (noise) are generated in the vicinity of the outlet ports of the fans 20A to 20C, and the sounds are propagated to the downstream side. The air sent from the fans 20A to 20C passes through the air passage and is sent to the heat exchanger 50. For example, during a cooling operation, a low-temperature refrigerant is supplied to the heat exchanger 50 from a pipe connected to the outdoor unit (not shown). The air that has been sent to the heat exchanger 50 is cooled by the refrigerant flowing through the heat exchanger 50 so as to become cold air, and is directly released from the outlet port 3 into the room.

[0393] Further, the operations of the noise cancellation mechanisms D to F are also completely the same as that described in Embodiment 12 and are operated so that the control sounds are output to make the noise detected by the noise/noise cancellation effect detection microphones 211 to 213 approach zero, resulting in suppression of noise to the noise/noise cancellation effect detection microphones 211 to 213.

[0394] In the indoor unit 100 according to Embodiment 16, other than the noise of the fan 20B, the noise/noise cancellation effect detection microphone 213 picks up noise that are emitted from the neighboring fans 20A and 20C (crosstalk noise components). On the other hand, the crosstalk noise components that are detected by the noise/noise cancellation effect detection microphones 211 and 212 are smaller than the crosstalk noise components that are detected by the noise/noise cancellation effect detection microphone 213. This is because the noise/noise cancellation effect detection microphones 211 and 212 each have only one neighboring fan (fan 20B). Accordingly, the noise cancellation effect of the noise cancellation mechanisms D and E are higher compared to that of the noise cancellation mechanism F.

[0395] The individual fan control of the fans 20A to 20C is substantially the same as the details described in Embodiment 15. The individual fan control of Embodiment 16 is different from the individual fan control of Embodiment 15 in that the S1 to S3 that are input to the noise cancellation amount calculating means 138 are digital values of the sound pressure level detected by the noise/noise cancellation effect detection microphones 211 to 213. Further, the individual fan control of Embodiment 16 is different from the individual fan control of Embodiment 15 in that the blower fan information accumulated in the memory 132 is the identification numbers of the fans 20 emitting noise that are most highly related to the sound detected by the noise/noise cancellation effect detection microphones 211 to 213.

[0396] Accordingly, the individual-fan-control rotation-speed determination means 134C of the blower fan control means 174 determines the rotation speed of the fans such that the rotation speed of the fan that is highly related to the sound detected by the noise/noise cancellation effect detection microphone with a large noise cancellation amount is increased, and the rotation speed of the fan that is highly related to the sound detected by the noise/noise cancellation effect detection microphone with a small noise cancellation amount is reduced, on the basis of the noise cancellation amounts calculated by the noise cancellation amount calculating means 138 and the blower fan information stored in the memory 132. The rotation speed of each of the fans 20A to 20C may be determined such that the air volume obtained when carrying out the individual fan control is the same as that when carrying out the uniform-rotation-speed control.

[0397] For example, in the indoor unit 100 according to Embodiment 16, assume that the fan emitting noise that is most highly related to the sound detected by the noise/noise cancellation effect detection microphone 211 is fan 20A, the fan emitting noise that is most highly related to the sound detected by the noise/noise cancellation effect detection microphone 212 is 20C, and the fan emitting noise that is most highly related to the sound detected by the noise/noise cancellation effect detection microphone 213 is fan 20B. Further, assume that the noise cancellation amount at the noise/noise cancellation effect detection microphone 211 is -5 dB, the noise cancellation amount at the noise/noise cancellation effect detection microphone 212 is -5 dB, and the noise cancellation amount at the noise/noise cancellation effect detection microphone 213 is -2 db. In the above case, the individual-fan-control rotation-speed determination means 134C determines the rotation speed of each fan such that the rotation speed of the fans 20A and 20C are increased and the rotation speed of the fan 20B is reduced. Since the air volume and the rotation speed have a proportionality relation, for example, when with the configuration of Fig. 57, in the case where the rotation speed of the fans 20A and 20C are each increased by 10%, the air volume will be the same if the rotation speed of the fan 20B is decreased by 20%.

[0398] Note that the above-described determination method of the rotation speed of the fans 20A to 20C is exemplary and explanatory only. In the indoor unit 100 according to Embodiment 16, assume that the fan emitting noise that is most highly related to the sound detected by the noise/noise cancellation effect detection microphone 211 is fan 20A, the fan emitting noise that is most highly related to the sound detected by the noise/noise cancellation effect detection microphone 212 is 20C, and the fan emitting noise that is most highly related to the sound detected by the noise/noise cancellation effect detection microphone 213 is fan 20B. Further, assume that the noise cancellation amount at the noise/noise cancellation effect detection microphone 211 is -5 dB, the noise cancellation amount at the noise/noise cancellation effect detection microphone 212 is -3 dB, and the noise cancellation amount at the noise/noise cancellation effect detection microphone 213 is -2 db. In the above case, the rotation speed of each fan may be determined such that the rotation speed of the fan 20A is increased, the rotation speed of the fan 20B is reduced, and the rotation speed of the fan 20C is kept the same. That is, the rotation speed of each fan may be determined such that the rotation speed of the fan 20A that is highly related to the noise cancellation effect detection microphone 191 having the largest noise cancellation amount is increased, the rotation speed of the fan 20B that is highly related to the noise cancellation effect detection microphone 193 having the smallest noise cancellation amount is reduced, and the rotation speed of the fan 20C that is neither of the above is kept the same.

[0399] When an operating information signal (for example, such as a signal for a silent mode) is input from the remote control 280 indicating that the individual fan control is to be carried out, by switching the SWs 135, the rotation control signal of the uniform-rotation-speed control is switched to the rotation control signals for the individual fan control. These rotation control signals are output from the controller 281 to the fans 20A to 20c. The rotation control signals output from the controller 281 are input to the motor drivers 282A to 282C and the fans 20A to 20C are controlled to have rotation speeds in accordance with the rotation control signals.

[0400] Here, as described above, in the case of the indoor unit 100 according to Embodiment 16, compared to the noise cancellation amount in the region in the vicinity of the noise/noise cancellation effect detection microphone 213, the noise cancellation amount in the regions in the vicinity of the noise/noise cancellation effect detection microphones 211 and 212 are larger, in accordance with the size of the crosstalk noise components from the neighboring fan(s). Meanwhile, the noise cancellation amount in the region in the vicinity of the noise/noise cancellation effect detection microphone 213 is smaller. Now, as regards the indoor unit 100 according to Embodiment 16 provided with plural fans 20A to 20C, the rotation speed of the fans 20A and 20C that are emitting noise that are highly related to the noise cancellation effect detection microphones 191 and 192 having high noise cancellation amounts are increased and the rotation speed of the fan 20B that is emitting noise that is highly related to the noise cancellation effect detection microphone 193 having a small noise cancellation amount is reduced.

[0401] As a result, in the indoor unit 100 according to Embodiment 16, since the noise cancellation effect becomes further higher in a region with a high noise cancellation effect and the noise becomes smaller in a region with a low noise cancellation effect, the noise emitted from the entire outlet port 3 can be reduced compared to that of an indoor unit that uses a single fan or to that of an indoor unit that does not perform individual fan control. Further, in the indoor unit 100 according to Embodiment 16, deterioration of aerodynamic performance can be suppressed by individually controlling the rotation speed of the plural fans 20A to 20C so that the air volume is uniform to the air volume when uniform-rotation-speed control is performed.

[0402] Additionally, similar to the indoor unit 100 illustrated in Figs. 51 and 52 of Embodiment 12, the indoor unit 100 according to Embodiment 16 also divides the air passage of the indoor unit 100 into a plurality of regions such that the noise cancellation effect can be further increased.

[0403] That is, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated in their respective areas such that the noise cancellation mechanism D only reduces the noise emitted from the fan 20A, the noise cancellation mechanism E only reduces the noise emitted from the fan 20C, and the noise cancellation mechanism F only reduces the noise emitted from the fan 20B. Accordingly, the crosstalk noise components (noise emitted from the fan(s) provided in the neighboring passage(s)) detected by the noise/noise cancellation effect detection microphones 211 to 213 become smaller.

[0404] Further, since the air passage is made close to a duct structure, the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, the noise cancellation effect becomes higher still. Accordingly, in the indoor unit 100 according to Embodiment 16 as well, by dividing the air passage of the indoor unit 100 into a plurality of regions, noise can be further reduced compared to that of the configuration of Fig. 57. On the other hand, even in a case in which there is a fan provided with no noise cancellation mechanisms, a similar effect can be obtained by reducing the rotation speed of the fan 20 so that the noise in the region that is not provided with any noise cancellation mechanism is reduced. Further, in Figs. 51 and 52, the partition plates are inserted through the entire air passage regions; however, the partition plates may separate only a portion of the air passages, such that only the upstream side of the heat exchanger 50 or only the downstream side of the heat exchanger 50 is separated, for example.

[0405] Note that in Embodiment 16, the noise/noise cancellation effect detection microphones 211 to 213 are disposed on the downstream side of the control speakers 181 to 183; however, the noise/noise cancellation effect detection microphones 211 to 213 may be disposed on the upstream side of the control speakers 181 to 183. Additionally, in Embodiment 16, although three of each of the control speaker, the noise/noise cancellation effect detection microphone, and the signal processing device are disposed, the invention is not limited to this.

[0406] Further, in Embodiment 16, although the blower fan control means 174 is configured in the CPU 131 inside the controller 281, it may be configured by hardware such as a Large Scale Integration (LSI) or a Field Programmable Gate Array (FPGA). Furthermore, the configuration of the blower fan control means 174 is not limited to the configuration illustrated in Fig. 55.

[0407] Moreover, Embodiment 16 is configured such that the blower fan control means 174 increases the rotation speed of a fan that is emitting a noise that is highly related to the noise cancellation effect detection microphone having a high noise cancellation amount, and reduces the rotation speed of the fan that is emitting a noise that is highly related to the noise/noise cancellation effect detection microphone having a low noise cancellation amount; however, the configuration may be such that either one is performed.

[0408] Further, in Embodiment 16, the noise cancellation amounts of the noise/noise cancellation effect detection microphones 211 to 213 are used as parameters for controlling the rotation speed of the fans; however, it goes without saying that other parameters may be used for controlling the rotation speed of the fan. For example, the mean value of the sound pressure level detected by each of the noise/noise cancellation effect detection microphones 211 to 213 may be calculated, and the rotation speed of the fan that is emitting noise that is highly related to the sound detected by the noise/noise cancellation effect detection microphone with the highest mean value of the noise pressure level may be reduced. Further, for example, the mean value of the sound pressure level detected by each of the noise/noise cancellation effect detection microphones 211 to 213 may be calculated, and the rotation speed of the fan that is emitting noise that is highly related to the sound detected by the noise/noise cancellation effect detection microphone with the lowest mean value of the noise pressure level may be increased. Naturally, both of the above may be performed.

[0409] As described above, in the indoor unit 100 according to Embodiment 16, the plural fans 20A to 20C are disposed, and the controller 281 (more specifically, the blower fan control means 174) that individually controls the rotation speed of each of the fans 20A to 20C is provided. The blower fan control means 174 performs rotation speed control such that the rotation speed of a fan that is emitting a noise that is highly related to the noise/noise cancellation effect detection microphone having a high noise cancellation amount, among the noise cancellation amounts at the noise/noise cancellation effect detection microphones 211 to 213, is increased, and the rotation speed of the fan that is emitting a noise that is highly related to the noise/noise cancellation effect detection microphone having a low noise cancellation amount, among the noise cancellation amounts at the noise/noise cancellation effect detection microphones 211 to 213, is reduced. Accordingly, the noise cancellation effect becomes further higher in a region with a high noise cancellation amount and the noise becomes smaller in a region with a low noise cancellation amount. Thus, compared to an indoor unit that uses a single fan having a noise cancellation mechanism with the same configuration or to an indoor unit that does not perform individual fan control, the noise can be further reduced.

[0410] Further, in the indoor unit 100 according to Embodiment 16, since the fan that is emitting noise that is highly related to the noise detected by the noise/noise cancellation effect detection microphone with a large noise cancellation amount is specified, it is possible to perform precise rotation speed control even if plural fans 20A to 20C that emit different sound pressure levels are used.

[0411] Furthermore, since the blower fan control means 174 controls the rotation speed of each of the fans 20A to 20C so that the air volume emitted from the outlet port 3 is the same between when the individual fan control is performed and when the uniform-rotation-speed control is performed, it is possible to reduce noise without deteriorating the aerodynamic performance.

[0412] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the noise emitted by each of the fans 20A to 20C can be separated such that the noise cancellation mechanism D only reduces the noise emitted from the fan 20A, the noise cancellation mechanism E only reduces the noise emitted from the fan 20C, and the noise cancellation mechanism F only reduces the noise emitted from the fan 20B. Accordingly, in each of the regions, the crosstalk noise components due to the noise emitted from the neighboring region(s) becomes smaller.

[0413] Further, by dividing the air passage of the indoor unit 100 into a plurality of regions with the partition plates 90 and 90a, the air passage is made close to a duct structure and the noise is captured in one dimension. Accordingly, the phase of the noise propagating through the indoor unit 100 becomes uniform, and phase error with the interfering control sound becomes small; hence, compared to the configuration of Fig. 57, a higher noise cancellation effect can be obtained. On the other hand, even in a case in which there is a region with no noise cancellation mechanisms, a similar effect can be obtained by reducing the rotation speed of the fan that is not provided with any noise cancellation mechanism such that the noise in the region is reduced.

[0414] Additionally, in Embodiment 16, since the noise detection microphones 161 to 163 and the noise cancellation effect detection microphones 191 to 193 are integrated into the noise/noise cancellation effect detection microphones 211 to 213, the number of microphones can be reduced and, accordingly, the parts count is reduced; hence, cost can be further reduced. Reference Signs List

[0415] 1 casing; 1 b rear side portion; 2 inlet port; 3 outlet port; 5 bell mouth; 5a upper portion; 5b middle portion; 5c lower portion; 6 nozzle; 10 filter; 15 finger guard; 16 motor stay; 17 fixing member; 18 supporting member; 20 (20A-20C) fan; 20a rotation shaft; 21 boss; 25 impeller; 30 fan motor; 50 heat exchanger; 50a symmetry line; 51 front side heat exchanger; 55 rear side heat exchanger; 56 fin; 57 heat transfer pipe; 58 heat exchanger fitting; 70 horizontal vane; 90 partition plate; 90a partition plate; 100 indoor unit; 110 front side drain pan; 111 drainage channel; 111a tongue portion; 115 rear side drain pan; 116 connecting port; 117 drain hose; 121 multiplier; 122 adder; 123 delay element; 124 multiplier; 130 input unit; 131 CPU; 132 memory; 133 uniform-rotation-speed determination means; 134 (134A, 134B, 134C) individual-fan-control rotation-speed determination means; 135 SW; 136 averaging means; 137 coherence computing means; 138 noise cancellation amount calculating means; 139 pre-control sound-pressure-level storage means; 140 difference device; 151 microphone amplifier; 152 A/D converter; 153 weighting means; 154 D/A converter; 155 amplifier; 158, 160 FIR filter; 159 LMS algorithm; 161-163 noise detection microphone; 171-174 blower fan control means; 181-183 control speaker; 191-193 noise cancellation effect detection microphone; 201-208 signal processing device; 211-213 noise/noise cancellation effect detection microphone; 270 wall member; 280 remote control; 281 controller; 282A-282C motor driver.

Claims

1. An air-conditioning apparatus, comprising:

a casing formed with an inlet port in an upper portion thereof and with an outlet port on a front lower portion thereof;
a plurality of blower fans provided in parallel on a downstream side of the inlet port in the casing;
a heat exchanger provided on a downstream side of the fans and on an upstream side of the outlet port, the heat exchanger exchanging heat between air that has been blown out from the fans and a refrigerant;
a noise detection device detecting noise emitted from the fans;
a control sound output device outputting a control sound that reduces the noise;
a noise cancellation effect detection device detecting a noise cancellation effect of the control sound;
a control sound generation device making the control sound output device output the control sound on the basis of detection results of the noise detection device and the noise cancellation effect detection device; and
a controller performing individual rotation speed control for the plurality of fans,
wherein, the controller controls at least one rotation speed of the plurality of fans on the basis of a noise cancellation effect at a time when the control sound is interfered with the noise emitted from the fans.

2. The air-conditioning apparatus of claim 1, wherein, on the basis of the noise cancellation effect detected by the noise cancellation effect detection device, the controller changes the rotation speed depending on a relevance between a sound detected by the noise cancellation effect detection device and the fan.

3. The air-conditioning apparatus of claim 2, wherein the controller performs at least either one of rotation speed control that increases the rotation speed of one of the fans that is emitting noise that is most highly related to the sound detected by the noise cancellation effect detection device that has detected a higher noise cancellation effect and rotation speed control that reduces the rotation speed of one of the fans that is emitting noise that is most unrelated to the sound detected by the noise cancellation effect detection device.

4. The air-conditioning apparatus of claim 2 or 3, wherein the controller performs rotation speed control such that the rotation speed of one of the fans that is emitting noise that is most highly related to the sound detected by the noise cancellation effect detection device that has detected a low noise cancellation effect is reduced.

5. The air-conditioning apparatus of claim 2, comprising a plurality of the noise cancellation effect detection devices, wherein, on the basis of sound pressure levels detected by the noise cancellation effect detection devices, the controller performs at least either one of rotation speed control that increases the rotation speed of one of the fans that is emitting noise that is most highly related to the sound detected by one of the noise cancellation effect detection devices that has detected a lowest sound pressure level and rotation speed control that reduces the rotation speed of one of the fans that is emitting noise that is most highly related to the sound detected by one of the noise cancellation effect detection devices that has detected a highest sound pressure level.

6. The air-conditioning apparatus of claim 2, comprising a plurality of the noise detection devices and a plurality of the noise cancellation effect detection devices,
wherein, the controller calculates coherence values between detection values of the noise detection devices and detection values of the noise cancellation effect detection devices and performs at least either one of rotation speed control that increases the rotation speed of one of the fans that is emitting noise that is most highly related to the sound detected by one of the noise cancellation effect detection devices that has a largest coherence value and rotation speed control that reduces the rotation speed of one of the fans that is emitting noise that is most highly related to the sound detected by one of the noise cancellation effect detection devices that has a smallest coherence value.

7. The air-conditioning apparatus of claim 1 or 2, wherein the controller further comprises a memory that memorizes at least one of the fans that is closer in distance to the noise cancellation effect detection device and performs at least either one of rotation speed control that increases the rotation speed of the fan, being memorized in the memory, that is closer in distance to the noise cancellation effect detection device and rotation speed control that reduces the rotation speed of one or some of the fans other than the fan, being memorized in the memory, that is closer in distance to the noise cancellation effect detection device.

8. The air-conditioning apparatus of claim 1 or 2, wherein the controlled further comprises a memory that memorizes at least one of the fans that is close in distance to the noise cancellation effect detection device and performs at least either one of rotation speed control that reduces the rotation speed of the fan that is close in distance to the noise cancellation effect detection device that has detected a higher sound pressure level and rotation speed control that increases the rotation speed of the fan that is close in distance to the noise cancellation effect detection device that has detected a low sound pressure level.

9. The air-conditioning apparatus of claim 1 or 2, wherein the controller further comprises a memory that memorizes each fan that is closer in distance to the corresponding noise cancellation effect detection device, calculates a coherence value between a detection value of each noise detection device and a detection value of the corresponding noise cancellation effect detection device, and performs at least either one of rotation speed control that reduces the rotation speed of the fan that is closer in distance to the noise cancellation effect detection device that has a small coherence value and rotation speed control that increases the rotation speed of the fan that is closer in distance to the noise cancellation effect detection device that has a large coherence value.

10. The air-conditioning apparatus of any one of claims 1 to 9, wherein an inside of the casing is divided into a plurality of regions by means of a partition plate.

11. The air-conditioning apparatus of claim 10, wherein, when the individual rotation speed control for the plurality of fans is performed, the controller performs rotation speed control such that one or some of the fans provided in one or some of the regions, among the plurality of regions, that are not provided with the noise cancellation effect detection device is reduced.

12. The air-conditioning apparatus of claim 10 or 11, wherein, when the individual rotation speed control of the plurality of fans is performed, the controller performs rotation speed control such that one or some of the fans provided in one or some of the regions, among the plurality of regions, that are provided with the noise cancellation effect detection device is increased.

13. The air-conditioning apparatus of any one of claims 1 to 12, wherein, when the individual rotation speed control of the plurality of fans is performed, the controller performs the individual rotation speed control of the plurality of fans such that an air volume is similar to the air volume before execution of the rotation speed control.

14. An air-conditioning apparatus, comprising:

a casing formed with an inlet port in an upper portion thereof and with an outlet port on a front lower portion thereof;
a plurality of blower fans provided in parallel on a downstream side of the inlet port in the casing;
a heat exchanger provided on a downstream side of the fans and on an upstream side of the outlet port, the heat exchanger exchanging heat between air that has been blown out from the fans and a refrigerant;
a control sound output device outputting a control sound that reduces noise emitted from the fans;
a noise/noise cancellation effect detection device detecting the noise, the noise/noise cancellation effect detection device detecting a noise cancellation effect of the control sound;
a control sound generation device making the control sound output device output the control sound on the basis of a detection result of the noise/noise cancellation effect detection device; and
a controller performing individual rotation speed control for the plurality of fans,
wherein, the controller controls at least one rotation speed of the plurality of fans on the basis of a noise cancellation effect at a time when the control sound is interfered with the noise emitted from the fans.

15. The air-conditioning apparatus of claim 14, wherein, on the basis of the noise cancellation effect detected by the noise/noise cancellation effect detection device, the controller changes the rotation speed depending on a relevance between a sound detected by the noise/noise cancellation effect detection device and the fans.

16. The air-conditioning apparatus of claim 15, wherein the controller performs at least either one of rotation speed control that increases the rotation speed of one of the fans that is emitting noise that is most highly related to the sound detected by the noise/noise cancellation effect detection device that has detected a higher noise cancellation effect and rotation speed control that reduces the rotation speed of one of the fans that is emitting noise that is most unrelated to the sound detected by the noise/noise cancellation effect detection device.

17. The air-conditioning apparatus of claim 15 or 16, wherein the controller performs rotation speed control such that the rotation speed of one of the fans that is emitting noise that is most highly related to the sound detected by the noise/noise cancellation effect detection device that has detected a low noise cancellation effect is reduced.

18. The air-conditioning apparatus of claim 15, comprising a plurality of the noise/noise cancellation effect detection devices, wherein, on the basis of sound pressure levels detected by the noise/noise cancellation effect detection devices, the controller performs at least either one of rotation speed control that increases the rotation speed of one of the fans that is emitting noise that is most highly related to the sound detected by a noise/noise cancellation effect detection device that has detected a lowest sound pressure level and rotation speed control that reduces the rotation speed of one of the fans that is emitting noise that is most highly related to the sound detected by a noise/noise cancellation effect detection device that has detected a highest sound pressure level.

19. The air-conditioning apparatus of claim 14 or 15, wherein the controller further comprises a memory that memorizes at least one of the fans that is close in distance to the noise/noise cancellation effect detection device and performs at least either one of rotation speed control that increases the rotation speed of the fan, being memorized in the memory, that is close in distance to the noise/noise cancellation effect detection device and rotation speed control that reduces the rotation speed of one or some of the fans other than the fan, being memorized in the memory, that is close in distance to the noise/noise cancellation effect detection device.

20. The air-conditioning apparatus of claim 14 or 15, wherein the controller further comprises a memory that memorizes at least one of the fans that is close in distance to the noise/noise cancellation effect detection device and performs at least either one of rotation speed control that reduces the rotation speed of the fan that is close in distance to the noise/noise cancellation effect detection device that has detected a higher sound pressure level and rotation speed control that increases the rotation speed of the fan that is close in distance to the noise/noise cancellation effect detection device that has detected a low sound pressure level.

21. The air-conditioning apparatus of any one of claims 14 to 20, wherein an inside of the casing is divided into a plurality of regions by means of a partition plate.

22. The air-conditioning apparatus of claim 21, wherein, when performing the individual rotation speed control for the plurality of fans, the controller performs rotation speed control such that one or some of the fans provided in one or some of the regions, among the plurality of regions, that are not provided with the noise/noise cancellation effect detection device is reduced.

23. The air-conditioning apparatus of claim 21 or 22, wherein, when performing the individual rotation speed control for the plurality of fans, the controller performs rotation speed control such that one or some of the fans provided in one or some of the regions, among the plurality of regions, that are provided with the noise/noise cancellation effect detection device is increased.

24. The air-conditioning apparatus of any one of claims 14 to 23, wherein, when performing the individual rotation speed control for the plurality of fans, the controller performs the individual rotation speed control for the plurality of fans such that an air volume is similar to the air volume before execution of the rotation speed control.

25. An air-conditioning apparatus, comprising:

a casing formed with an inlet port in an upper portion thereof and with an outlet port on a front lower portion thereof;
a plurality of blower fans provided in parallel on a downstream side of the inlet port in the casing;
a heat exchanger provided on a downstream side of the fans and on an upstream side of the outlet port, the heat exchanger exchanging heat between air that has been blown out from the fans and a refrigerant;
a noise detection device detecting noise emitted from the fans;
a control sound output device outputting a control sound that reduces the noise;
a noise cancellation effect detection device detecting a noise cancellation effect of the control sound;
a control sound generation device making the control sound output device output the control sound on the basis of detection results of the noise detection device and the noise cancellation effect detection device; and
a controller performing individual rotation speed control for the plurality of fans,
wherein, the controller performs at least either one of rotation speed control that increases rotation speed of the fans that are disposed at two ends of the casing and rotation speed control that reduces the rotation speed of one or some of the fans other than the fans that are disposed at the two ends of the casing.

26. The air-conditioning apparatus of claim 25, wherein an inside of the casing is divided into a plurality of regions by means of a partition plate.

27. The air-conditioning apparatus of claim 26, wherein, when performing the individual rotation speed control for the plurality of fans, the controller performs rotation speed control such that one or some of the fans provided in one or some of the regions, among the plurality of regions, that are not provided with the noise cancellation effect detection device is reduced.

28. The air-conditioning apparatus of claim 26 or 27, wherein, when performing the individual rotation speed control of the plurality of fans, the controller performs rotation speed control such that one or some of the fans provided in one or some of the regions, among the plurality of regions, that are provided with the noise cancellation effect detection device is increased.

29. The air-conditioning apparatus of any one of claims 25 to 28, wherein, when performing the individual rotation speed control of the plurality of fans, the controller performs the individual rotation speed control for the plurality of fans such that an air volume is similar to the air volume before execution of the rotation speed control.

30. An air-conditioning apparatus, comprising:

a casing formed with an inlet port in an upper portion thereof and with an outlet port on a front lower portion thereof;
a plurality of blower fans provided in parallel on a downstream side of the inlet port in the casing;
a heat exchanger provided on a downstream side of the fans and on an upstream side of the outlet port, the heat exchanger exchanging heat between air that has been blown out from the fans and a refrigerant;
a control sound output device outputting a control sound that reduces noise emitted from the fans;
a noise/noise cancellation effect detection de-

vice detecting the noise, the noise/noise cancellation effect detection device detecting a noise cancellation effect of the control sound;
a control sound generation device making the control sound output device output the control sound on the basis of a detection result of the noise/noise cancellation effect detection device; and
a controller performing individual rotation speed control for the plurality of fans,
wherein, the controller performs at least either one of rotation speed control that increases rotation speed of the fans that are disposed at two ends of the casing and rotation speed control that reduces the rotation speed of one or some of the fans other than the fans that are disposed at the two ends of the casing.

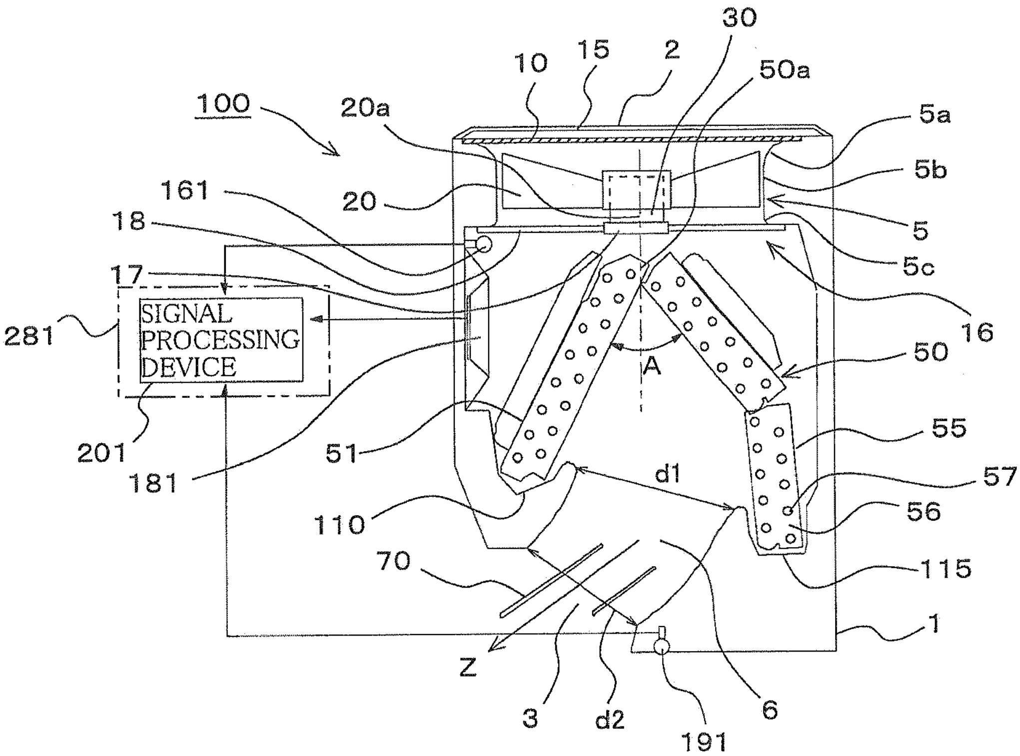
31. The air-conditioning apparatus of claim 30, wherein an inside of the casing is divided into a plurality of regions by means of a partition plate.

32. The air-conditioning apparatus of claim 31, wherein, when performing the individual rotation speed control of the plurality of fans, the controller performs rotation speed control such that one or some of the fans provided in one or some of the regions, among the plurality of regions, that are not provided with the noise/noise cancellation effect detection device is reduced.

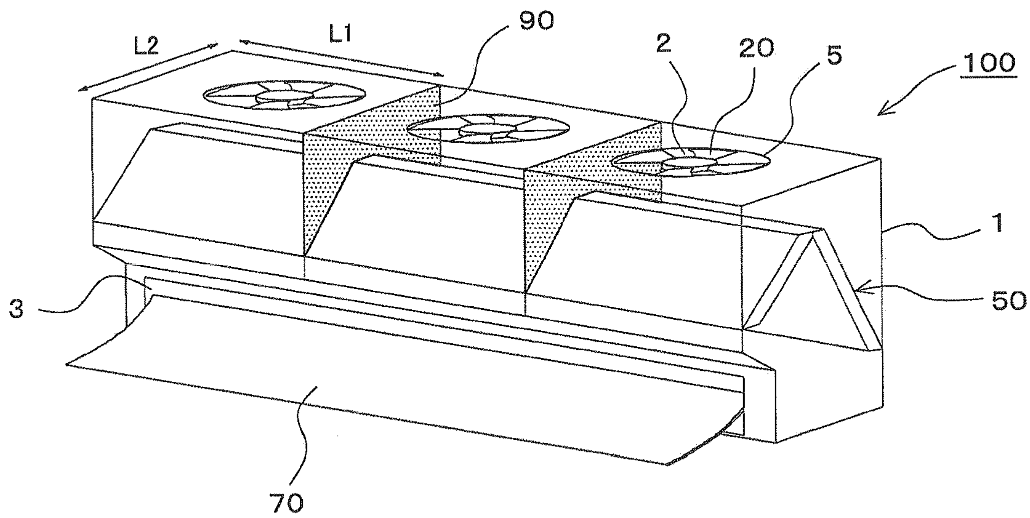
33. The air-conditioning apparatus of claim 31 or 32, wherein, when performing the individual rotation speed control of the plurality of fans, the controller performs rotation speed control such that one or some of the fans provided in one or some of the regions, among the plurality of regions, that are provided with the noise/noise cancellation effect detection device is increased.

34. The air-conditioning apparatus of any one of claims 30 to 33, wherein, when performing the individual rotation speed control of the plurality of fans, the controller performs the individual rotation speed control for the plurality of fans such that an air volume is similar to the air volume before execution of the rotation speed control.

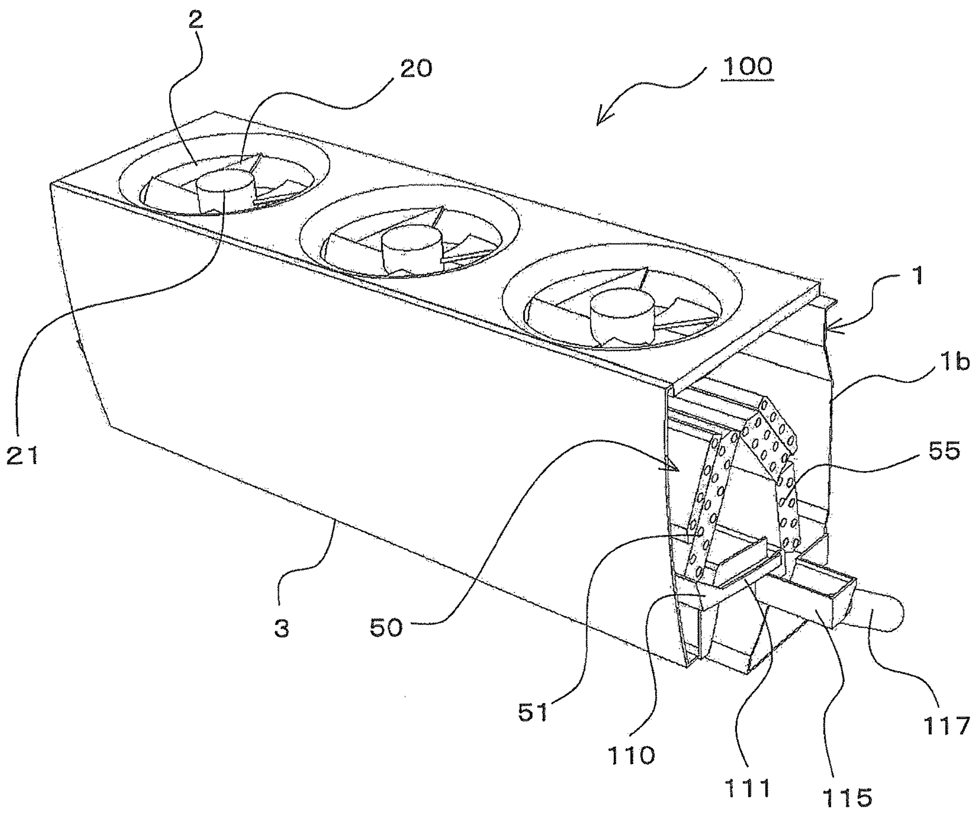
F I G. 1


100
10
15
2
30
50a
20a
5a
5b
161
20
5
18
5c
17
16
SIGNAL PROCESSING DEVICE
281
50
A
55
201
51
181
57
d1
56
110
115
70
1
Z
3
d2
6
191

F I G. 2


L2
L1
90
2
20
5
100
1
3
50
70

F I G. 3



F I G. 4

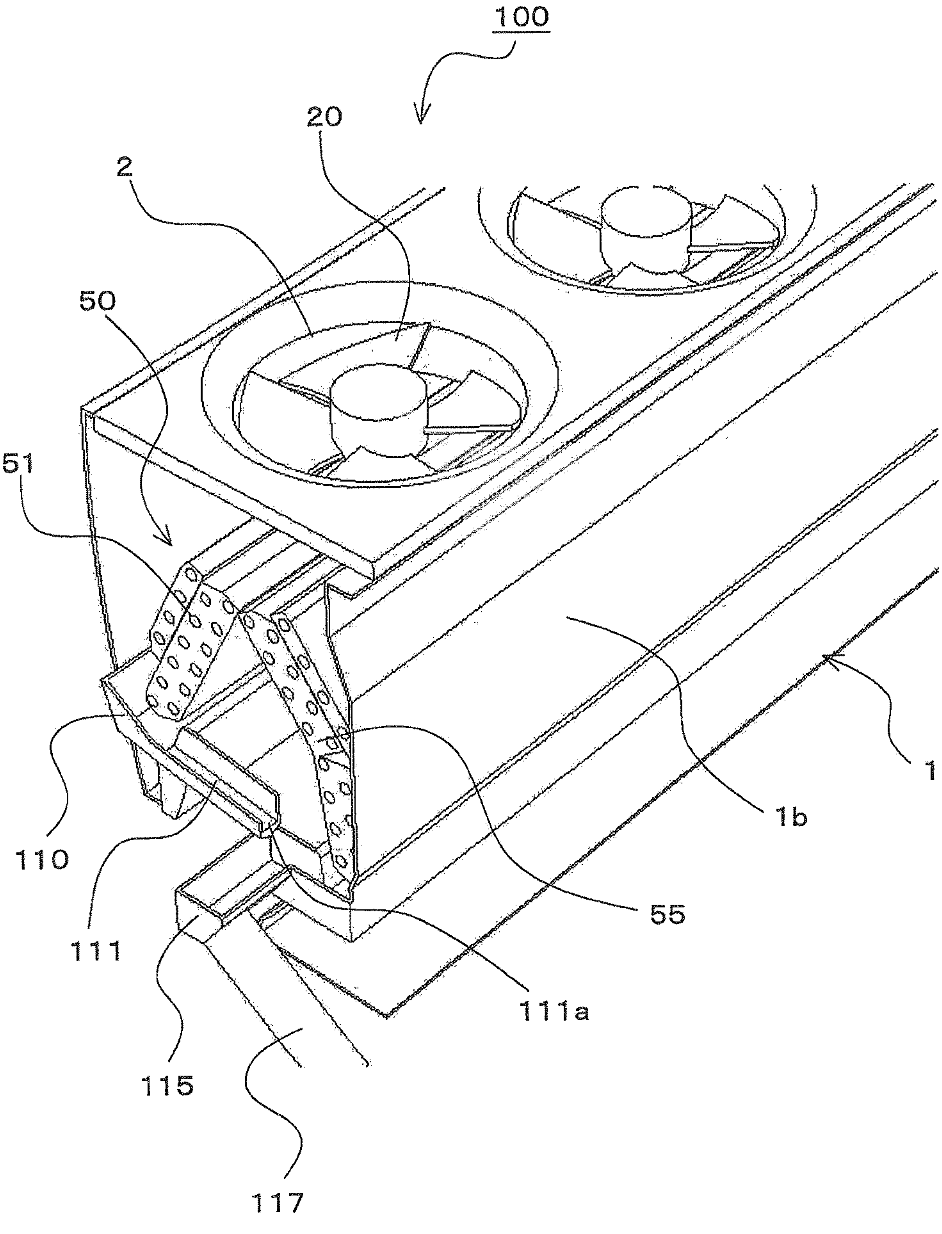
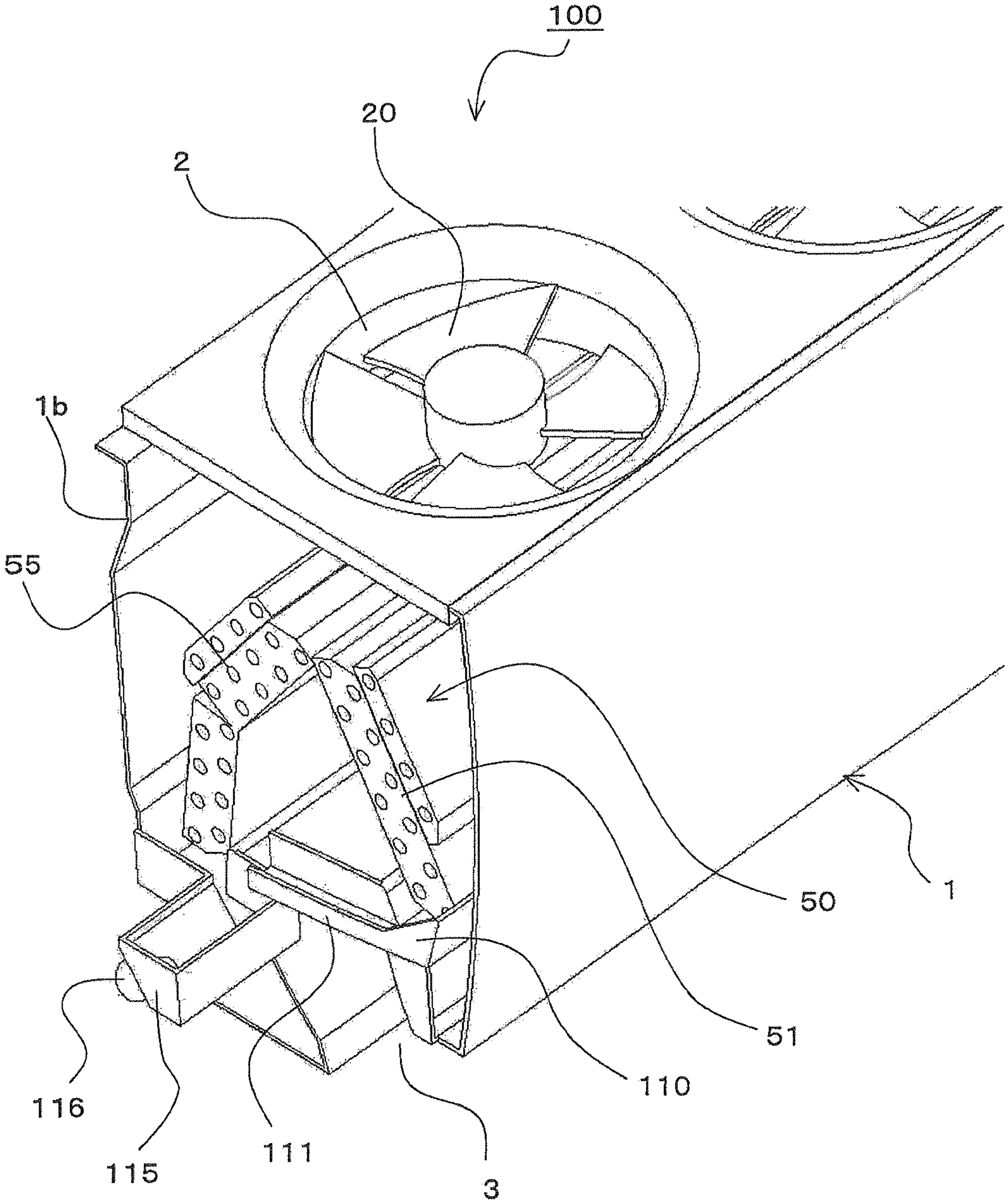
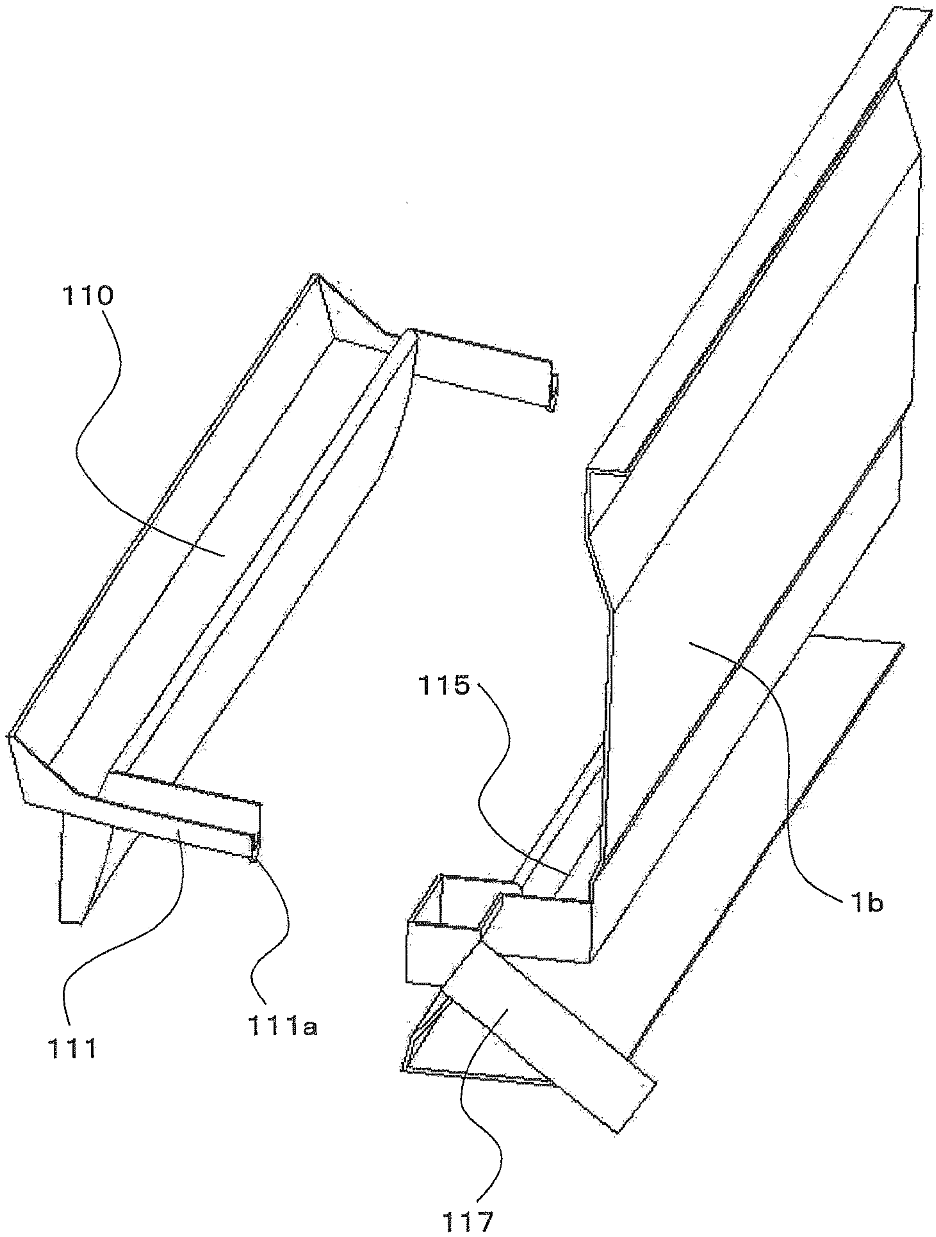


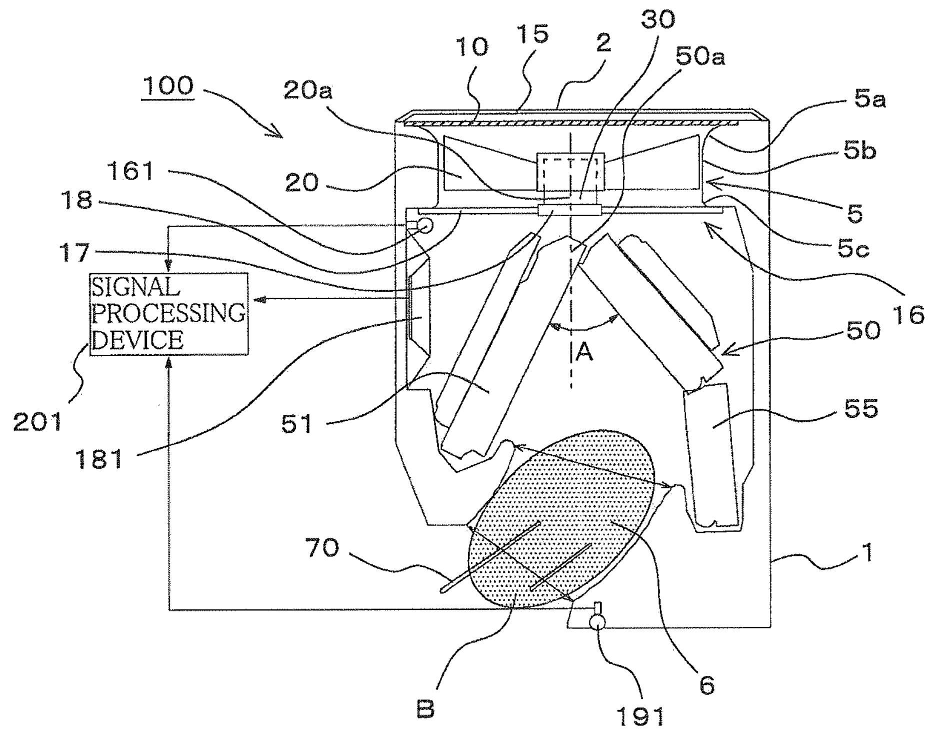
FIG. 5



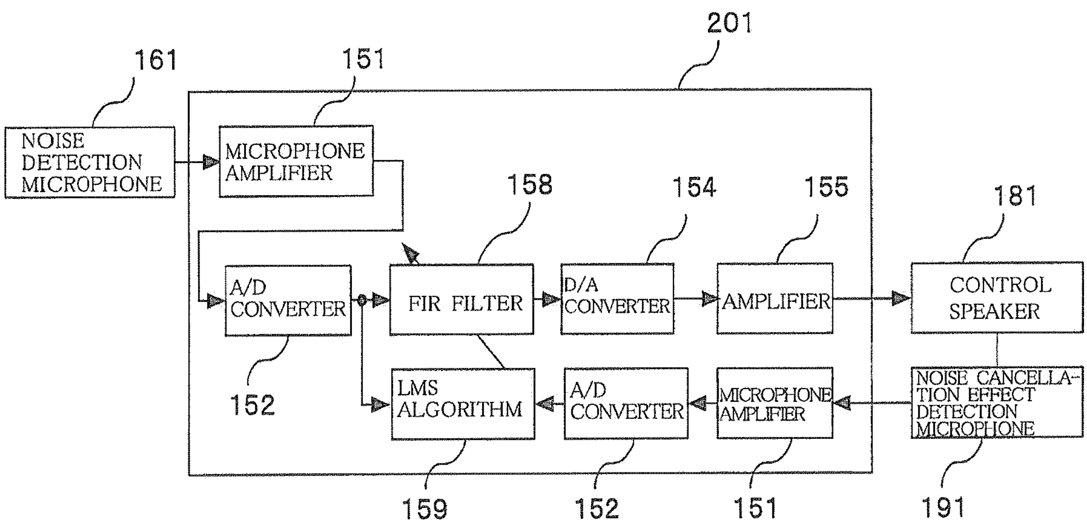
F I G. 6



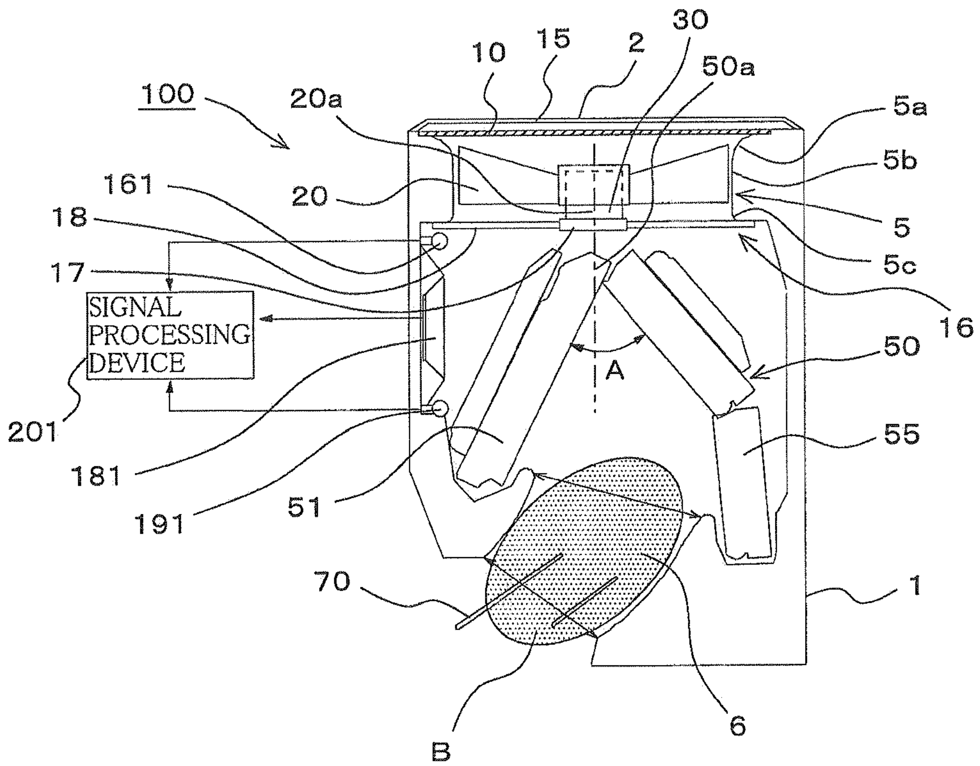
F I G. 7


100
10
15
2
30
50a
5a
20a
5b
161
20
5
18
5c
17
16
SIGNAL PROCESSING DEVICE
50
A
201
51
55
181
70
1
B
6
191

F I G. 8


201
161
151
NOISE DETECTION 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 CANCELLATION EFFECT DETECTION MICROPHONE
159
152
151
191

F I G. 9


100
10
15
2
30
50a
20a
5a
5b
161
20
5
18
5c
17
16
SIGNAL
PROCESSING
DEVICE
50
A
201
55
181
51
191
70
1
B
6

F I G. 1 0

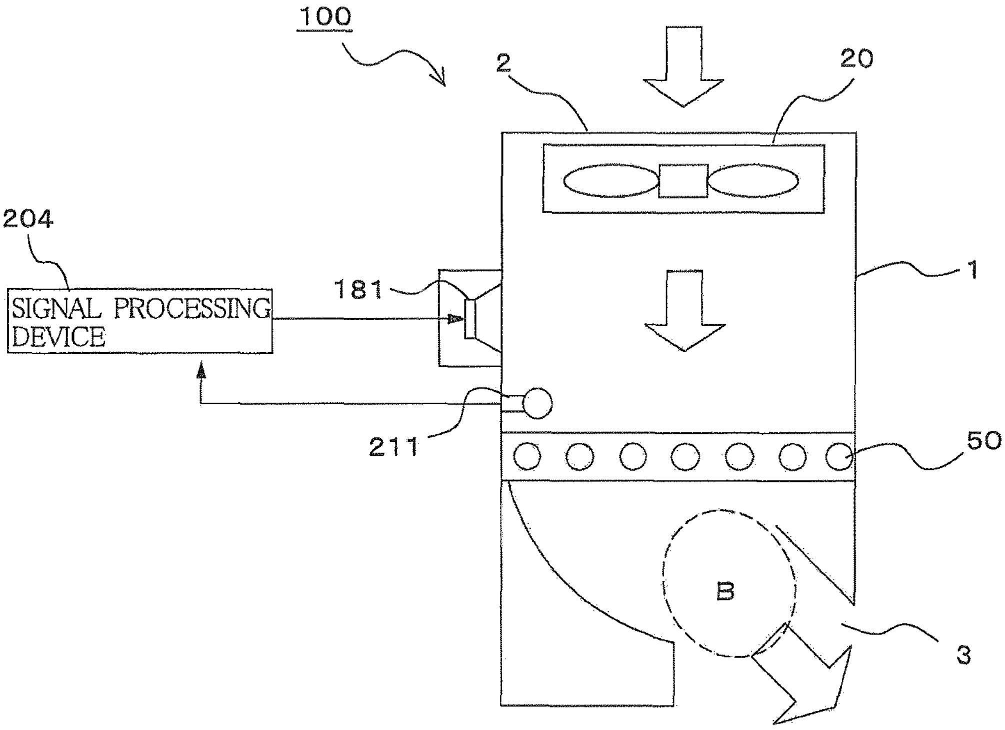


FIG. 11

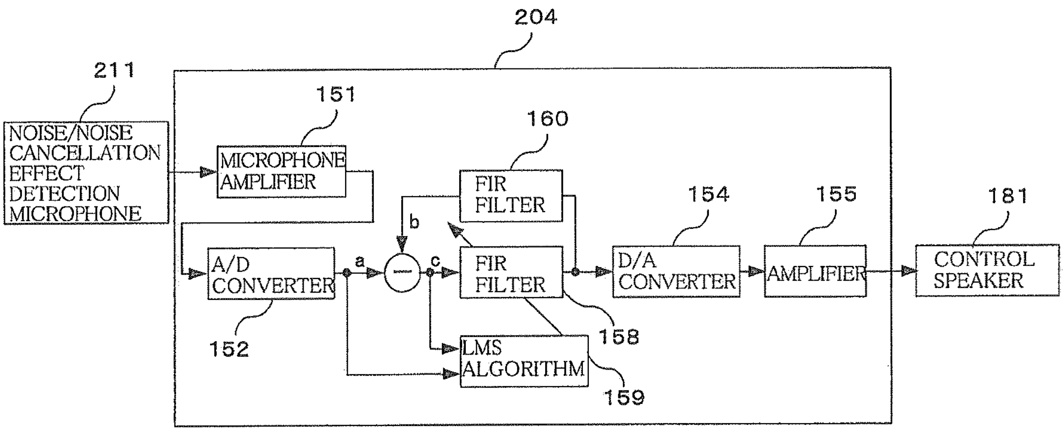


FIG. 12

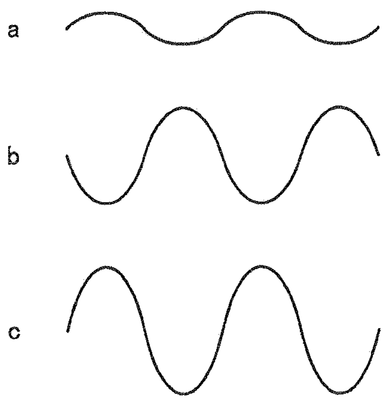


FIG. 13

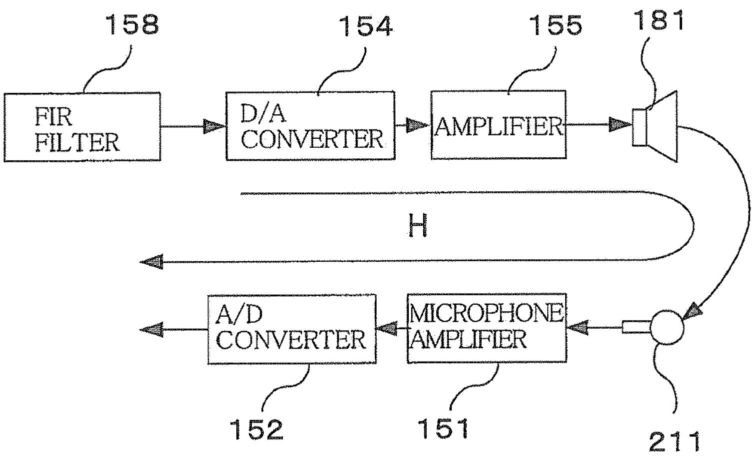
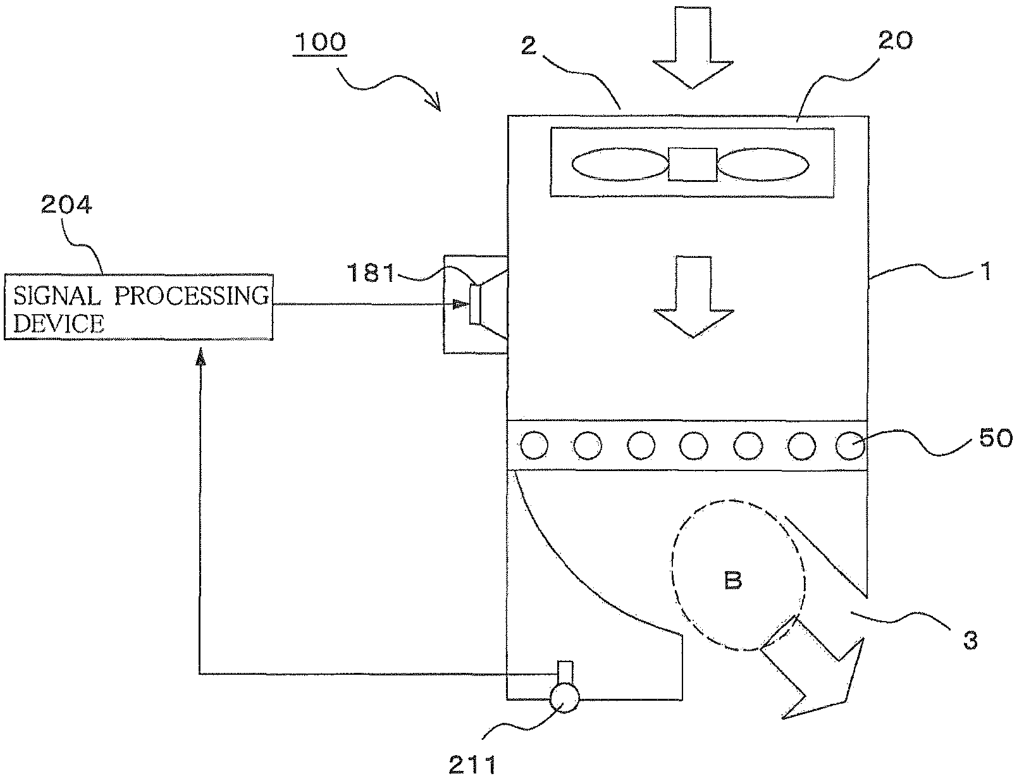


FIG. 14



F I G. 1 5

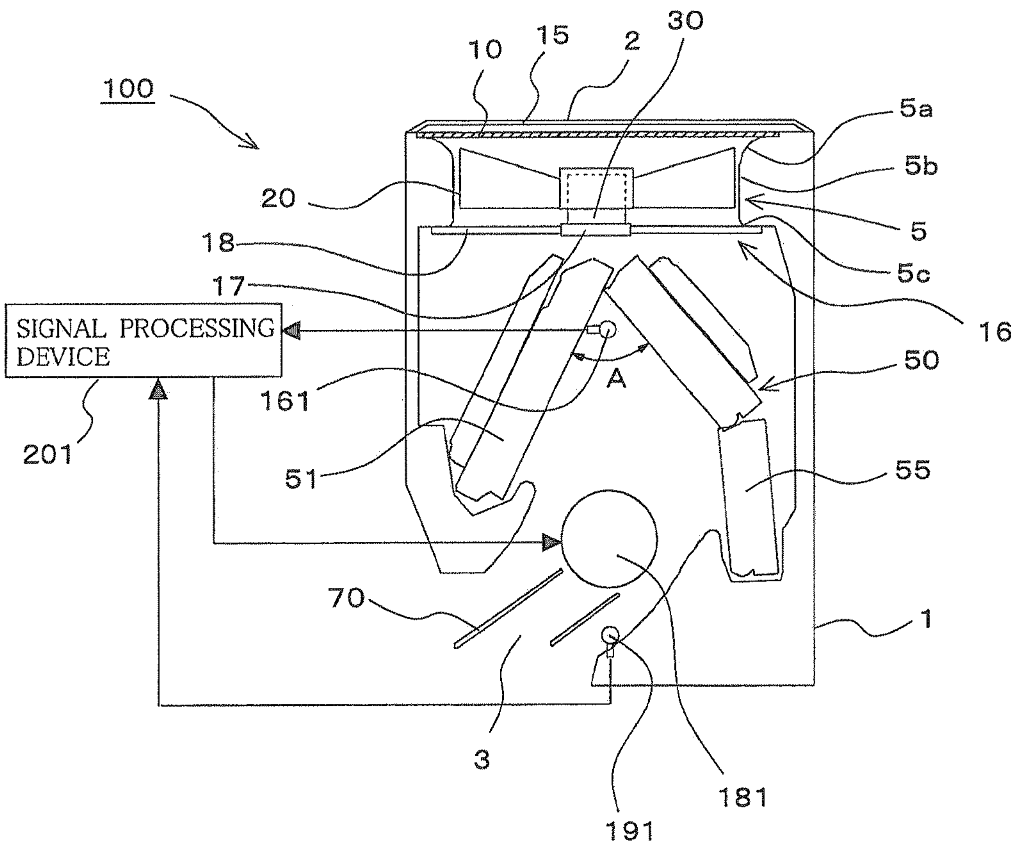
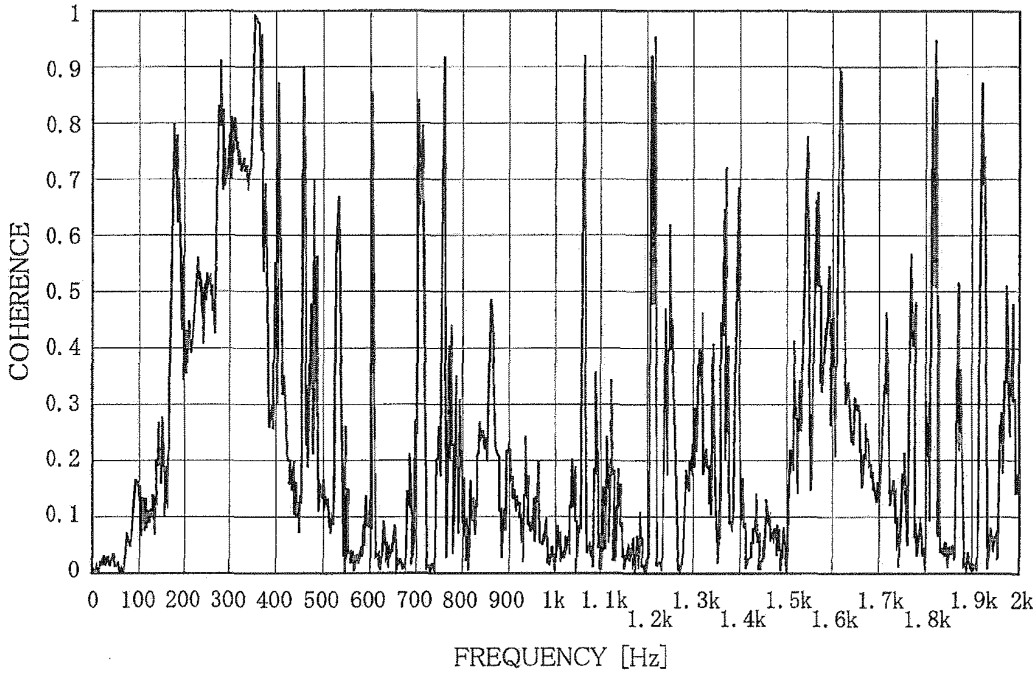
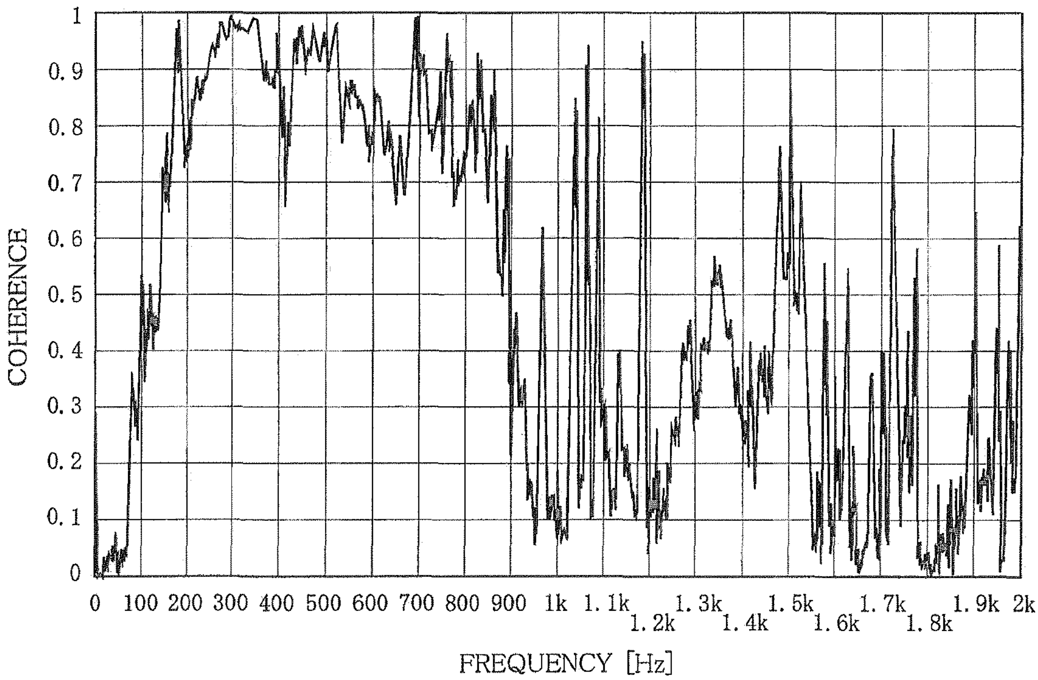

100
10
15
2
30
5a
5b
5
5c
16
50
55
1
20
18
17
SIGNAL PROCESSING DEVICE
201
161
A
51
70
3
191
181

FIG. 16

(a)


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
COHERENCE
0 100 200 300 400 500 600 700 800 900 1k 1.1k 1.2k 1.3k 1.4k 1.5k 1.6k 1.7k 1.8k 1.9k 2k
FREQUENCY [Hz]

(b)


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
COHERENCE
0 100 200 300 400 500 600 700 800 900 1k 1.1k 1.2k 1.3k 1.4k 1.5k 1.6k 1.7k 1.8k 1.9k 2k
FREQUENCY [Hz]

F I G. 1 7

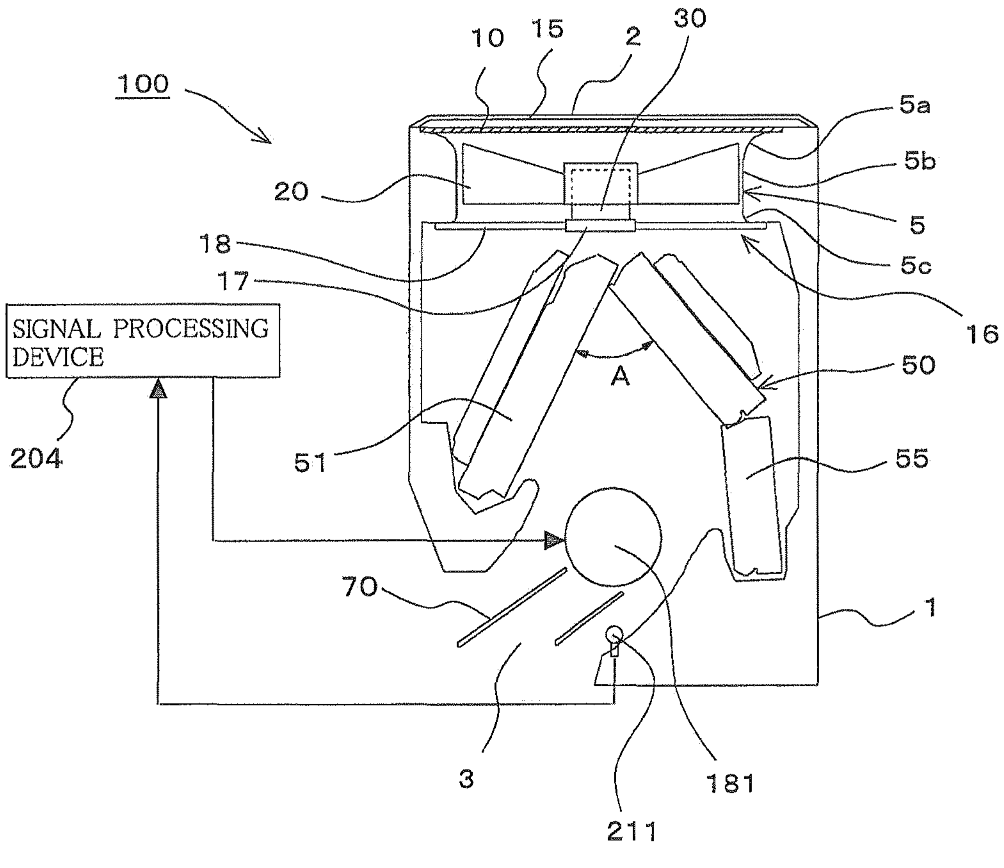

100
10
15
2
30
5a
5b
5
5c
16
20
18
17
SIGNAL PROCESSING DEVICE
204
A
50
51
55
70
1
3
181
211

FIG. 18

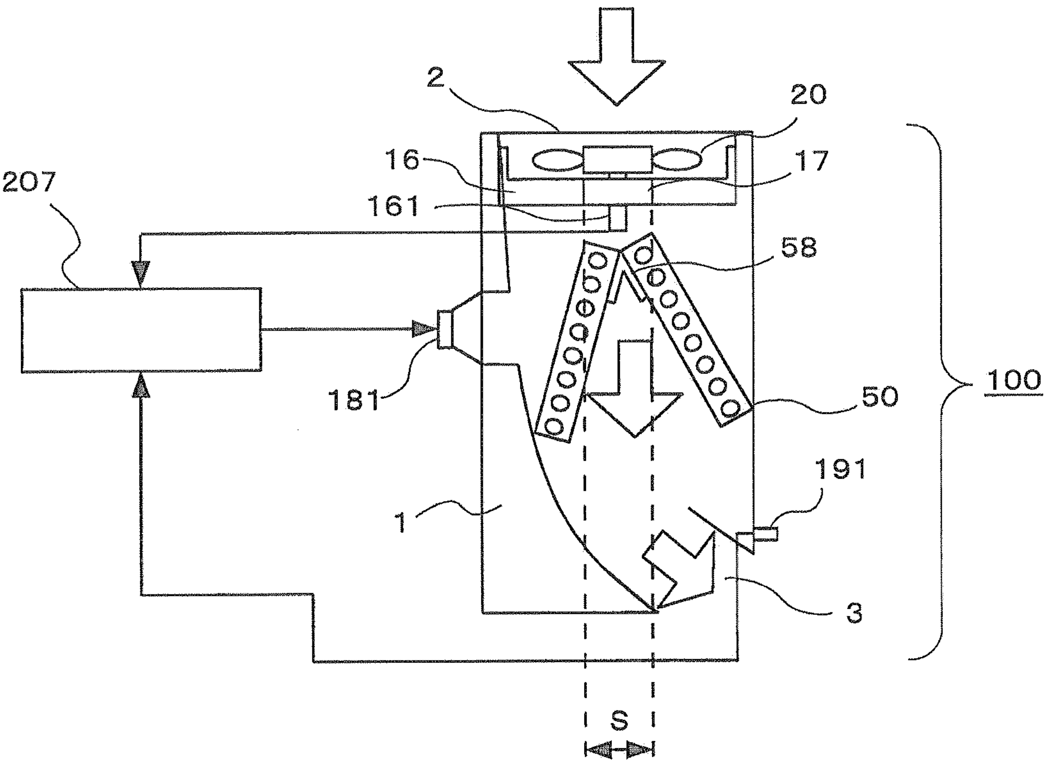
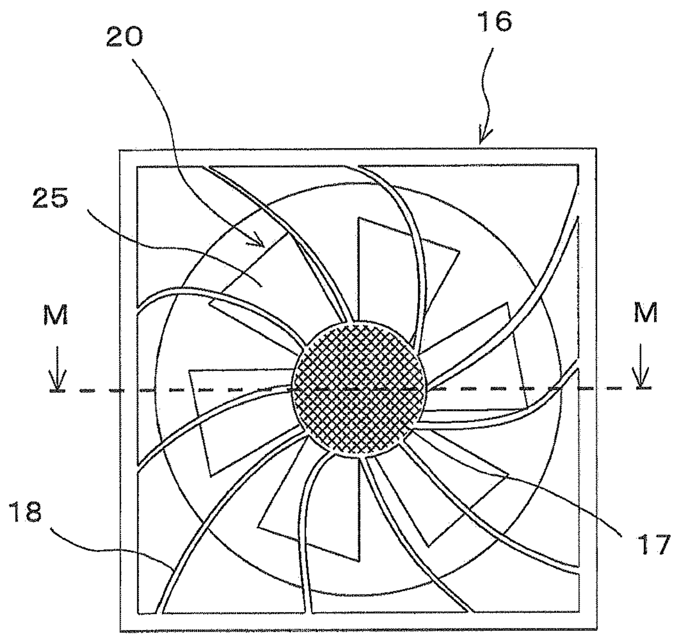


FIG. 19



F I G. 2 0

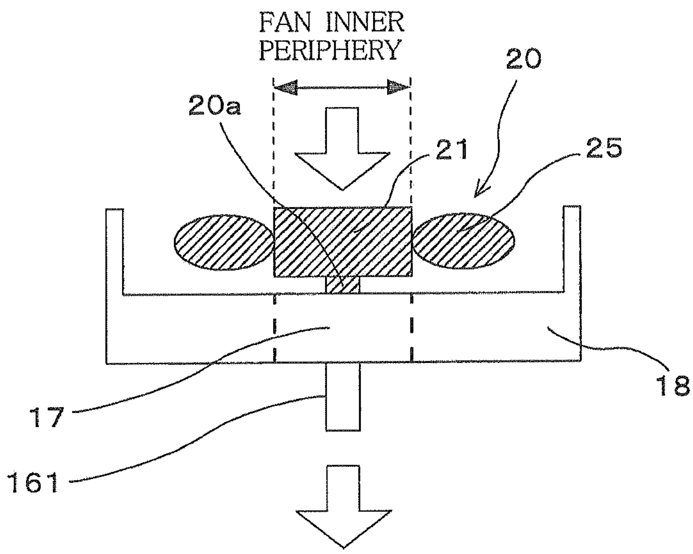
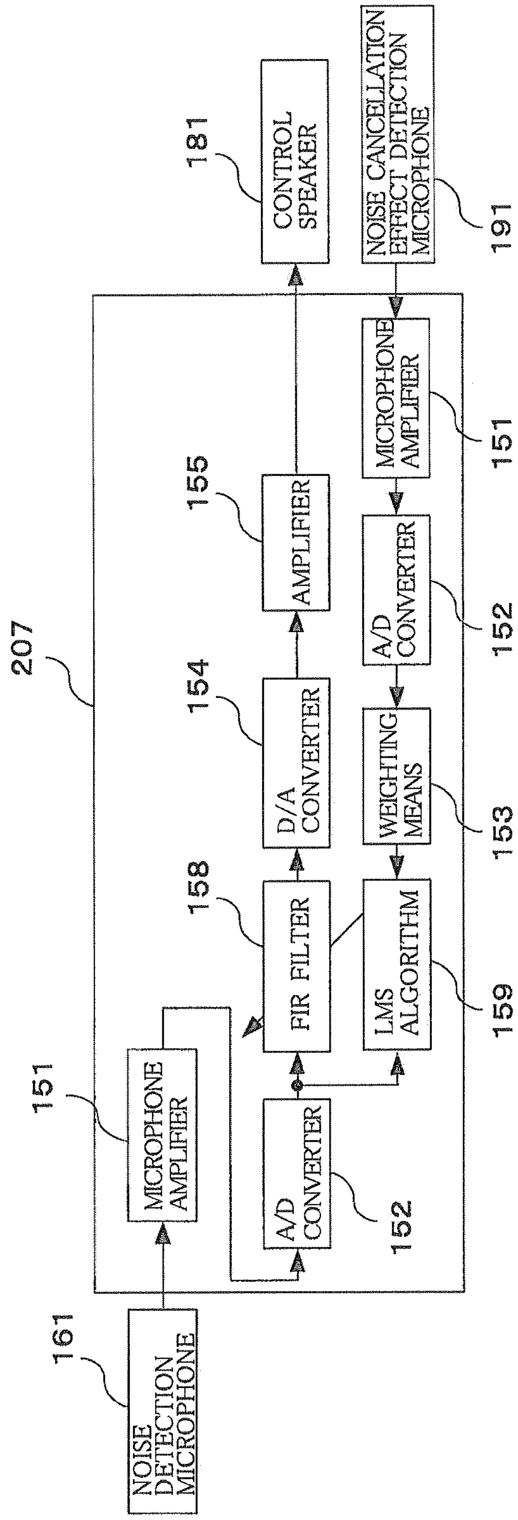


FIG. 21


NOISE DETECTION MICROPHONE
161
207
MICROPHONE AMPLIFIER
151
A/D CONVERTER
152
FIR FILTER
158
LMS ALGORITHM
159
D/A CONVERTER
154
WEIGHTING MEANS
153
AMPLIFIER
155
A/D CONVERTER
152
MICROPHONE AMPLIFIER
151
CONTROL SPEAKER
181
NOISE CANCELLATION EFFECT DETECTION MICROPHONE
191

F I G. 2 2

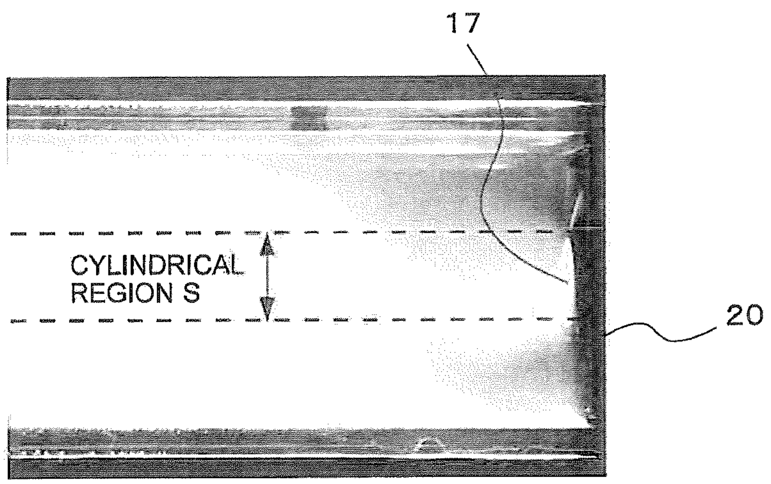


FIG. 23

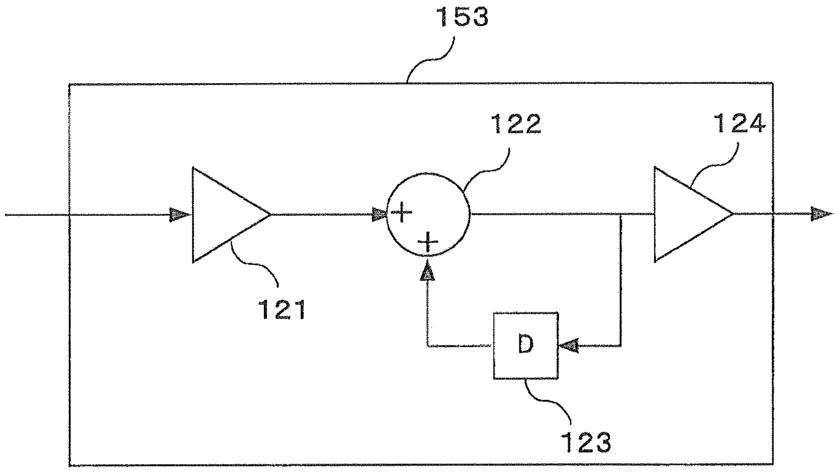


FIG. 24

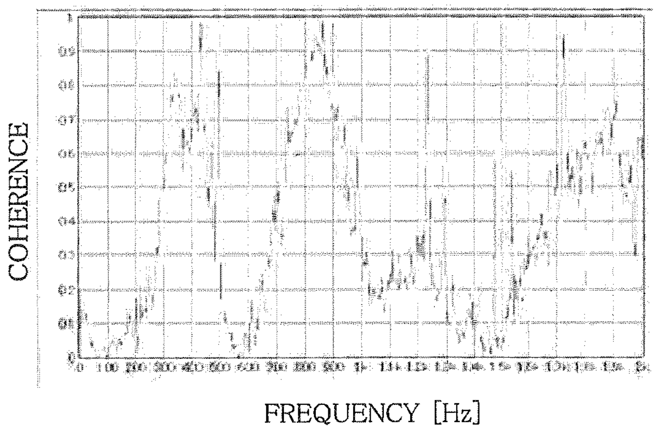
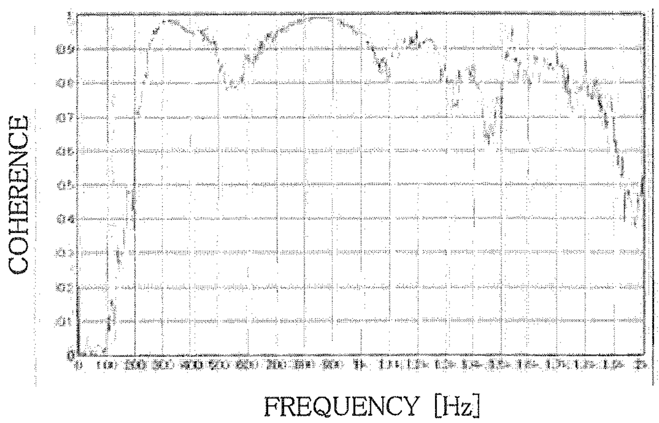
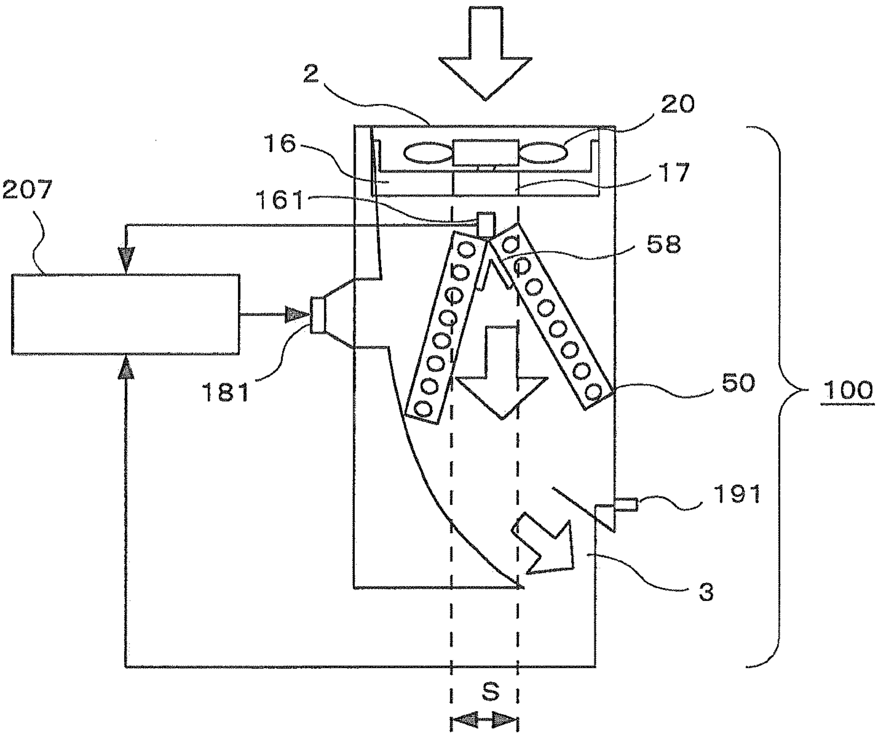


FIG. 25



F I G. 2 6


2
20
16
17
161
207
58
181
50
100
191
3
S

F I G. 2 7

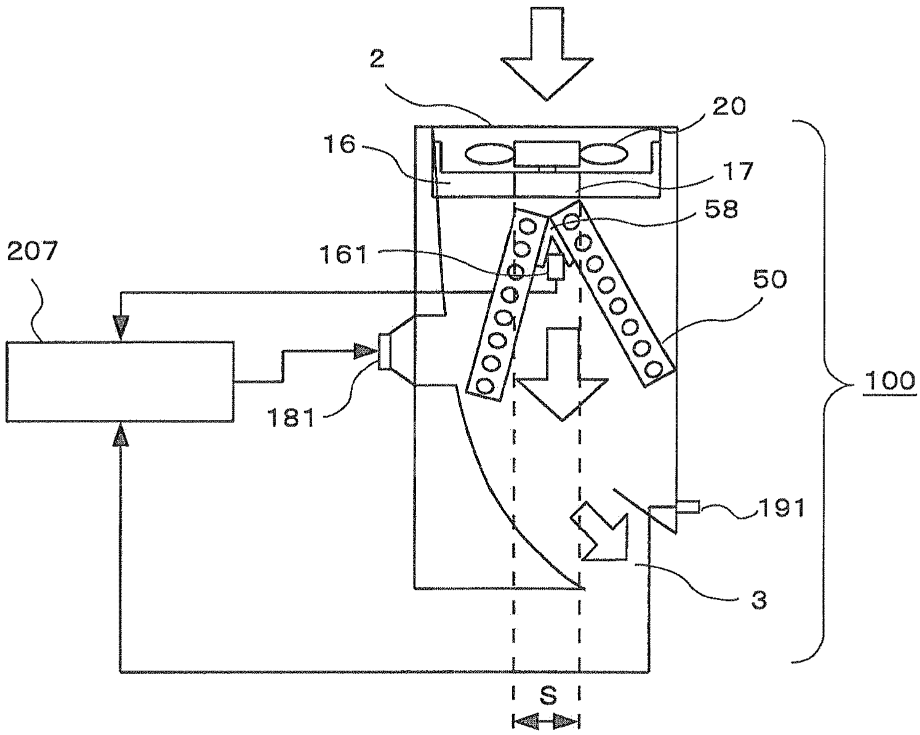

2
20
16
17
58
207
161
50
181
100
191
3
S

FIG. 28

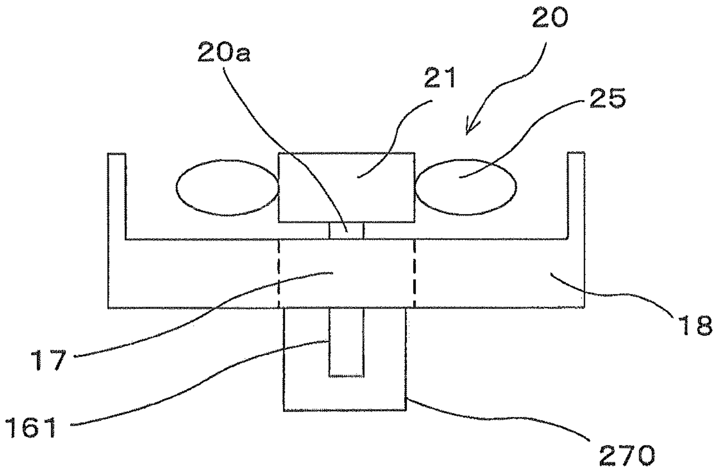


FIG. 29

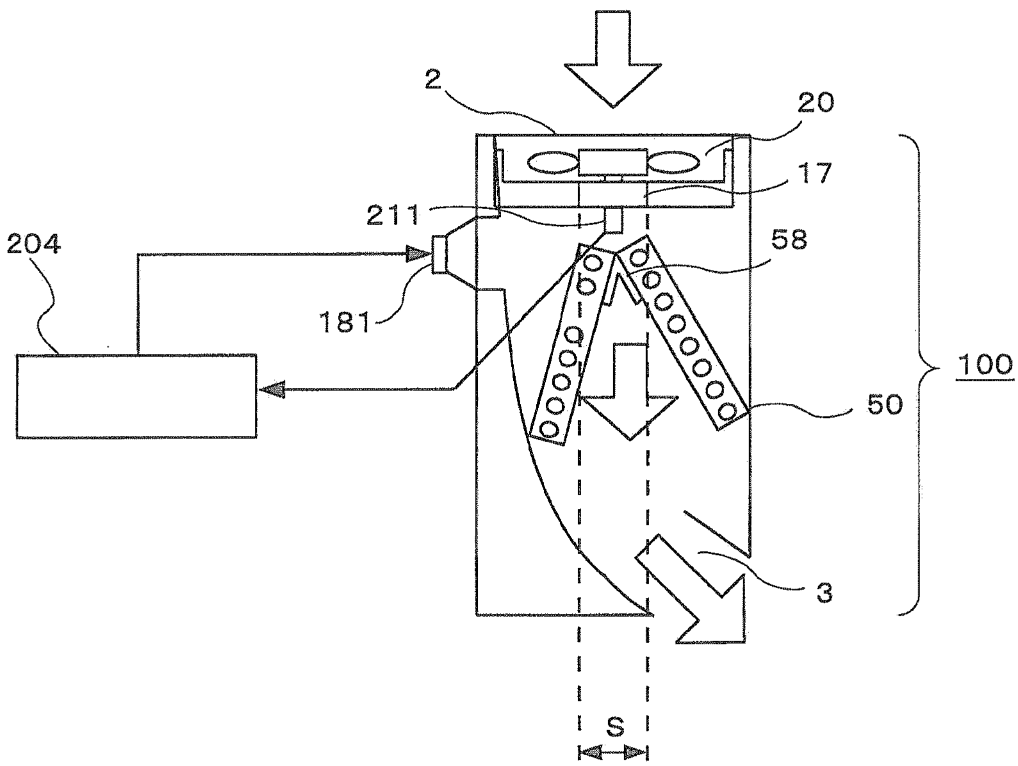


FIG. 30

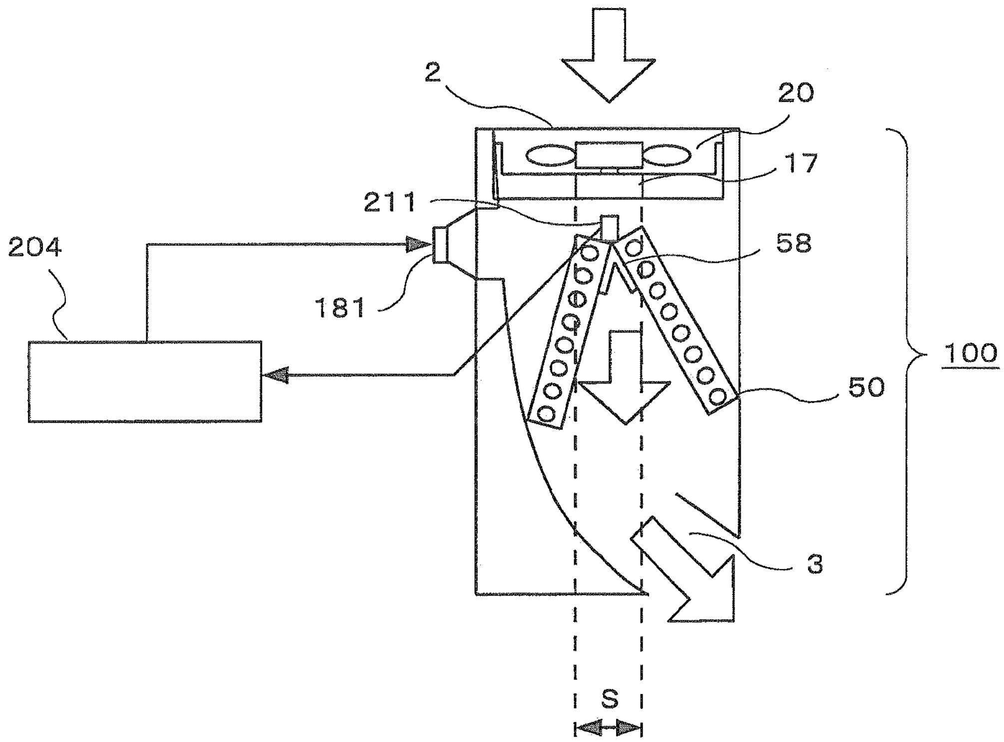
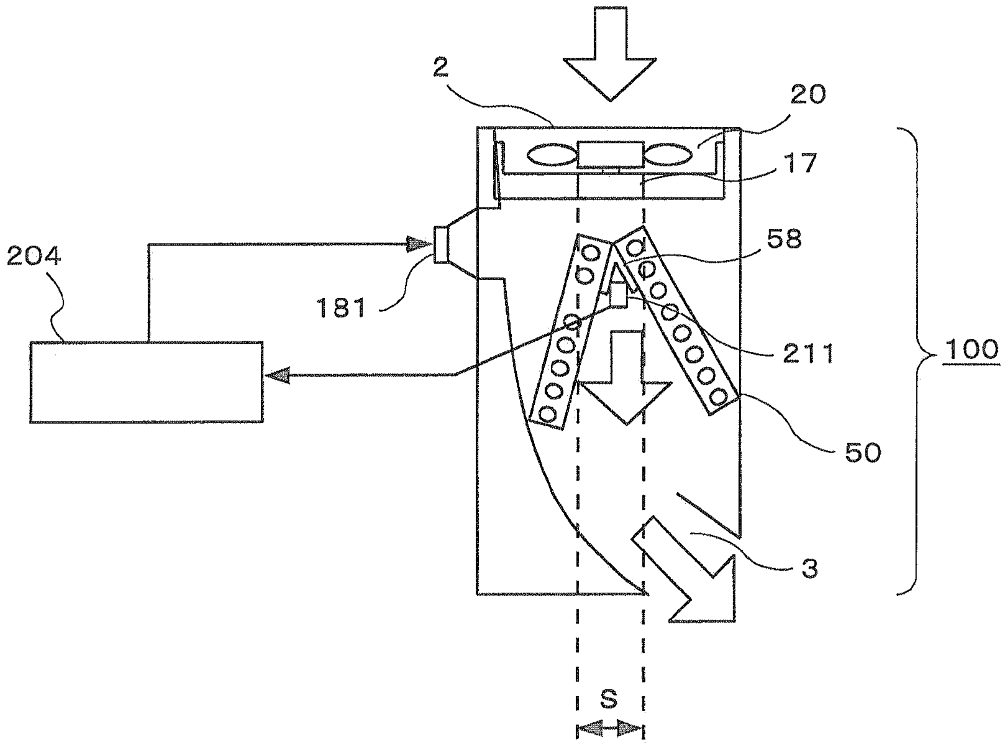
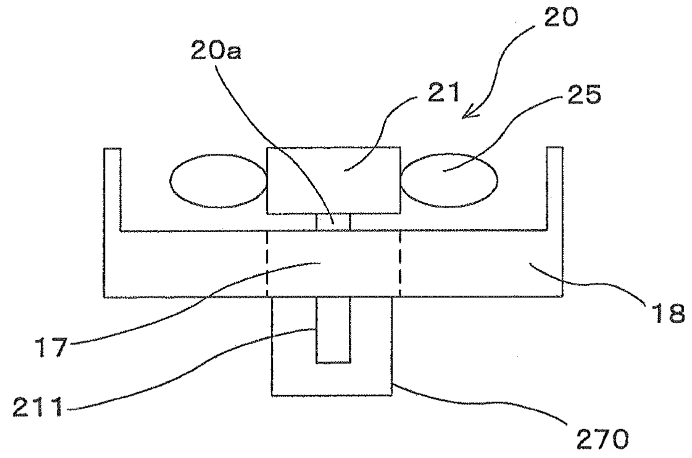


FIG. 31



F I G. 3 2



F I G. 3 3

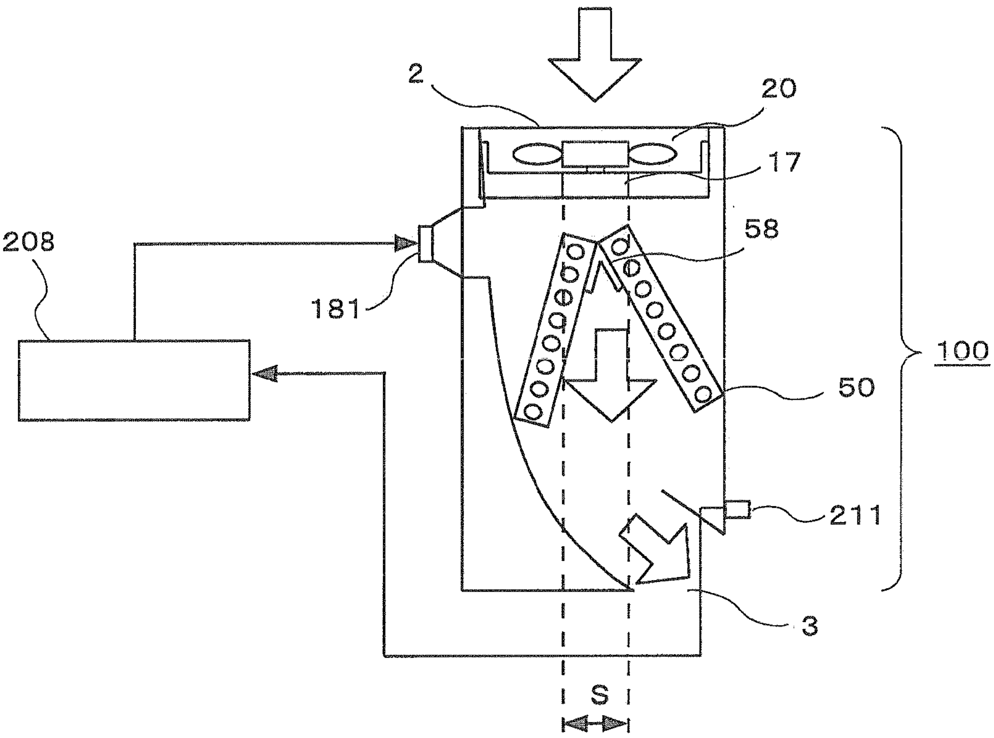


FIG. 34

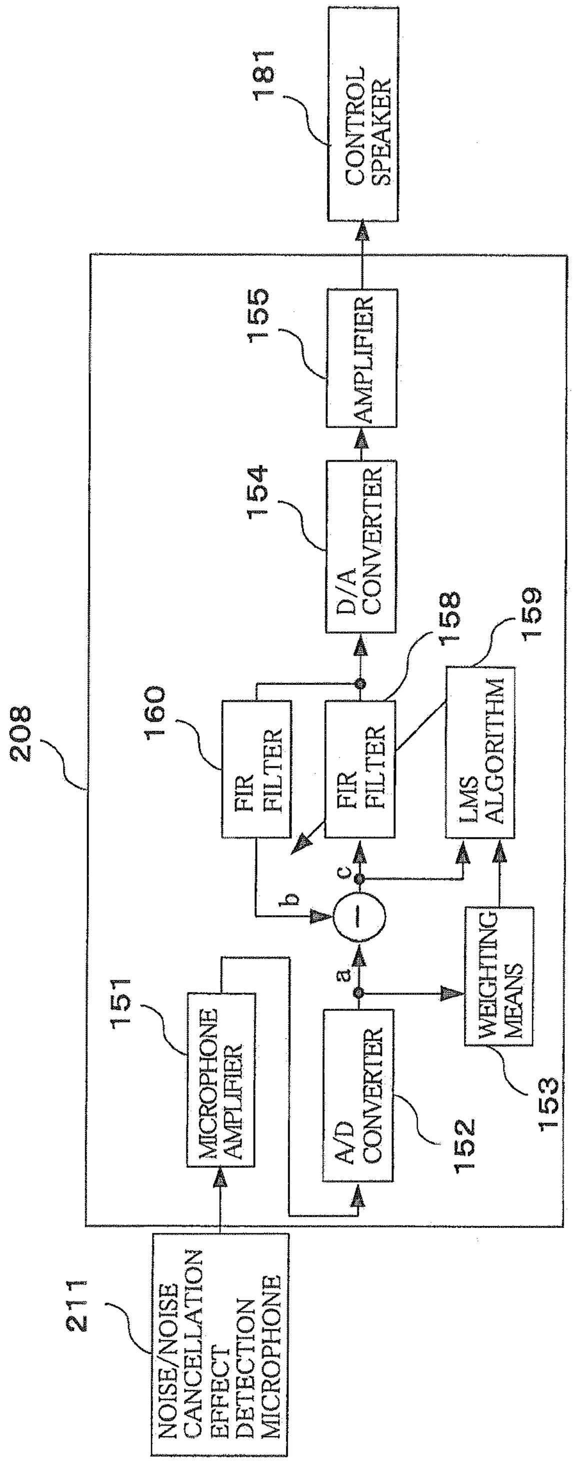

211
NOISE/NOISE CANCELLATION EFFECT DETECTION MICROPHONE
208
151
MICROPHONE AMPLIFIER
A/D CONVERTER
152
WEIGHTING MEANS
153
a
b
c
160
FIR FILTER
FIR FILTER
158
LMS ALGORITHM
159
D/A CONVERTER
154
AMPLIFIER
155
CONTROL SPEAKER
181

FIG. 35

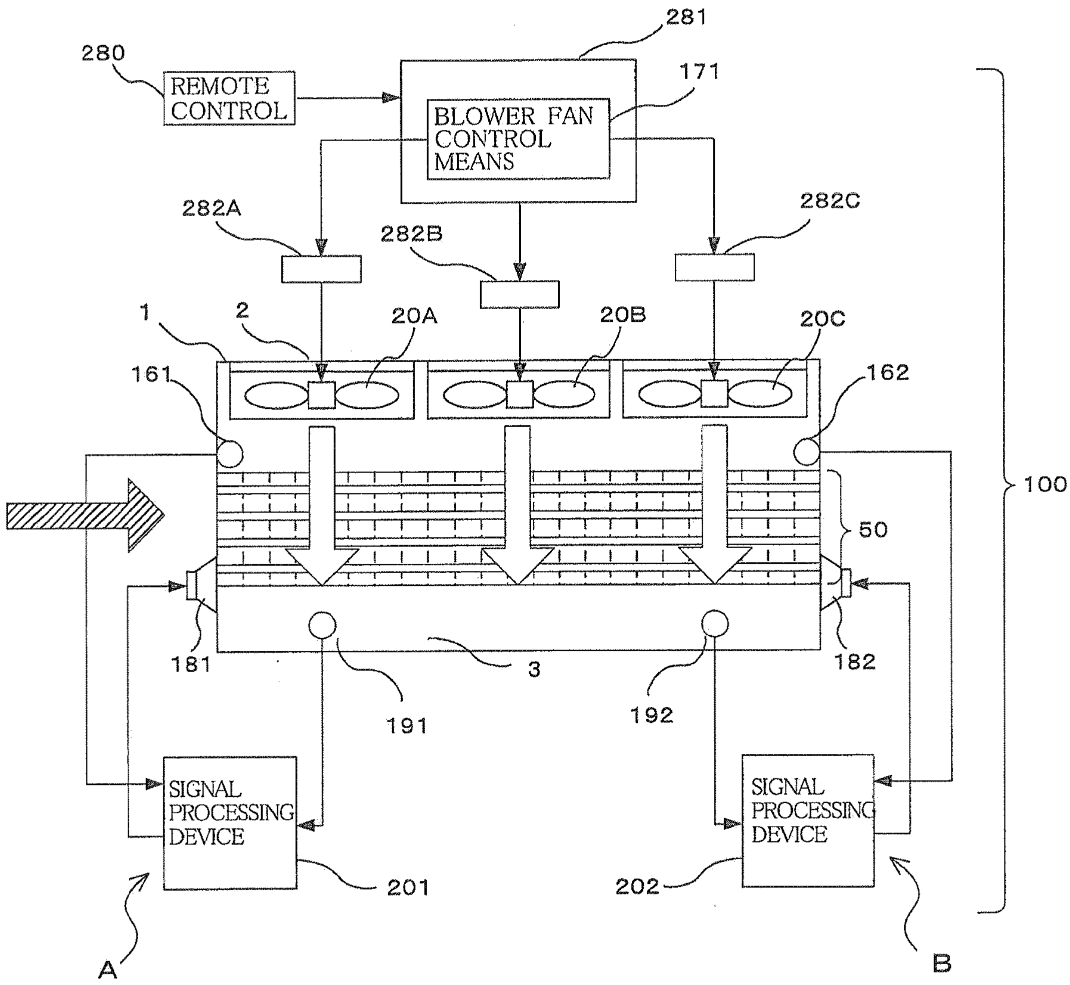

281
280
REMOTE CONTROL
171
BLOWER FAN CONTROL MEANS
282A
282B
282C
1
2
20A
20B
20C
161
162
100
50
181
3
182
191
192
SIGNAL PROCESSING DEVICE
SIGNAL PROCESSING DEVICE
201
202
A
B

FIG. 36

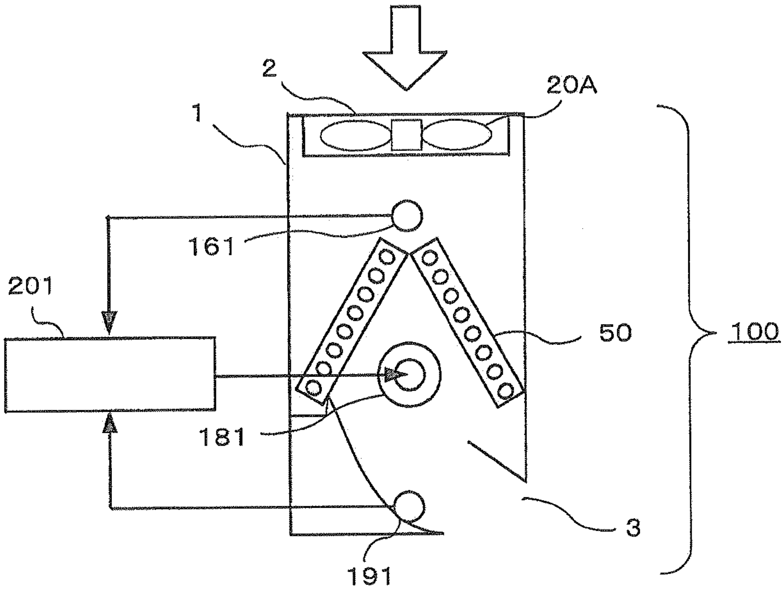


FIG. 37

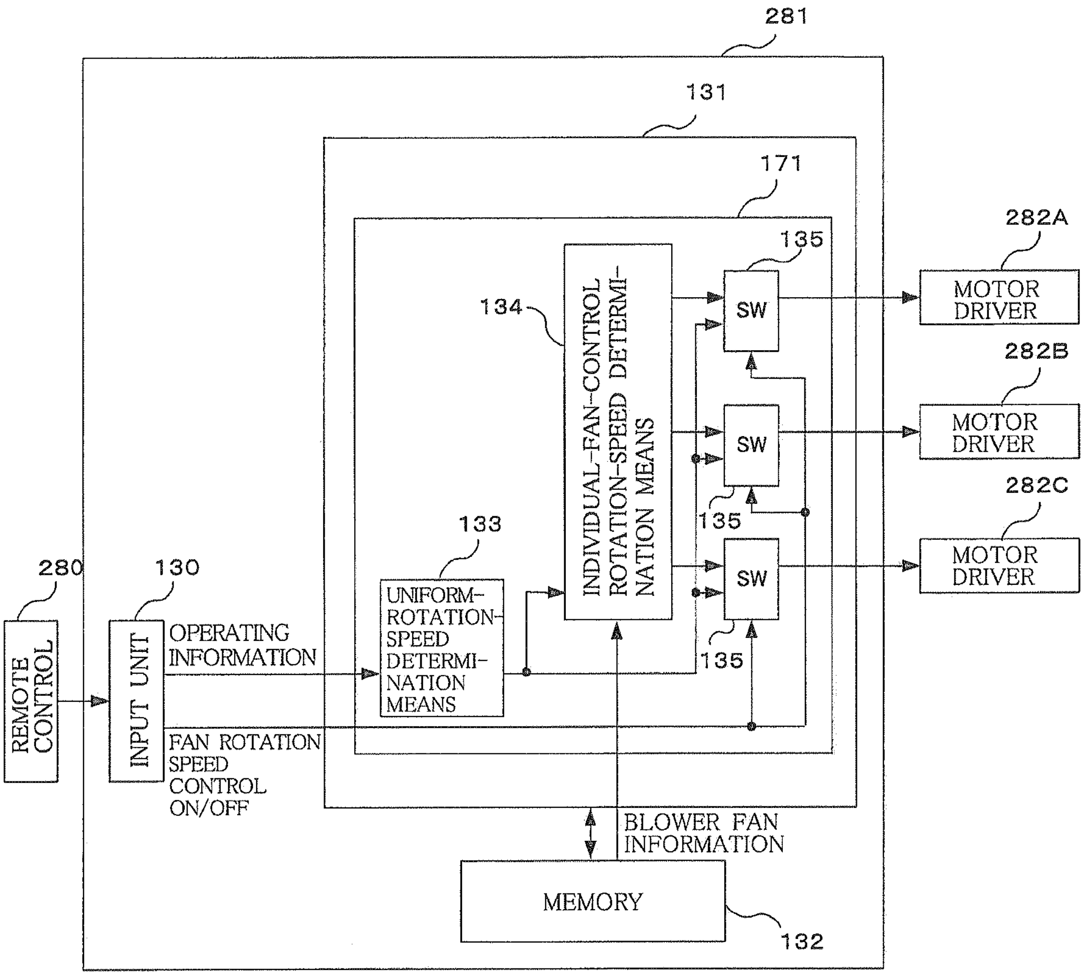
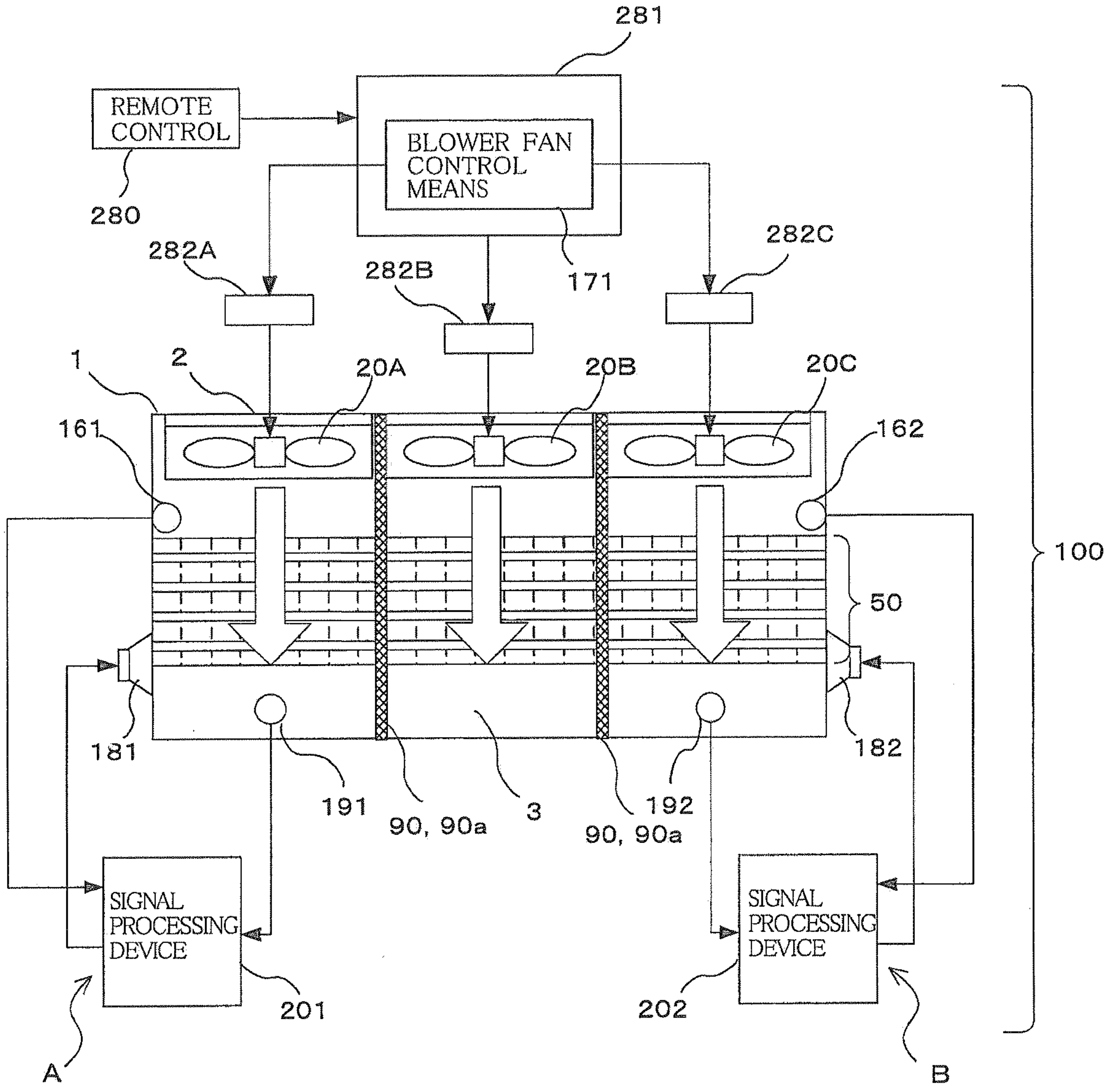

281
131
171
282A
135
134
MOTOR DRIVER
SW
282B
MOTOR DRIVER
SW
INDIVIDUAL-FAN-CONTROL ROTATION-SPEED DETERMI-NATION MEANS
135
282C
133
MOTOR DRIVER
SW
280
130
UNIFORM-ROTATION-SPEED DETERMI-NATION MEANS
135
REMOTE CONTROL
INPUT UNIT
OPERATING INFORMATION
FAN ROTATION SPEED CONTROL ON/OFF
BLOWER FAN INFORMATION
MEMORY
132

FIG. 38


281
REMOTE CONTROL
BLOWER FAN CONTROL MEANS
280
282A
282B
171
282C
1
2
20A
20B
20C
161
162
100
50
181
182
191
90, 90a
3
192
90, 90a
SIGNAL PROCESSING DEVICE
SIGNAL PROCESSING DEVICE
201
202
A
B

F I G. 3 9

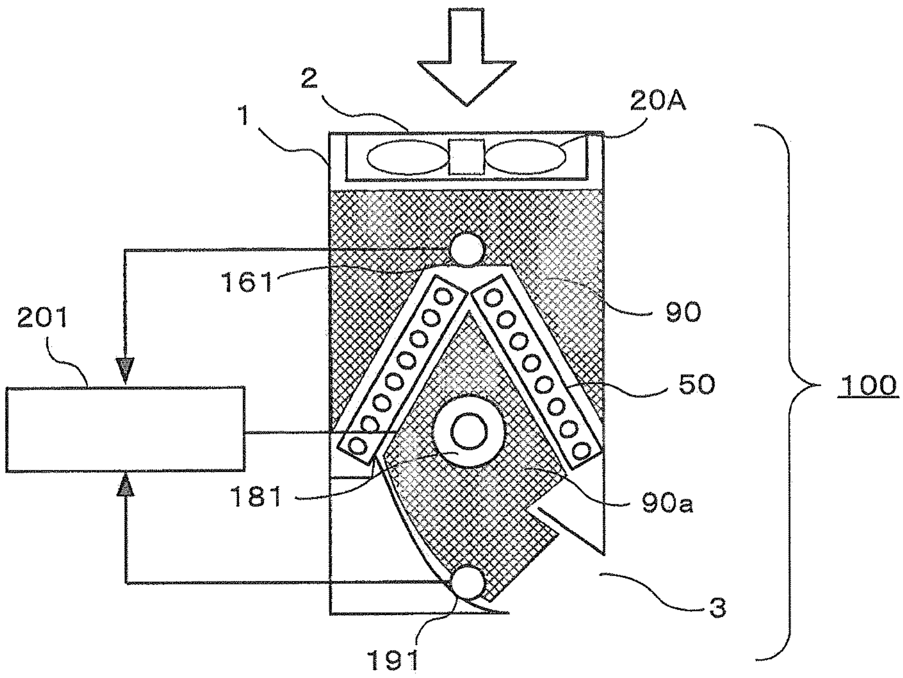


FIG. 40

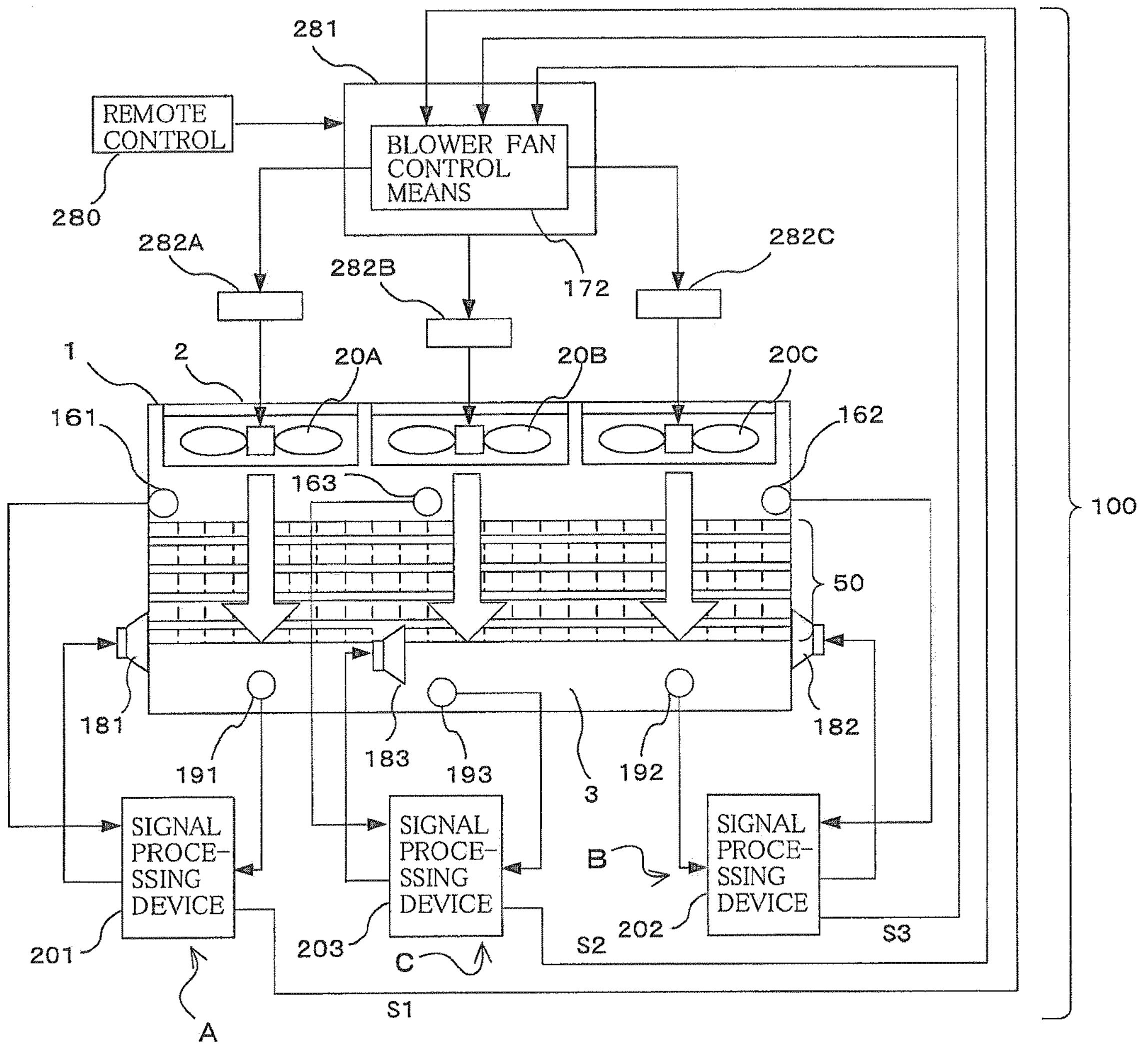

281
REMOTE CONTROL
BLOWER FAN CONTROL MEANS
280
282A
282B
172
282C
1
2
20A
20B
20C
161
163
162
100
50
181
183
182
191
193
3
192
SIGNAL PROCESSING DEVICE
SIGNAL PROCESSING DEVICE
SIGNAL PROCESSING DEVICE
B
201
203
202
S2
S3
C
A
S1

FIG. 41

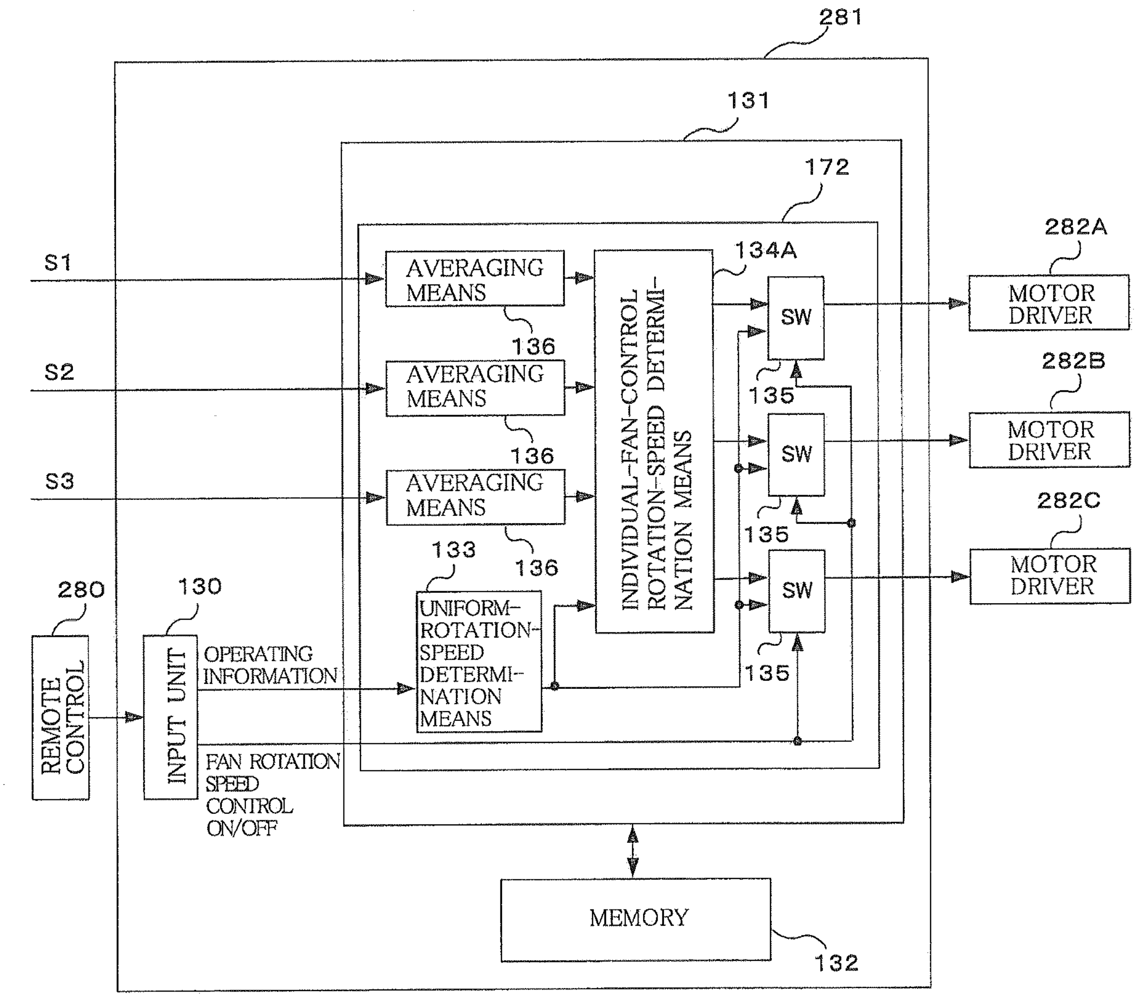
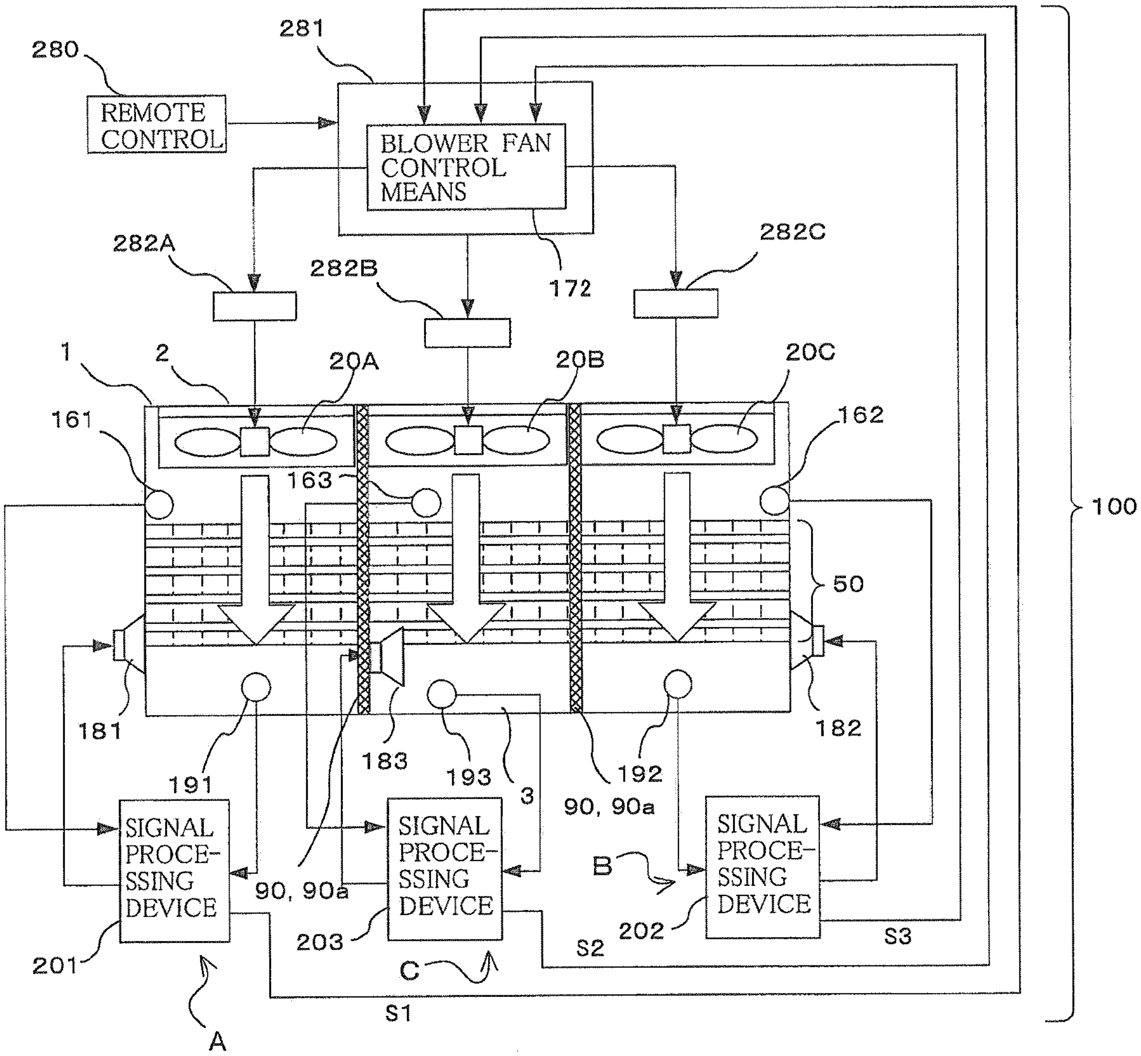
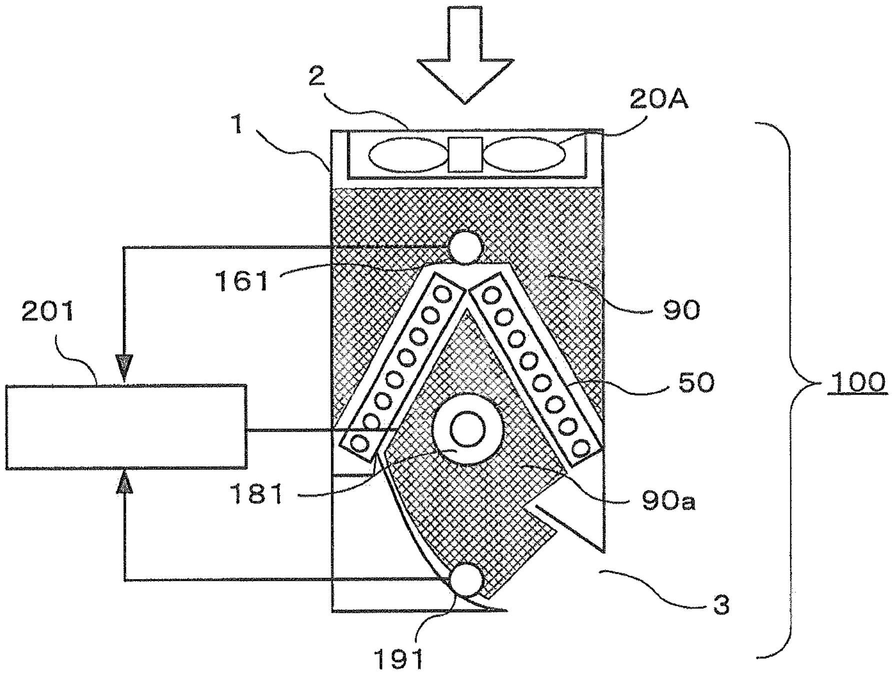

281
131
172
S1
S2
S3
AVERAGING MEANS
AVERAGING MEANS
AVERAGING MEANS
136
136
136
INDIVIDUAL-FAN-CONTROL ROTATION-SPEED DETERMI-NATION MEANS
134A
SW
SW
SW
135
135
135
282A
282B
282C
MOTOR DRIVER
MOTOR DRIVER
MOTOR DRIVER
133
UNIFORM-ROTATION-SPEED DETERMI-NATION MEANS
280
REMOTE CONTROL
130
INPUT UNIT
OPERATING INFORMATION
FAN ROTATION SPEED CONTROL ON/OFF
MEMORY
132

FIG. 42


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

F I G. 4 3



F I G. 4 4

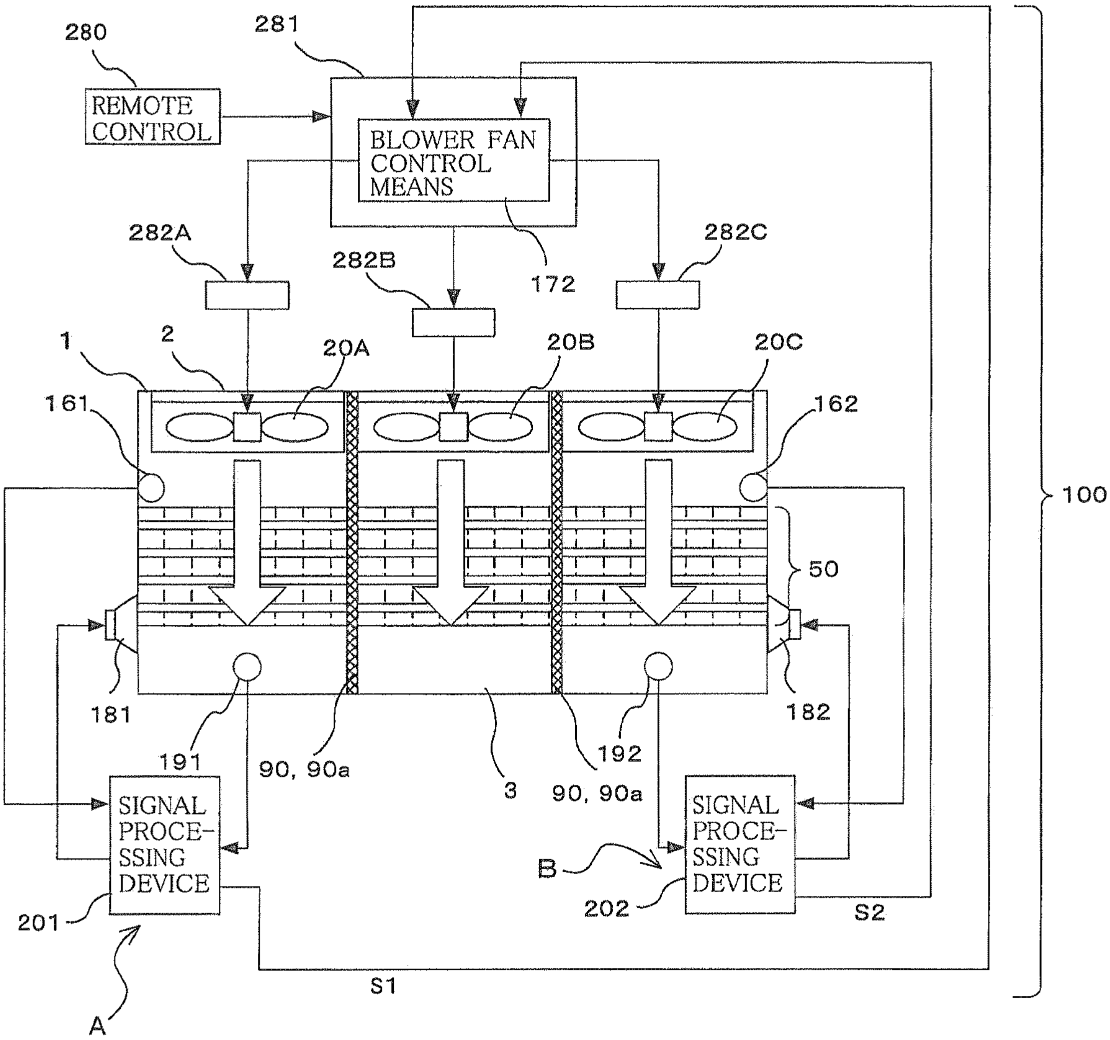
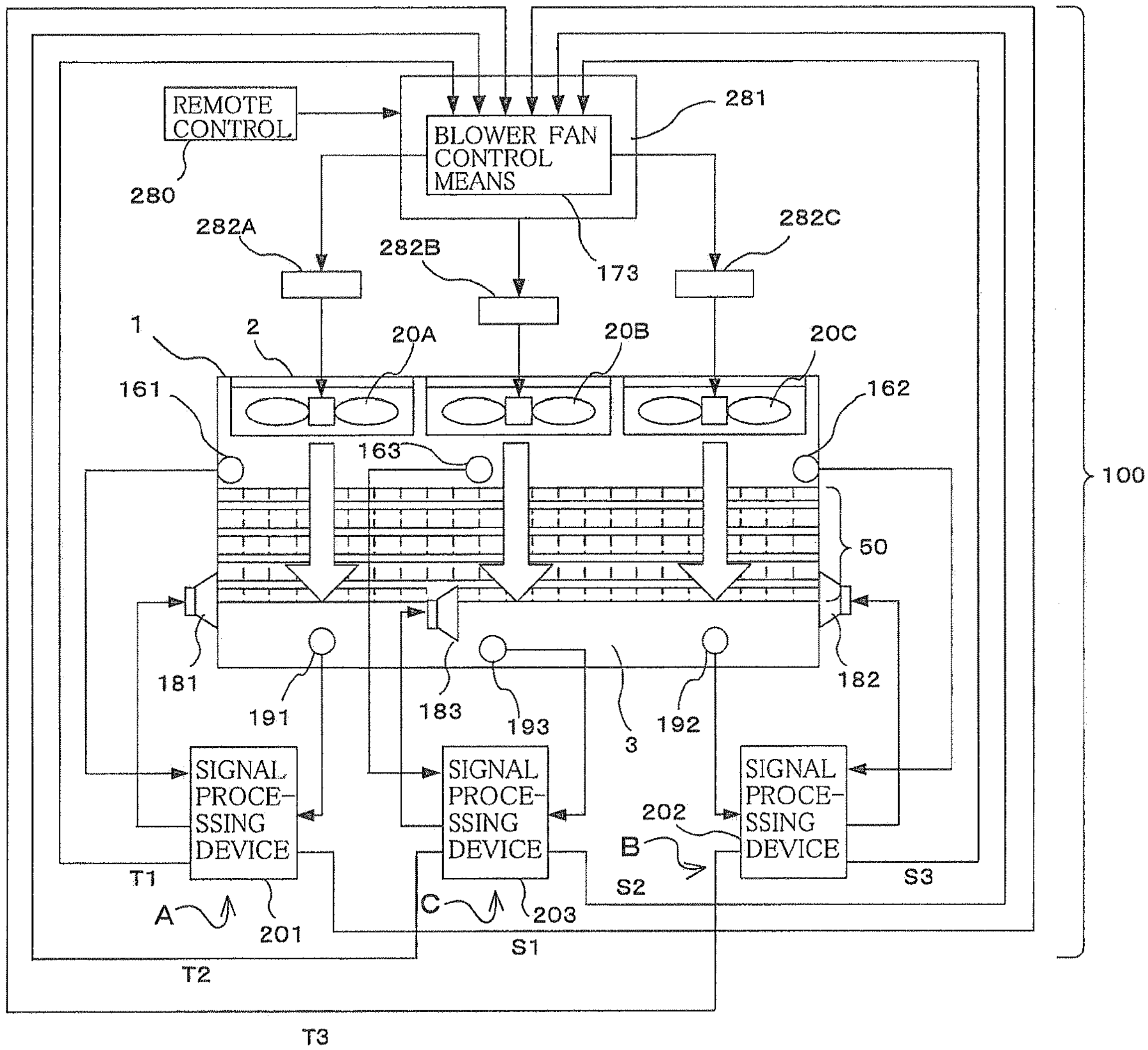

280
281
REMOTE CONTROL
BLOWER FAN CONTROL MEANS
282A
282B
282C
172
1
2
20A
20B
20C
161
162
100
50
181
182
191
192
90, 90a
3
90, 90a
SIGNAL PROCE-SSING DEVICE
SIGNAL PROCE-SSING DEVICE
B
201
202
S2
S1
A

FIG. 45


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

F I G. 4 6

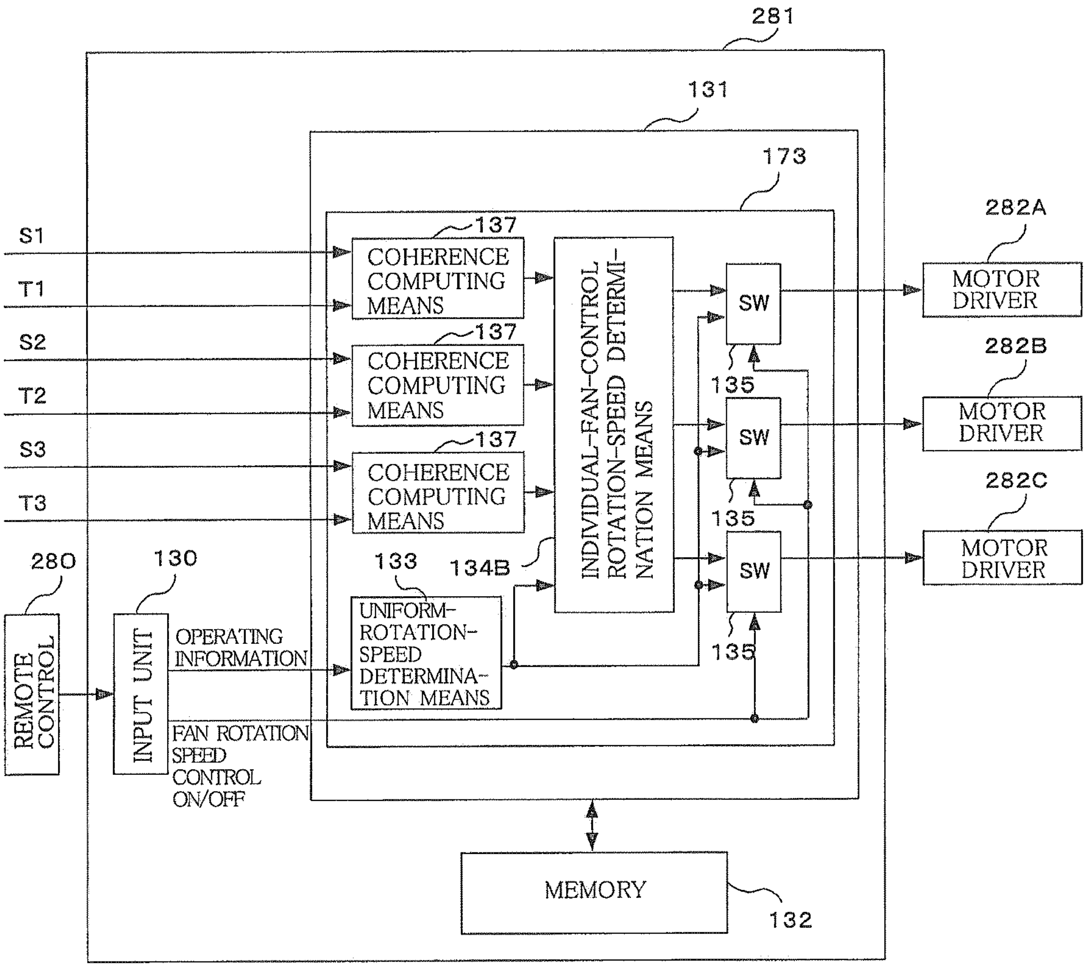

281
131
173
S1
T1
S2
T2
S3
T3
137
COHERENCE COMPUTING MEANS
137
COHERENCE COMPUTING MEANS
137
COHERENCE COMPUTING MEANS
INDIVIDUAL-FAN-CONTROL ROTATION-SPEED DETERMINATION MEANS
SW
SW
SW
135
135
135
282A
MOTOR DRIVER
282B
MOTOR DRIVER
282C
MOTOR DRIVER
280
REMOTE CONTROL
130
INPUT UNIT
OPERATING INFORMATION
FAN ROTATION SPEED CONTROL ON/OFF
133
UNIFORM-ROTATION-SPEED DETERMINATION MEANS
134B
MEMORY
132

FIG. 47

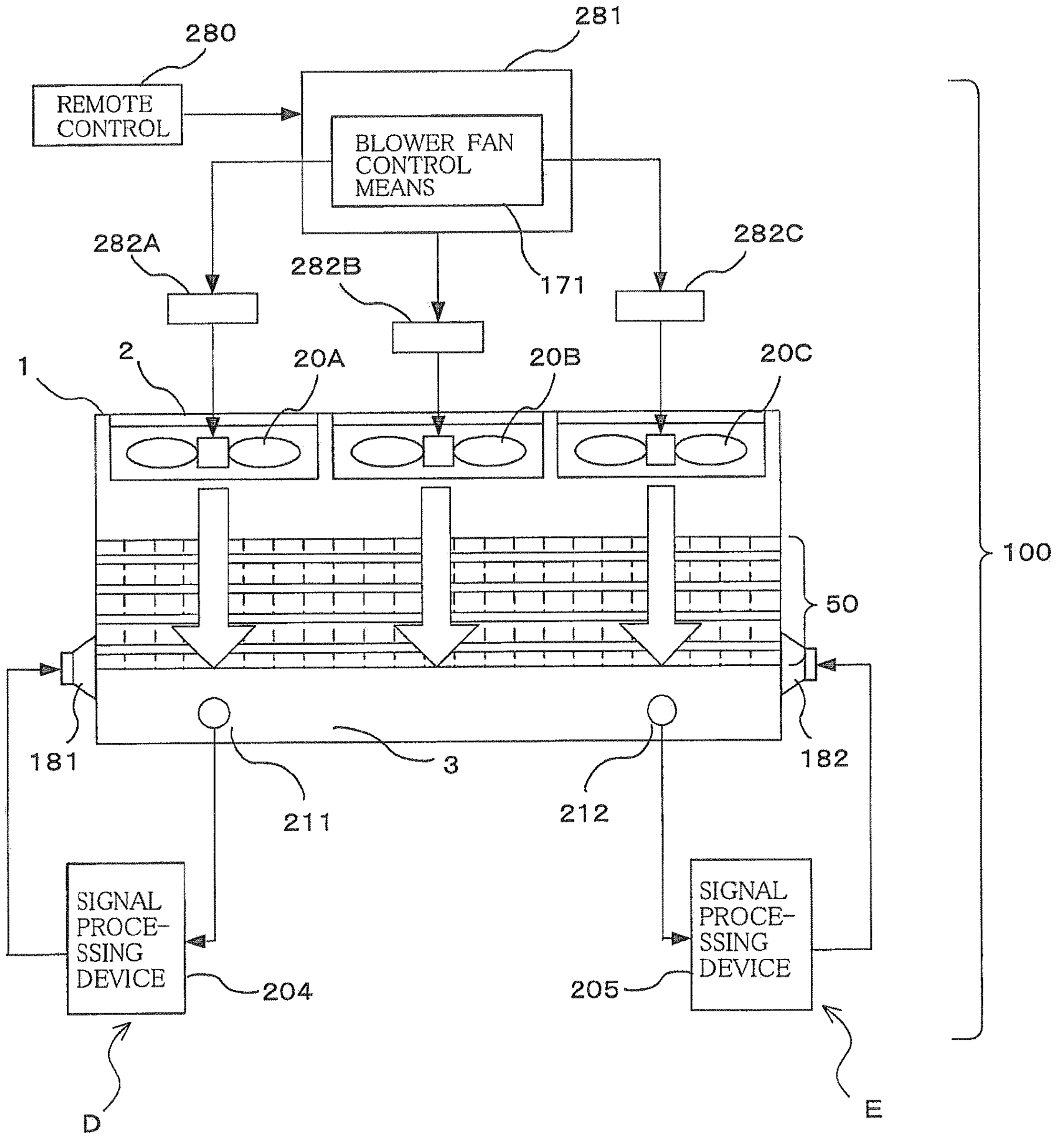
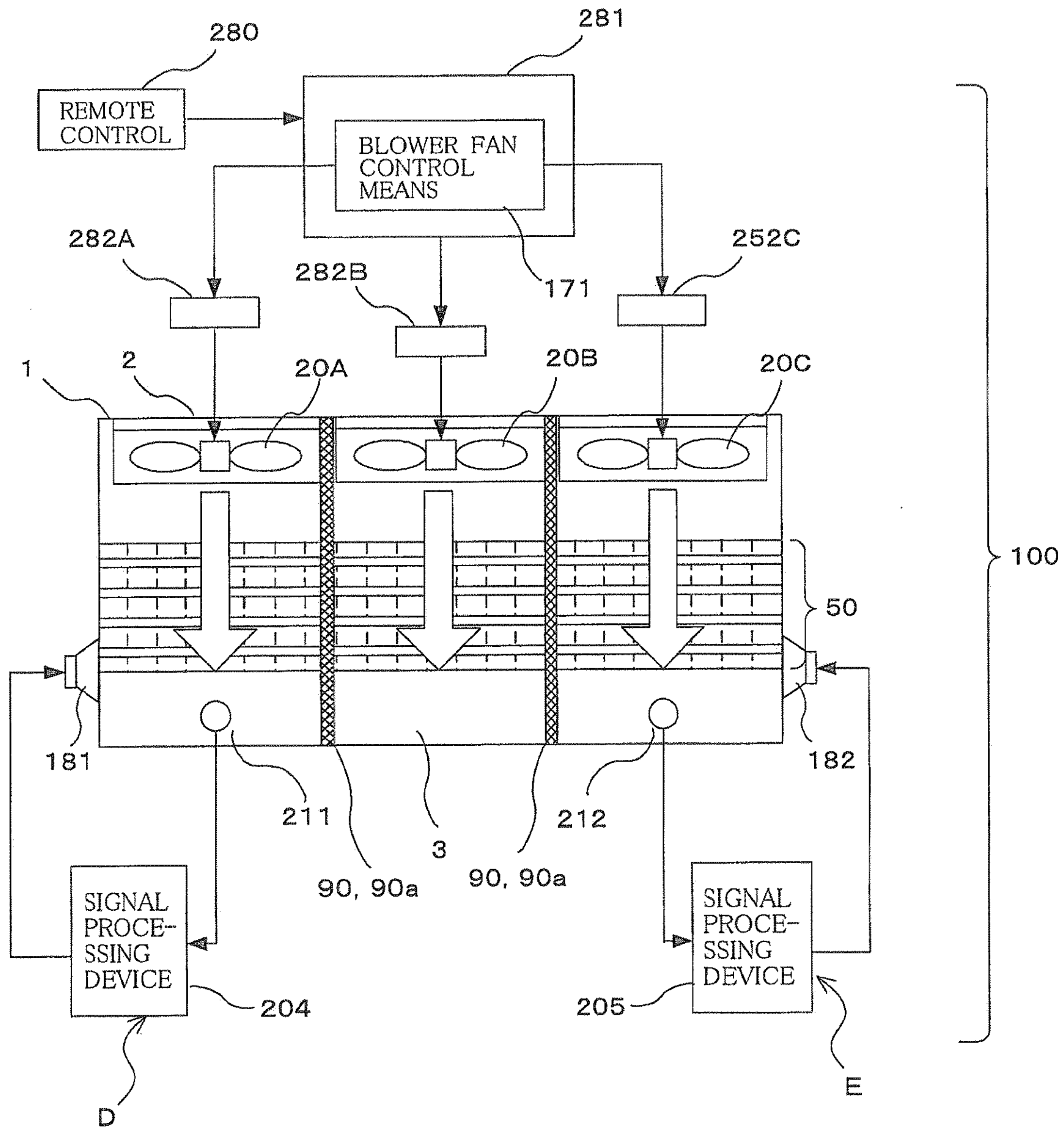

280
REMOTE CONTROL
281
BLOWER FAN CONTROL MEANS
171
282A
282B
282C
1
2
20A
20B
20C
100
50
181
182
3
211
212
SIGNAL PROCE-SSING DEVICE
204
SIGNAL PROCE-SSING DEVICE
205
D
E

FIG. 48


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

F I G. 4 9

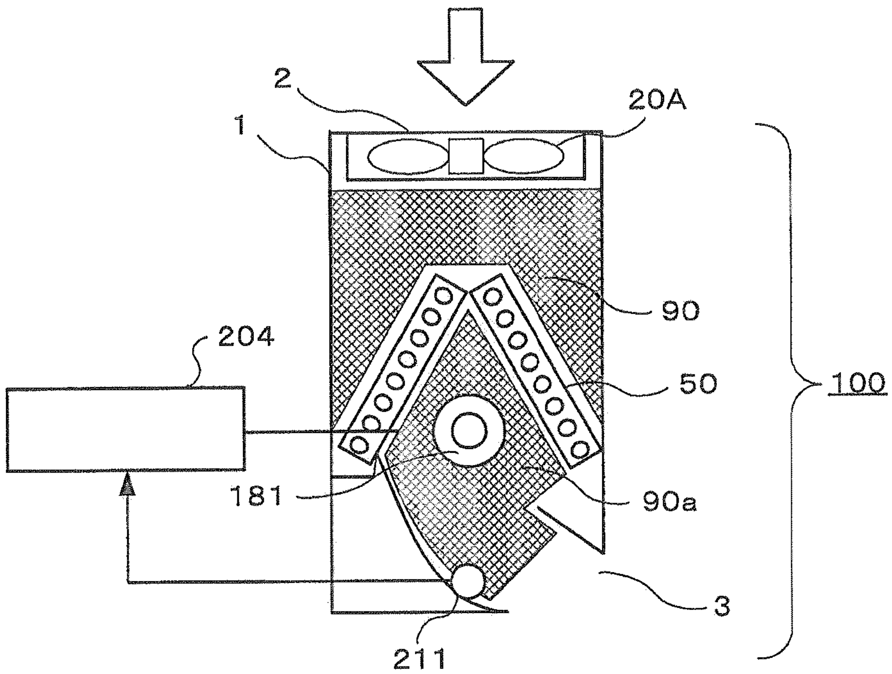
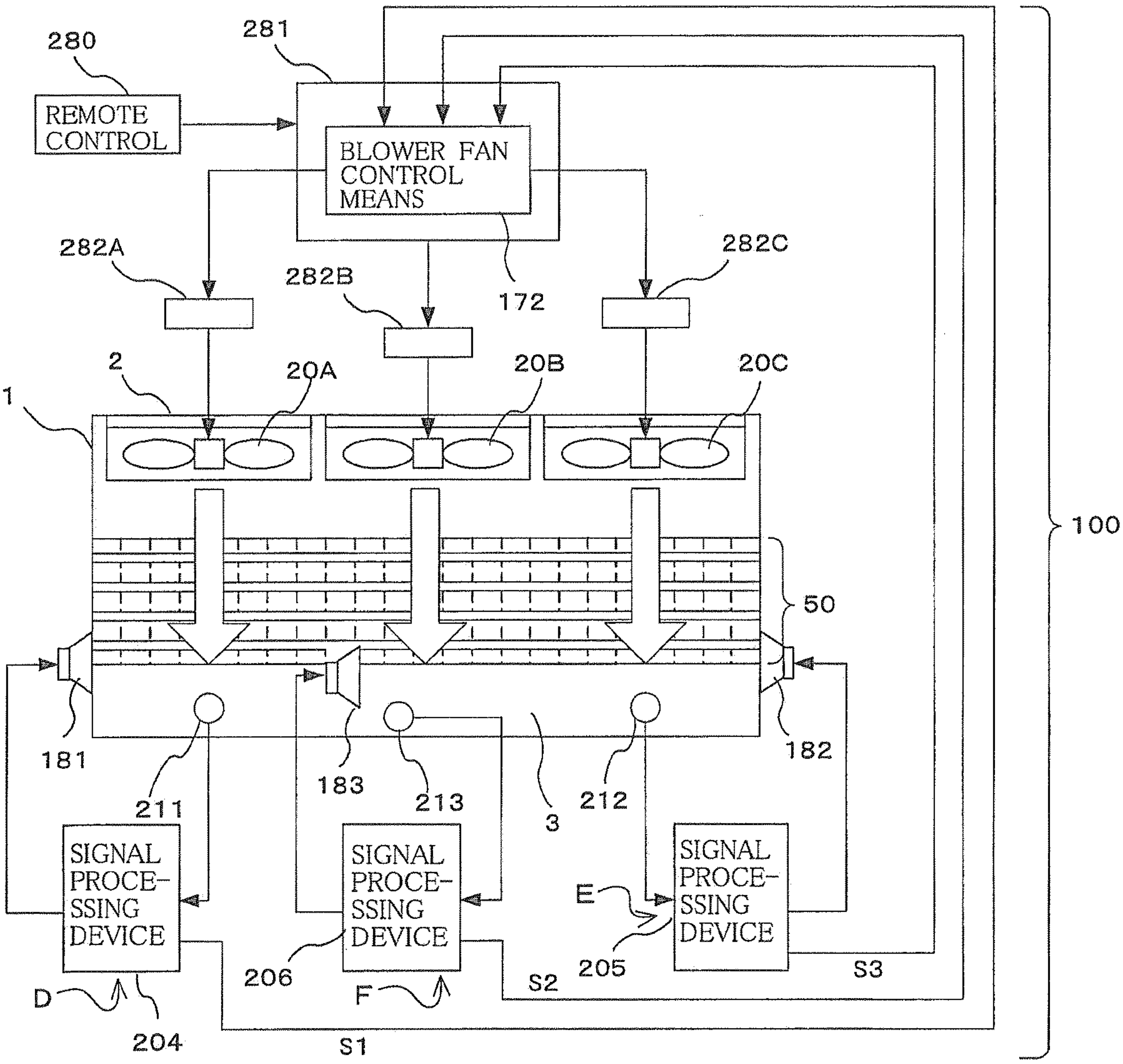


FIG. 50


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

F I G. 5 1

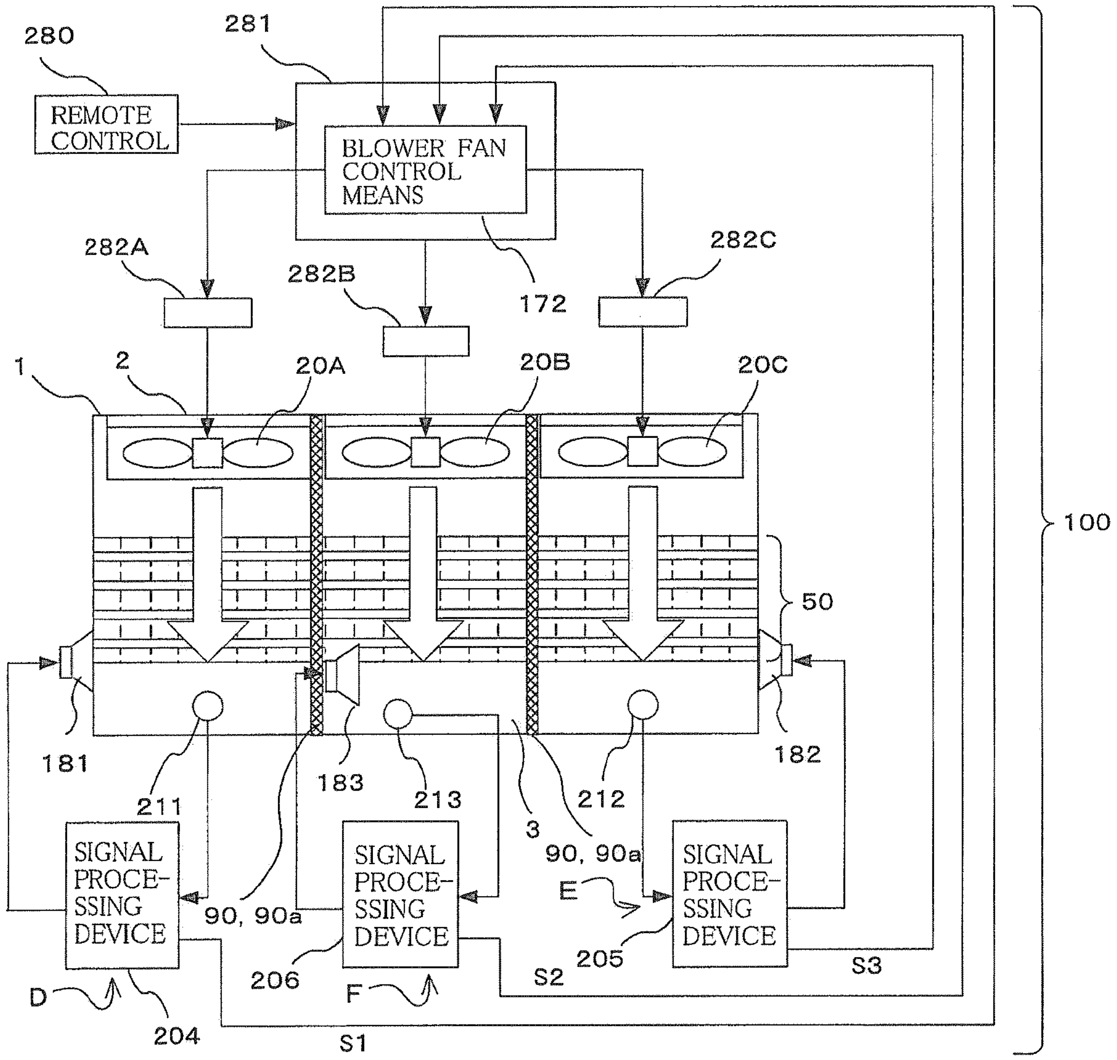

280
REMOTE CONTROL
281
BLOWER FAN CONTROL MEANS
172
282A
282B
282C
1
2
20A
20B
20C
100
50
181
182
183
211
212
213
3
90, 90a
90, 90a
E
SIGNAL PROCE-SSING DEVICE
SIGNAL PROCE-SSING DEVICE
SIGNAL PROCE-SSING DEVICE
204
205
206
D
F
S1
S2
S3

FIG. 52

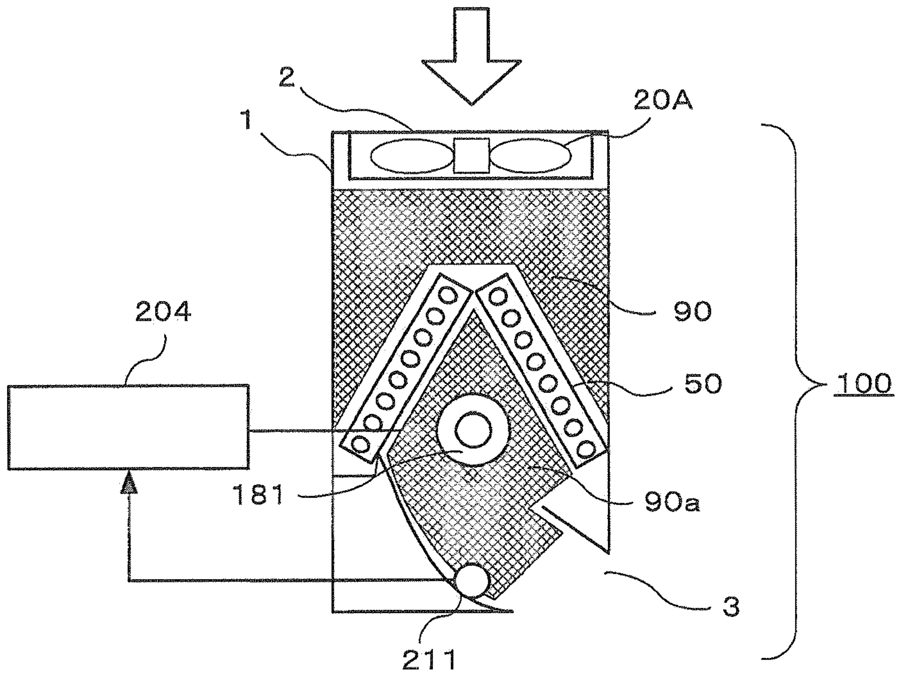
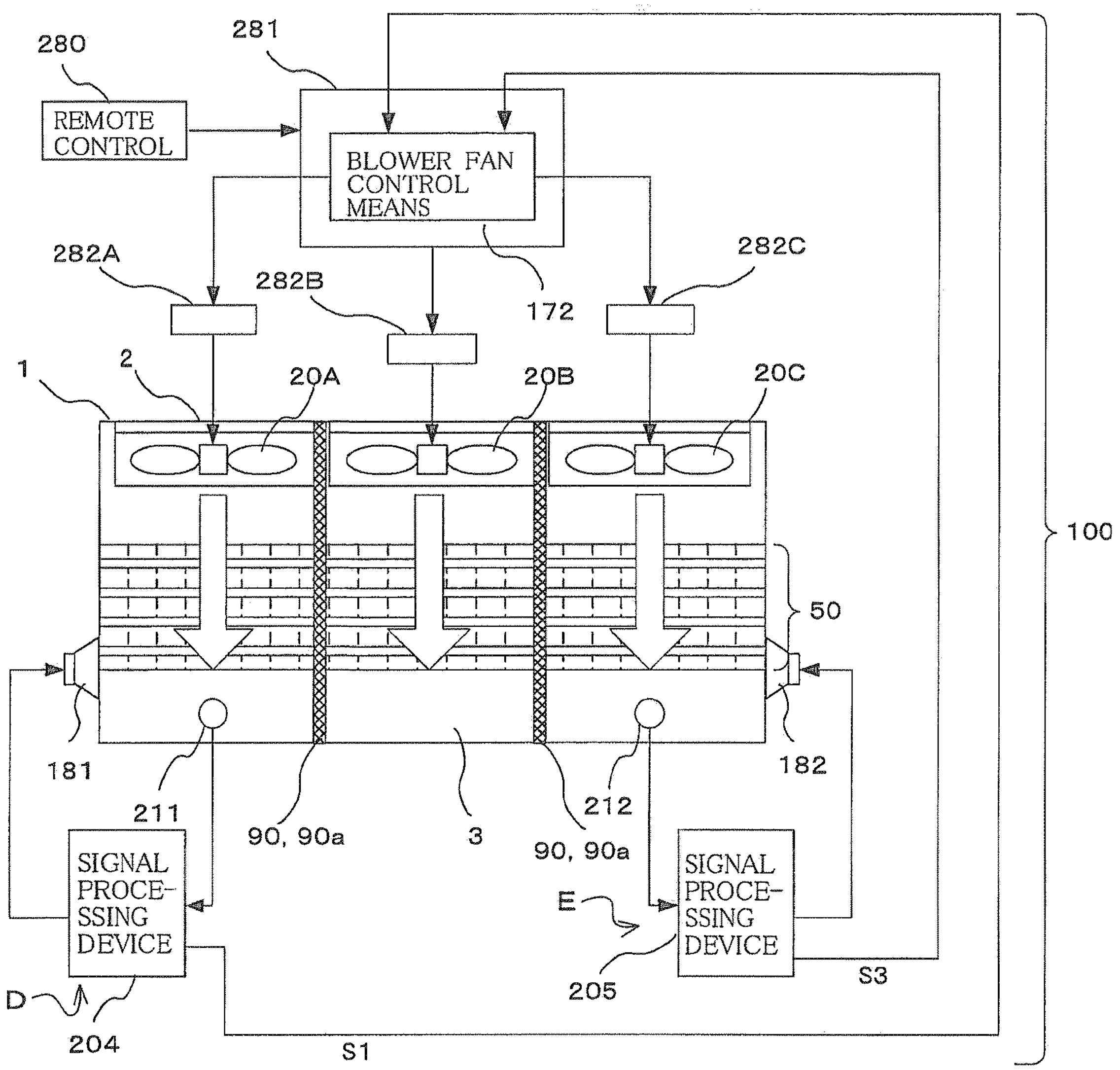


FIG. 53


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

F I G. 5 4

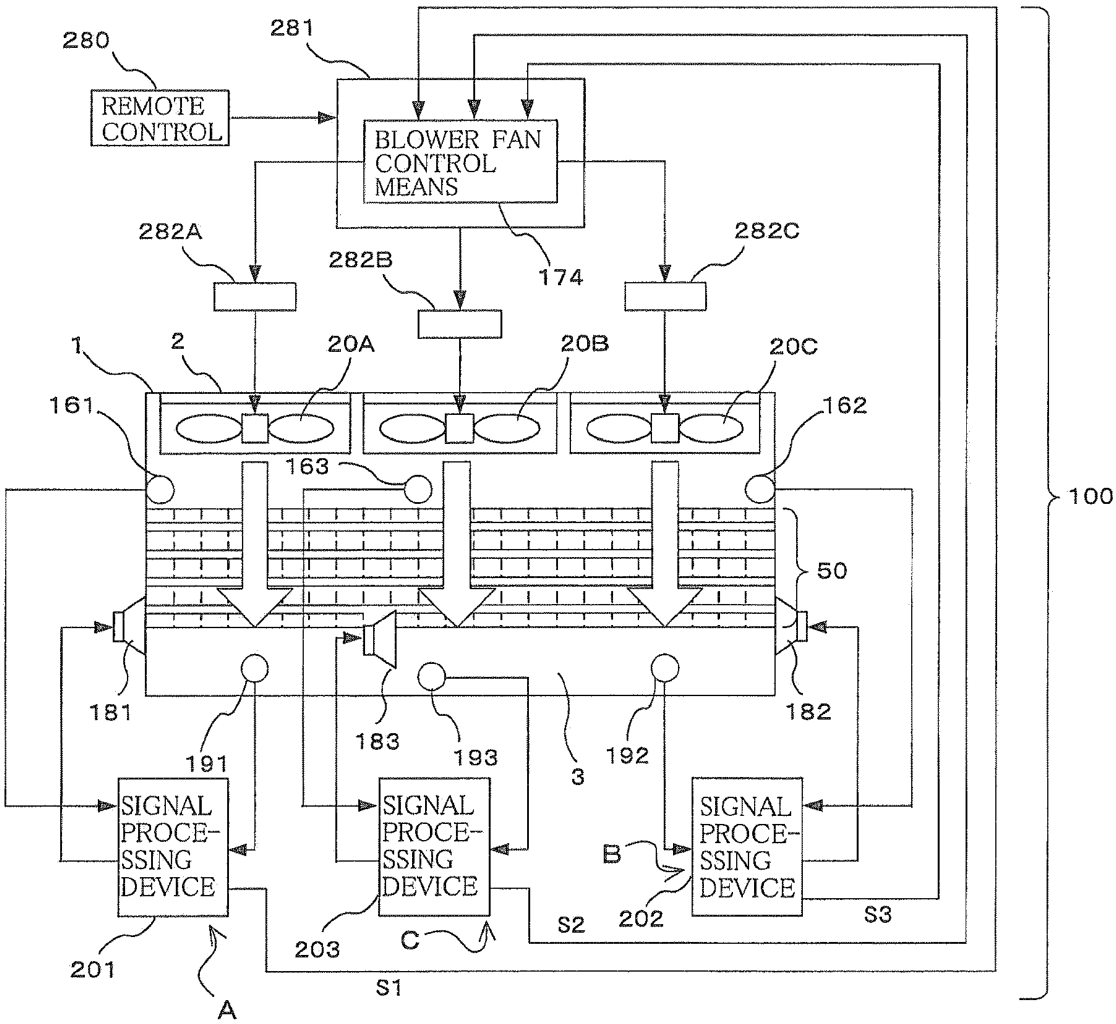

280
281
REMOTE CONTROL
BLOWER FAN CONTROL MEANS
282A
282B
174
282C
1
2
20A
20B
20C
161
163
162
100
50
181
183
193
3
192
182
191
SIGNAL PROCE-SSING DEVICE
SIGNAL PROCE-SSING DEVICE
B
SIGNAL PROCE-SSING DEVICE
203
C
S2
202
S3
201
A
S1

FIG. 55

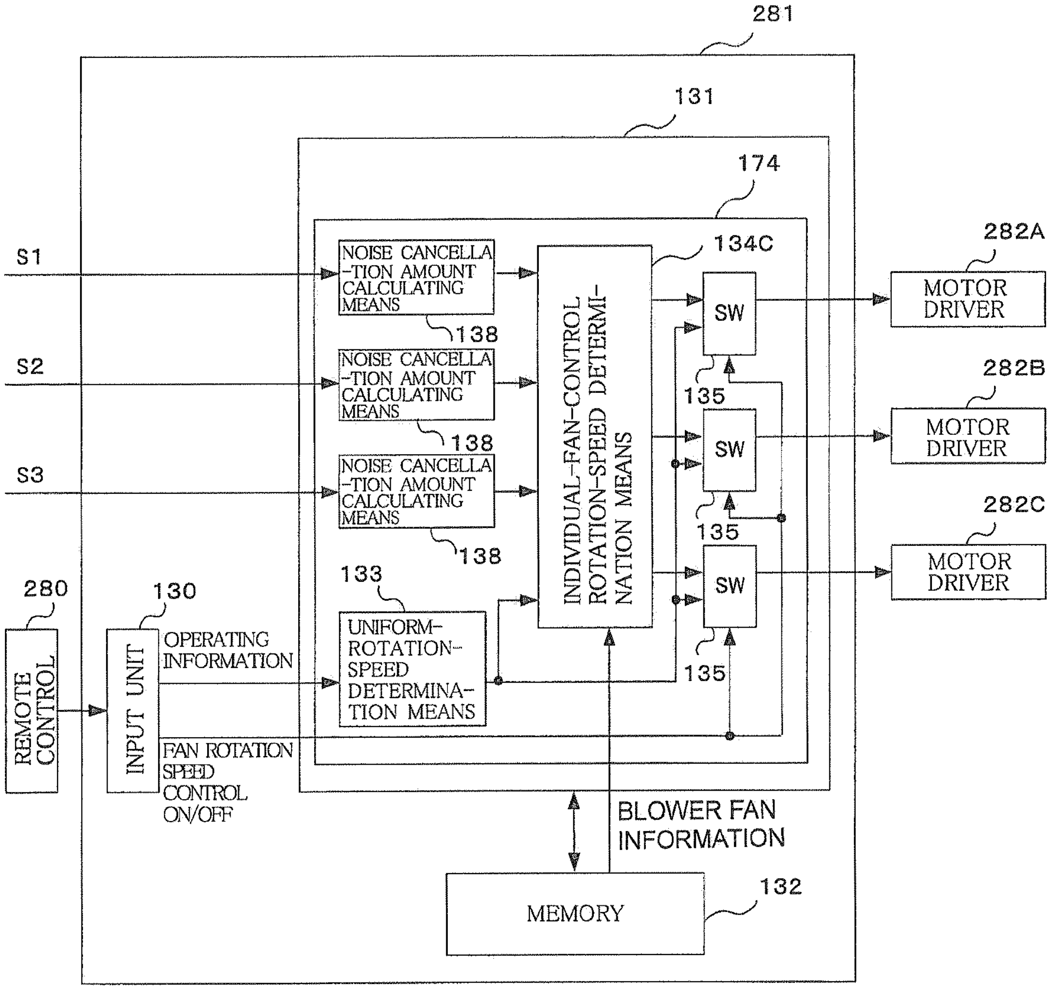

281
131
174
S1
S2
S3
NOISE CANCELLA-TION AMOUNT CALCULATING MEANS
138
NOISE CANCELLA-TION AMOUNT CALCULATING MEANS
138
NOISE CANCELLA-TION AMOUNT CALCULATING MEANS
138
134C
INDIVIDUAL-FAN-CONTROL ROTATION-SPEED DETERMI-NATION MEANS
SW
SW
SW
135
135
135
282A
MOTOR DRIVER
282B
MOTOR DRIVER
282C
MOTOR DRIVER
280
REMOTE CONTROL
130
INPUT UNIT
OPERATING INFORMATION
FAN ROTATION SPEED CONTROL ON/OFF
133
UNIFORM-ROTATION-SPEED DETERMINA-TION MEANS
BLOWER FAN INFORMATION
MEMORY
132

FIG. 56

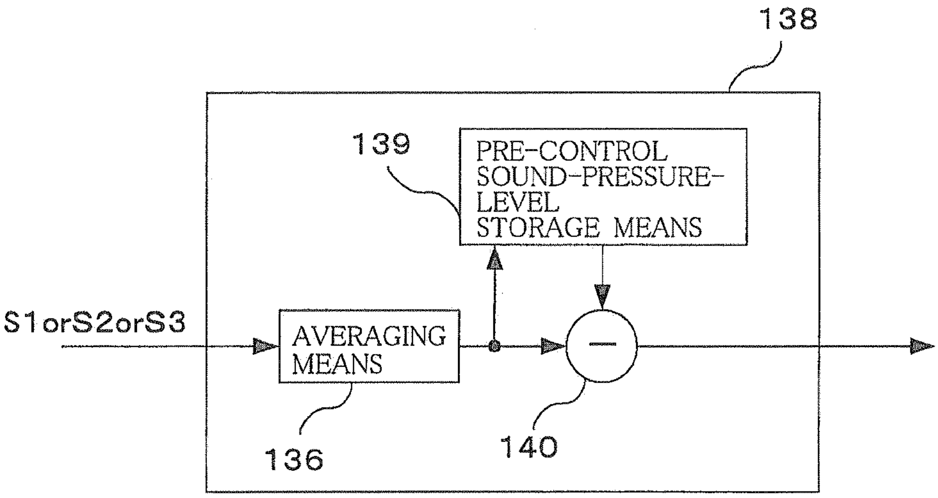
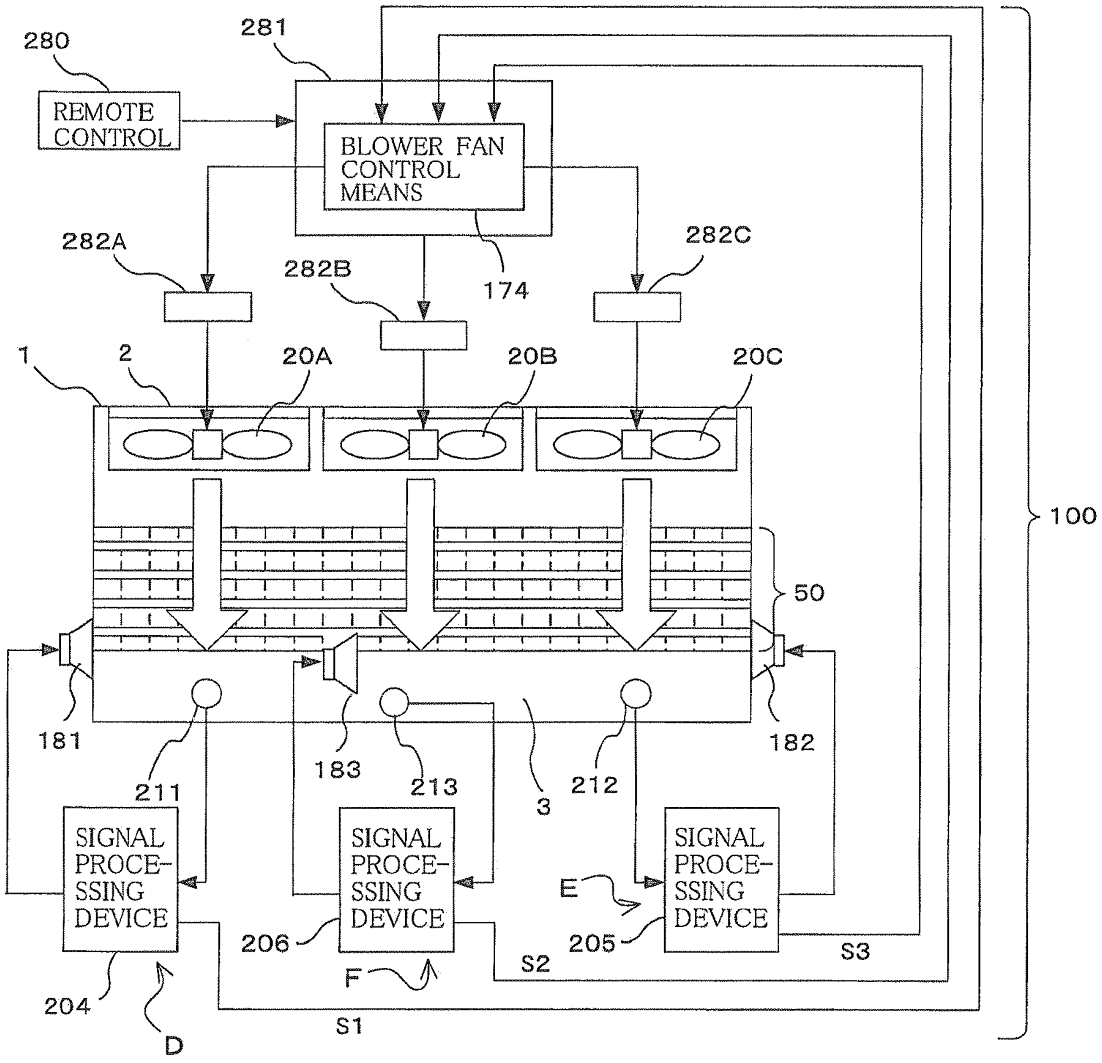

138
139
PRE-CONTROL SOUND-PRESSURE-LEVEL STORAGE MEANS
S1orS2orS3
AVERAGING MEANS
136
140

FIG. 57


280
REMOTE CONTROL
281
BLOWER FAN CONTROL MEANS
174
282A
282B
282C
1
2
20A
20B
20C
100
50
181
182
183
211
212
213
3
SIGNAL PROCESSING DEVICE
SIGNAL PROCESSING DEVICE
SIGNAL PROCESSING DEVICE
204
205
206
D
E
F
S1
S2
S3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/002005

A. CLASSIFICATION OF SUBJECT MATTER
F24F11/04(2006.01)i, *F24F13/06*(2006.01)i, *F24F13/20*(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)
F24F11/04, F24F13/06, F24F13/20

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	1996-2011
Kokai Jitsuyo Shinan Koho	1971-2011	Toroku Jitsuyo Shinan Koho	1994-2011

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.
A Y	JP 2001-116451 A (Matsushita Seiko Co., Ltd.), 27 April 2001 (27.04.2001), paragraphs [0020] to [0026]; fig. 4, 5 (Family: none)	1-24 25-34
A Y	JP 2004-53235 A (Kiyoshi YANAGIMACHI, Yasuko YANAGIMACHI, Hiroshi YANAGIMACHI, Taku YANAGIMACHI, Kyoko TANAKA, Aya TANAKA), 19 February 2004 (19.02.2004), paragraphs [0011], [0021]; fig. 2 (Family: none)	1-24 25-34

☒ 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
26 April, 2011 (26.04.11)	17 May, 2011 (17.05.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2011/002005

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 192841/1985(Laid-open No. 100475/1987) (Daikin Industries, Ltd.), 26 June 1987 (26.06.1987), fig. 1, 2 (Family: none)	1-24 25-34
A Y	JP 34-9384 B1 (Toraji MORIYASU, Minoru UEMATSU), 20 October 1959 (20.10.1959), fig. 1 (Family: none)	1-24 25-34
A Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 13437/1991(Laid-open No. 1914/1993) (Mitsubishi Electric Corp.), 14 January 1993 (14.01.1993), paragraphs [0008] to [0010]; fig. 1, 2 (Family: none)	1-24 25-34
A Y	JP 4-281125 A (Mitsubishi Electric Corp.), 06 October 1992 (06.10.1992), paragraphs [0021] to [0024]; fig. 1, 2 (Family: none)	1-24 25-34
A Y	JP 2004-340431 A (Nakano Refrigerators Co., Ltd.), 02 December 2004 (02.12.2004), paragraphs [0008], [0014], [0016]; fig. 1, 2 (Family: none)	1-24 25-34
A Y	JP 2004-286294 A (Toshiba Carrier Corp.), 14 October 2004 (14.10.2004), paragraphs [0007] to [0009], [0013]; fig. 2 (Family: none)	1-24 25-34
A Y	JP 2004-332973 A (Hitachi, Ltd.), 25 November 2004 (25.11.2004), paragraphs [0021] to [0047]; fig. 1 to 13 (Family: none)	1-24 25-34
A Y	JP 9-264564 A (Mitsubishi Heavy Industries, Ltd.), 07 October 1997 (07.10.1997), paragraphs [0015] to [0024]; fig. 1, 2 (Family: none)	1-24 25-34

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/002005

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A Y	JP 2007-93068 A (Sanyo Electric Co., Ltd.), 12 April 2007 (12.04.2007), paragraphs [0020] to [0021]; fig. 1 & CN 1940406 A	1-24 26,31
P,A	WO 2010/089920 A1 (Mitsubishi Electric Corp.), 12 August 2010 (12.08.2010), entire text; all drawings (Family: none)	1-34

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2005003244 A **[0003]**
- JP 2009067265 W **[0005]**