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

(11) EP 2 236 951 A1

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

(43) Date of publication:
06.10.2010 Bulletin 2010/40

(21) Application number: **08863837.4**

(22) Date of filing: **17.12.2008**

(51) Int Cl.:
F24F 13/28 *(2006.01)* ***F24F 1/00*** *(2006.01)*
F24F 11/02 *(2006.01)*

(86) International application number:
PCT/JP2008/003807

(87) International publication number:
WO 2009/081545 (02.07.2009 Gazette 2009/27)

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

(30) Priority: **21.12.2007 JP 2007329785**
21.12.2007 JP 2007329787
15.02.2008 JP 2008034546
15.02.2008 JP 2008034553

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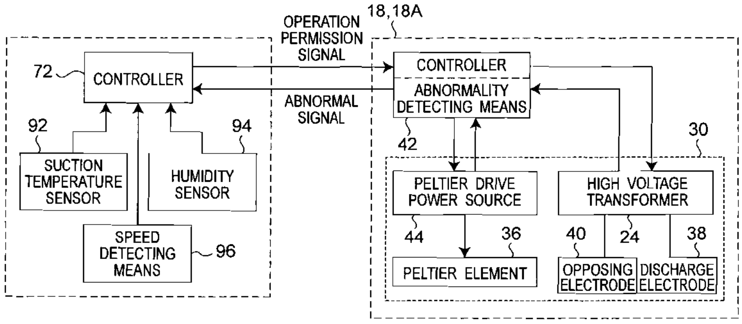
(54) **AIR CONDITIONER**

(57) An operation permission region of an electrostatic atomizing device 18, 18A is defined depending on the temperature and humidity of air sucked into an indoor unit. If a temperature detected by a suction temperature detecting means 92 and a humidity detected by a humidity detecting means 94 fall within the operation permission region, operation of the electrostatic atomizing device 18, 18A is permitted, while if any one of the temperature detected by the suction temperature detecting means 92 and the humidity detected by the humidity detecting means 94 is out of the operation permission region, the operation of the electrostatic atomizing device 18, 18A is prohibited.

Fig.13



EP 2 236 951 A1

Description

Technical Field

[0001] The present invention relates to an air conditioner provided with an indoor unit that has an air cleaning function for cleaning indoor air.

Background Art

[0002] Some conventional air conditioners have a deodorizing function. For this purpose, they include an air cleaning filter disposed in proximity to, for example, suction openings in an indoor unit to adsorb odorous components or a deodorizing unit disposed in, for example, an air passage and having an oxidation decomposing function to adsorb the odorous components.

[0003] However, because the air conditioners having a deodorizing function remove odorous components contained in air, which has been sucked through the suction openings, for deodorization, they cannot remove odorous components contained in air inside a room or those adhering to curtains, walls, and the like.

[0004] In view of this, an air conditioner having an electrostatic atomizing device has been proposed. The electrostatic atomizing device is disposed in the air passage in the indoor unit to generate an electrostatic mist of a nanometer size in particle diameter and subsequently blows it out together with air into the room, thereby removing the odorous components contained in indoor air or those adhering to curtains, walls, and the like (see, for example, Patent Document 1 or 2).

[0005] Another air conditioner has been proposed in which an electrostatic atomizing device includes Peltier elements. In this air conditioner, there are provided a suction temperature detecting means for detecting the temperature of air sucked into an indoor unit, a humidity detecting means for detecting the humidity of such air, a Peltier element drive power source, and a high voltage power source for applying a high voltage to a high voltage electrode. The Peltier element drive power source and the high voltage power source are controlled based on a detection result of the suction temperature detecting means and that of the humidity detecting means to thereby obtain water necessary for electrostatic atomization without feeding water (see, for example, Patent Document 3).

[0006] A further air conditioner has been proposed in which neither the suction temperature detecting means nor the humidity detecting means is provided for the electrostatic atomization, and a stable electrostatic atomizing control is conducted by feedback controlling a Peltier element drive power source based on a detected discharge current using a relationship between an amount of dew condensation water and an amount of discharge current generated during the electrostatic atomization (see, for example, Patent Document 4).

Patent Document 1: Japanese Laid-Open Patent Publication No. 2005-282873
Patent Document 2 : Japanese Laid-Open Patent Publication No. 2006-234245
Patent Document 3: Japanese Laid-Open Patent Publication No. 2006-149538
Patent Document 4 : Japanese Laid-Open Patent Publication No. 2007-21373

Disclosure of the Invention

Problems to be Solved by the Invention

[0007] However, the air conditioner as disclosed in Patent Document 3 requires a cooling surface temperature detecting means for detecting the temperature of a cooling surface of the Peltier elements, and a control means controls the voltage of the Peltier element drive power source to bring the temperature of the cooling surface detected by the cooling surface temperature detecting means close to a dew-point temperature. The construction is complicated, giving rise to cost problems.

[0008] Because the air conditioner as disclosed in Patent Document 4 does not have the suction temperature detecting means and the humidity detecting means, when the humidity inside a room is high, the distance between water condensed on a high voltage electrode and an opposing electrode is reduced to thereby generate an abnormal sound or make it impossible to generate an electrostatic mist of a desired size in particle diameter. On the other hand, when the humidity inside the room is low, the dew-point temperature is not reached even if the Peltier elements show their maximum powers, thus giving rise to a possibility of ozone being generated, or even when the dew-point temperature is below the freezing point, the electrostatic atomizing device operates unnecessarily, thus reducing the life of the electrostatic atomizing device or making it impossible to achieve energy saving.

[0009] The present invention has been developed to overcome the above-described disadvantage.

[0010] It is accordingly an objective of the present invention to provide an air conditioner having an electrostatic atomizing device wherein an operation permission region is defined in which the electrostatic atomizing device can generate a desired electrostatic mist without generating noises or ozone. Only when the temperature and humidity of air sucked into an indoor unit are both within the operation permission region, operation of the electrostatic atomizing device is permitted, thus making it possible to provide an inexpensive air conditioner of a simple construction that can increase the life of the electrostatic atomizing device or achieve energy saving.

Means to Solve the Problems

[0011] In accomplishing the above objective, the air conditioner according to the present invention is provided with an indoor unit having an air cleaning function for cleaning indoor air, and includes an electrostatic atomizing device for generating an electrostatic mist, a suction temperature detecting means for detecting a temperature of air sucked into the indoor unit, and a humidity detecting means for detecting a humidity of the air sucked into the indoor unit, wherein an operation permission region of the electrostatic atomizing device is defined based on the temperature and humidity of the air sucked into the indoor unit. When the temperature detected by the suction temperature detecting means and the humidity detected by the humidity detecting means fall within the operation permission region, operation of the electrostatic atomizing device is permitted, while when any one of the temperature detected by the suction temperature detecting means and the humidity detected by the humidity detecting means is out of the operation permission region, the operation of the electrostatic atomizing device is prohibited. Also, an excessive dew condensation region is defined out of the operation permission region when the humidity of the air sucked into the indoor unit is higher than a first predetermined value.

[0012] In another aspect of the present invention, the air conditioner includes an indoor unit, a human body detecting sensor mounted to the indoor unit to detect the presence or absence of a person, and an electrostatic atomizing device mounted to the indoor unit to generate an electrostatic mist. There are provided a skin care mode and a room care mode, and when a determination is made that a person is present in a predetermined region in a range that can be detected by the human body detecting sensor, a wind direction control in the skin care mode is conducted to direct air discharged from the indoor unit toward the predetermined region to render an electrostatic mist to reach the predetermined region, while when a determination is made that nobody is present in the range that can be detected by the human body detecting sensor, a wind direction control in the room care mode is conducted to direct the electrostatic mist upward or render the electrostatic mist to reach a region remote from the indoor unit.

Effects of the Invention

[0013] The air conditioner according to the present invention defines an operation permission region of the electrostatic atomizing device based on the temperature and humidity of the air sucked into the indoor unit, and when the temperature detected by the suction temperature detecting means and the humidity detected by the humidity detecting means fall within the operation permission region, operation of the electrostatic atomizing device is permitted, while when any one of them is out of the operation permission region, the operation of the electrostatic atomizing device is prohibited. Accordingly, the air conditioner according to the present invention is of a simple construction, can avoid generation of noises or ozone without causing an increase in cost, and can increase the life of the electrostatic atomizing device or achieve energy saving.

[0014] In the skin care mode, the wind direction is controlled to direct air discharged from the indoor unit toward a region that has been determined by the human body detecting sensor that a person is present there or a region of region property having a high frequency of presence of a person so that an electrostatic mist may reach such a region. By so doing, the electrostatic mist is supplied to a user to improve his or her skin.

[0015] In the room care mode, if a determination is made that nobody is present in a range that can be detected by the human body detecting sensor, the electrostatic mist is directed upward or rendered to reach a region remote from the indoor unit. By so doing, the electrostatic mist is supplied to wall surfaces, curtains, and the like to which odorous components may adhere, thus making it possible to efficiently or effectively sterilize and remove odorous components and realize comfortable indoor conditions.

Brief Description of the Drawings

[0016]

Fig. 1 is a perspective view of an indoor unit of an air conditioner according to the present invention with a portion thereof removed.
Fig. 2 is a schematic vertical sectional view of the indoor unit of Fig. 1.
Fig. 3 is a perspective view of an electrostatic atomizing device mounted in the indoor unit of Fig. 1.
Fig. 4 is a front view of the electrostatic atomizing device and a portion of a frame of the indoor unit of Fig. 1.

Fig. 5 is a schematic view of the electrostatic atomizing device.

Fig. 6 is a block diagram of the electrostatic atomizing device.

Fig. 7 is a perspective view of the indoor unit, particularly depicting a state in which the electrostatic atomizing device is mounted with respect to a body of the indoor unit.

Fig. 8 is a perspective view of a modification of the indoor unit, particularly depicting a state in which the electrostatic atomizing device is mounted with respect to the body of the indoor unit.

Fig. 9 is a side view of the indoor unit of Fig. 1, particularly depicting a positional relationship between the electrostatic atomizing device and a ventilation fan unit.

Fig. 10 is a perspective view of a modification of the electrostatic atomizing device.

Fig. 11 is a side view of the indoor unit of Fig. 1, particularly depicting a positional relationship between the electrostatic atomizing device of Fig. 10 and the ventilation fan unit.

Fig. 12 is a graph indicating an operation allowable zone of the electrostatic atomizing device.

Fig. 13 is a block diagram of the indoor unit and the electrostatic atomizing device, particularly depicting a signal transfer between a control unit of the former and that of the latter.

Fig. 14A is a front view of the indoor unit of the air conditioner according to the present invention having a human body detecting device.

Fig. 14B is a front view of the indoor unit of Fig. 14A with a cover of the human body detecting device removed.

Fig. 14C is a side view of the indoor unit of Fig. 14A.

Fig. 15A is a perspective view of the indoor unit, depicting a state in which front suction openings are opened by a front panel.

Fig. 15B is a side view of the indoor unit of Fig. 15A.

Fig. 16 is a vertical sectional view of the indoor unit of Fig. 14A.

Fig. 17A is a front view of the human body detecting device.

Fig. 17B is a side view of the human body detecting device of Fig. 17A.

Fig. 17C is a perspective view of the human body detecting device of Fig. 17A.

Fig. 18A is a schematic view of the indoor unit, depicting a change in the field of view caused by a change in the mounting position of the human body detecting device.

Fig. 18B is another schematic view of the indoor unit, depicting a change in the field of view caused by a change in the mounting position of the human body detecting device.

Fig. 18C is a further schematic view of the indoor unit, depicting a change in the field of view caused by a change in the mounting position of the human body detecting device.

Fig. 18D is a still further schematic view of the indoor unit, depicting a change in the field of view caused by a change in the mounting position of the human body detecting device.

Fig. 19 is a schematic view of human position discriminating regions that are detected by sensor units provided in the human body detecting device.

Fig. 20 is a schematic view of segmentalized regions to be detected by three sensor units.

Fig. 21 is a flowchart for setting region property to each region shown in Fig. 19.

Fig. 22 is a flowchart for finally determining the presence or absence of a person in each region shown in Fig. 19.

Fig. 23 is a timing chart depicting a determination of the presence or absence of a person by each sensor unit.

Fig. 24 is a schematic plan view of a house in which the indoor unit of Fig. 14A has been installed.

Fig. 25 is a graph depicting long-term cumulative results obtained by each sensor unit with respect to the house of Fig. 24.

Fig. 26 is a schematic plan view of another house in which the indoor unit of Fig. 14A has been installed.

Fig. 27 is a graph depicting long-term cumulative results obtained by each sensor unit with respect to the house of Fig. 26.

Fig. 28 is a set of vertical sectional views of the indoor unit, each depicting an operating state of a vertical wind direction changing blade mounted to the indoor unit of Fig. 14A.

Fig. 29 is a schematic view indicating set speeds of an indoor fan when each region shown in Fig. 19 is air conditioned.

Fig. 30 is a schematic view indicating set angles of the vertical wind direction changing blade and those of horizontal wind direction changing blades when each region shown in Fig. 19 is heated.

Fig. 31 is a schematic view indicating set angles of the vertical wind direction changing blade and those of the horizontal wind direction changing blades during rising or in an instable state when each region shown in Fig. 19 is cooled.

Fig. 32 is a schematic view indicating set angles of the vertical wind direction changing blade and those of the horizontal wind direction changing blades in a stable state when each region shown in Fig. 19 is cooled.

Fig. 33 is a flowchart depicting a wind direction control that is conducted depending on the number of regions to be air conditioned.

Fig. 34A is a schematic view depicting an air conditioning mode in which two regions are air conditioned.

Fig. 34B is a schematic view depicting another air conditioning mode in which two regions are air conditioned.
Fig. 34C is a schematic view depicting a further air conditioning mode in which two regions are air conditioned.
Fig. 34D is a schematic view depicting a still further air conditioning mode in which two regions are air conditioned.
Fig. 34E is a schematic view depicting another air conditioning mode in which two regions are air conditioned.
Fig. 35A is a schematic view depicting an air conditioning mode in which three regions are air conditioned.
Fig. 35B is a schematic view depicting another air conditioning mode in which three regions are air conditioned.
Fig. 35C is a schematic view depicting a further air conditioning mode in which three regions are air conditioned.
Fig. 36 is a schematic view indicating set angles of the vertical wind direction changing blade and those of the horizontal wind direction changing blades when the electrostatic atomizing device is operated with no persons.
Fig. 37 is a schematic view indicating set speeds of the indoor fan when the electrostatic atomizing device is operated with no persons.
Fig. 38 is a timing chart for carrying out an energy saving operation by controlling the capacity of the indoor fan and the power of a compressor mounted in an outdoor unit.
Fig. 39 is a timing chart depicting a temperature control during heating.
Fig. 40 is a timing chart depicting a temperature control during cooling.

Explanation of Reference Numerals

[0017] 2 indoor unit body, 2a front suction opening, 2b upper suction opening, 4 front panel, 5 filter, 6 heat exchanger, 8 indoor fan, 10 discharge opening, 12 vertical wind direction changing blade, 14 horizontal wind direction changing blade, 16 ventilation fan unit, 18, 18A electrostatic atomizing device, 20 main passage, 22 bypass passage, 22a bypass suction port, 22b bypass discharge port, 22c bypass suction pipe, 22d bypass discharge pipe, 22e storage space, 24 high voltage transformer, 26 bypass fan, 28 radiating portion, 30 electrostatic atomizing unit, 32 silencer, 34 casing, 36 Peltier element, 36a radiating surface, 36b cooling surface, 38 discharge electrode, 40 opposing electrode, 42 controller, 44 Peltier drive power source, 46 frame, 46a rear wall, 46b side wall, 46c partition wall, 46d opening, 48 rear guider, 48a rear wall,
48b side wall, 58 discharge port, 62 opening, 64 damper, 66 unit housing, 68 silencer housing, 72 controller, 92 suction temperature sensor, 94 humidity sensor, 96 speed detecting means, 100 cover, 114 middle blade, 116 middle blade drive mechanism, 118, 120, 122, 124 arm, 126, 128, 130, 132, 134 sensor unit, 126a, 128a, 130a, 132a, 134a circuit board, 126b, 128b, 130b, 132b, 134b lens, 136 sensor holder.

Best Mode for Carrying out the Invention

[0018] Embodiments of the present invention are explained hereinafter with reference to the drawings.

(Whole construction of air conditioner)

[0019] An air conditioner includes an outdoor unit and an indoor unit connected to each other via refrigerant piping, and Figs. 1 and 2 depict the indoor unit of the air conditioner according to the present invention.
[0020] As shown in Figs. 1 and 2, the indoor unit includes a main body 2 having front suction openings 2a and upper suction openings 2b both defined therein as suction openings through which indoor air is sucked into the main body 2. The indoor unit also includes a movable front panel (hereinafter referred to simply as "front panel") 4 to open and close the front suction openings 2a. When the air conditioner is not in operation, the front panel 4 is held in close contact with the main body 2 to close the front suction openings 2a, while when the air conditioner is brought into operation, the front panel 4 moves away from the main body 2 to open the front suction openings 2a.
[0021] The main body 2 accommodates therein a fitter 5 disposed downstream of the front suction openings 2a and the upper suction openings 2b to remove dust contained in air, a heat exchanger 6 disposed downstream of the filter 5 to heat exchange with indoor air sucked through the front suction openings 2a and the upper suction openings 2b, and an indoor fan 8 operable to convey air heat exchanged by the heat exchanger 6. The main body 2 also includes a vertical wind direction changing blade 12 operable to open and close a discharge opening 10, through which air conveyed by the indoor fan 8 is blown out into a room, and also operable to vertically change the direction of air blown out from the discharge opening 10, and horizontal wind direction changing blades 14 operable to horizontally change the wind direction. The front panel 4 is connected at an upper portion thereof to an upper portion of the main body 2 via a plurality of arms (not shown) provided on respective side portions thereof. Because one of the plurality of arms is connected to a drive motor (not shown), when the air conditioner is brought into operation, the front panel 4 is moved forward from a position (where the front suction openings 2a are closed) during a halt of the air conditioner by driving the drive motor. The vertical wind direction changing blade 12 is similarly connected to a lower portion of the main body 2 via a plurality of arms (not shown) provided on respective side portions thereof.

(Construction of electrostatic atomizing device)

[0022] A ventilation fan unit 16 operable to ventilate indoor air is disposed at a side portion (at a left side portion as viewed from the front of the indoor unit or on a side of a bypass passage 22 with respect to a partition wall 46c explained later) of the indoor unit, and an electrostatic atomizing device 18 is disposed rearwardly of the ventilation fan unit 16. The electrostatic atomizing device 18 has an air cleaning function of cleaning indoor air by generating an electrostatic mist.

[0023] It is to be noted here that Fig. 1 depicts a state in which the front panel 4 and a cover (not shown) for covering the main body 2 are both removed, and Fig. 2 depicts a state in which the electrostatic atomizing device 18 accommodated within the main body 2 is separated from the main body 2 for clarification of junctions between the main body 2 of the indoor unit and the electrostatic atomizing device 18. In fact, the electrostatic atomizing device 18 has a shape as shown in Fig. 3 and is mounted in a left side portion of the main body 2, as shown in Fig. 1 or 4.

[0024] As shown in Figs. 2 and 4, the electrostatic atomizing device 18 is disposed in the bypass passage 22 bypassing the main passage 20 that communicates the front suction openings 2a and the upper suction openings 2b with the discharge opening 10 via the heat exchanger 6, the indoor fan 8, and the like. A high voltage transformer 24 employed as a high voltage power source and a bypass fan 26 are disposed on an upstream side of the bypass passage 22, and an electrostatic atomizing unit 30 having a radiating portion 28 to promote radiation thereof and a silencer 32 are disposed on a downstream side of the bypass passage 22. Accordingly, the high voltage transformer 24, the bypass fan 26, the radiating portion 28, the electrostatic atomizing unit 30, and the silencer 32 are arrayed in this order from the upstream side, and all of them are accommodated within a casing 34 constituting a portion of the bypass passage 22, thus making it possible to enhance assemblage. Also, because the casing 34 forms the passage, not only can a mounting space for these members be reduced, but an air flow created by the bypass fan 26 can also be positively directed to heating elements such as the high voltage transformer 24 and the radiating portion 28 to cool them. In addition, the electrostatic mist generated by the electrostatic atomizing unit 30 can be assuredly introduced to the discharge opening 10 and discharged into a room to be air conditioned.

[0025] Further, the casing 34 is vertically arranged so that the direction of air flowing inside the casing 34 may be parallel to the direction of air flowing through the main passage 20 as viewed from the front of the main body 2 of the indoor unit. As a result, the casing 34 can be juxtaposed with the ventilation fan unit 16 in a superimposed manner as viewed from the front of the main body 2, thereby making it possible to further reduce the mounting space.

[0026] Although the high voltage transformer 24 is not always accommodated within the casing 34, it is preferred that the former be accommodated within the latter in terms of suppression of a temperature increase or reduction of the mounting space, because the high voltage transformer 24 is cooled by the air flow in the bypass passage 22.

[0027] A conventional electrostatic atomizing unit 30 is explained hereinafter with reference to Figs. 5 and 6.

[0028] As shown in Fig. 5, the electrostatic atomizing unit 30 includes a plurality of Peltier elements 36 having a radiating surface 36a and a cooling surface 36b, the radiating portion (for example, radiating fins) 28 referred to above and held in thermally close contact with the radiating surface 36a, a discharge electrode 38 held in thermally close contact with the cooling surface 36b via an electrical insulator (not shown) and extending upwardly from the cooling surface 36b, and an opposing electrode 40 spaced away a predetermined distance from the discharge electrode 38.

[0029] As shown in Fig. 6, the electrostatic atomizing device 18 includes a controller 42 disposed adjacent the ventilation fan unit 16 (see Fig. 1). A Peltier drive power source 44 and the high voltage transformer 24 are electrically connected to the controller 42, while the Peltier elements 36 and the discharge electrode 38 are electrically connected to the Peltier drive power source 44 and the high voltage transformer 24, respectively.

[0030] In order for the electrostatic atomizing unit 30 to generate the electrostatic mist by causing high voltage discharge from the discharge electrode 38, the opposing electrode 40 is not always required. By way of example, if one terminal of a high voltage power source is connected to the discharge electrode 38, and the other terminal of the high voltage power source is connected to the frame via a structural body, a discharge occurs between the discharge electrode 38 and a portion of the structural body connected to the frame, which portion is positioned in close proximity to the discharge electrode 38. In this case, such structural body can be regarded as the opposing electrode 40.

[0031] In the electrostatic atomizing unit 30 of the above-described construction, when the controller 42 controls the Peltier drive power source 44 to flow an electric current through the Peltier elements 36, heat is transferred from the cooling surface 36b toward the radiating surface 36a, and the temperature of the discharge electrode 38 lowers, thus resulting in dew condensation on the discharge electrode 38. Further, when the controller 42 controls the high voltage transformer 24 to apply a high voltage to the discharge electrode 38 to which dew condensation water has adhered, the dew condensation water undergoes a discharge phenomenon, which in turn generates an electrostatic mist of a nanometer size in particle diameter. Because a negative high voltage power source is employed as the high voltage transformer 24, the electrostatic mist is negatively charged.

[0032] In this embodiment, as shown in Fig. 7, the main passage 20 is delimited by a rear wall 46a of the frame 46 constituting the main body 2, opposite side walls 46b (only a left side wall is shown in Fig. 7) extending forward from respective side end portions of the rear wall 46a, a rear wall 48a of a rear guider (air guide) 48 formed below the frame

46, and opposite side walls (only a left side wall is shown in Fig. 7) 48b extending forward from respective side end portions of the rear wall 48a. One (left side wall) 46b of the side walls of the frame 46 and one (left side wall) 48b of the side walls of the rear guider 48 form a partition wall 46c that partitions the bypass passage 22 from the main passage 20. The side wall 46b of the frame 46 has a bypass suction port 22a of the bypass passage 22 defined therein, and the side wall 48b of the rear guider 48 has a bypass discharge port 22b of the bypass passage 22 defined therein.

[0033] In the case of air conditioners, low-temperature air that has passed the heat exchanger 6 of the indoor unit has a high relative humidity during cooling. Accordingly, in the electrostatic atomizing device 18 provided with the Peltier elements 36 to supply moisture, it is likely that dew condensation would occur on the whole Peltier elements 36 as well as on the discharge electrode 38 in the form of a pin. On the other hand, during heating, high-temperature air that has passed the heat exchanger 6 has a low relative humidity and, hence, the possibility of dew condensation on the discharge electrode 38 is extremely low.

[0034] In view of this, the partition wall 46c is provided to separate the bypass passage 22 from the main passage 20, and the electrostatic atomizing device 18 for generating the electrostatic mist is provided in the bypass passage 22, as described above, so that the electrostatic atomizing device 18 may be supplied with air that does not pass the heat exchanger 6 and is accordingly not controlled in temperature and humidity. By so doing, dew condensation on the whole Peltier elements 36 of the electrostatic atomizing unit 30 is effectively prevented during cooling, thereby enhancing safety, while the electrostatic mist can be positively generated even during heating.

[0035] The bypass passage 22 includes a bypass suction pipe 22c, the casing 34 referred to above, and a bypass discharge pipe 22d. One end of the bypass suction pipe 22c is connected to the bypass suction port 22a defined in the frame side wall 46b, and the bypass suction pipe 22c extends leftward from the bypass suction port 22a (in a direction generally perpendicular to the left side wall 46b and generally parallel to the front panel 4). The other end of the bypass suction pipe 22c is connected to one end of the casing 34, the other end of which is connected to one end of the bypass discharge pipe 22d that extends downward and is then bent rightward. The other end of the bypass discharge pipe 22d is connected to the bypass discharge port 22b defined in the side wall 48b of the rear guider 48. By configuring a portion of the bypass passage 22 with the casing 34, the mounting space can be reduced, and an integral configuration of these members can positively introduce the electrostatic mist from the electrostatic atomizing unit 30 into the main passage 20 via the bypass discharge pipe 22d to discharge the electrostatic mist to the room to be air conditioned.

[0036] The bypass suction port 22a is positioned between the filter 5 and the heat exchanger 6, i.e., downstream of the filter 5 and upstream of the heat exchanger 6. Because dust contained in air that has been sucked through the front suction openings 2a and the upper suction openings 2b is effectively removed by the fitter 5, intrusion of the dust into the electrostatic atomizing device 18 can be suppressed, thus making it possible to effectively prevent accumulation of the dust in the electrostatic atomizing unit 30 and steadily discharge the electrostatic mist.

[0037] In this embodiment, the filter 5 serves both as a filter for the electrostatic atomizing device 18 and a filter for the main passage 20 and, hence, maintenance work is completed by cleaning only the filter 5, thus resulting in simplification of maintenance.

[0038] On the other hand, the bypass discharge port 22b is positioned downstream of the heat exchanger 6 and the indoor fan 8 and in proximity to the discharge opening 10, so that the electrostatic mist discharged from the bypass discharge port 22b may ride an air flow in the main passage 20 and diffuse to thereby fill the whole room with the electrostatic mist. The placement of the bypass discharge port 22b at a position downstream of the heat exchanger 6 is due to the fact that if the former is positioned upstream of the latter, most (greater than about 80% to 90%) of the electrostatic mist made up of charged particles is absorbed by the heat exchanger 6 because the heat exchanger 6 is made of a metal. The placement of the bypass discharge port 22b at a position downstream of the indoor fan 8 is due to the fact that if the former is positioned upstream of the latter, because a turbulent flow is present inside the indoor fan 8, a portion (about 50%) of the electrostatic mist is absorbed by the indoor fan 8 when air flowing inside the indoor fan 8 impinges on various portions of the indoor fan 8.

[0039] Because the indoor fan 8 imparts a predetermined speed to an air flow on the side of the main passage 20 with respect to the side wall 48b of the rear guider 48 having the bypass discharge port 22b, a pressure difference is created between the side of the main passage 20 and the side of the bypass passage 22. That is, the pressure on the side of the main passage 20 is lower than that on the side of the bypass passage 22 and is accordingly negative with respect to the latter and, hence, air is introduced from the bypass passage 22 toward the main passage 20. For this reason, it is sufficient if a small-capacity fan is employed as the bypass fan 26 and, in some cases, the bypass fan 26 may be dispensed with.

[0040] The bypass discharge pipe 22d is connected to the partition wall 46c (side wall 48b of the rear guider 48) so as to extend in a direction generally perpendicular to the air flow within the main passage 20 at a junction (bypass discharge port 22b) with the main passage 20. The reason for this is that the electrostatic atomizing device 18 makes use of a discharge phenomenon to generate an electrostatic mist, as described above, and the use of the discharge phenomenon is inevitably followed by a discharge sound having a directivity. Accordingly, by connecting the bypass passage 22 to the partition wall 46c so as to extend generally parallel to the front panel 4 at the junction (bypass discharge port 22b) between the bypass passage 22 and the main passage 20, it is made extremely unlikely that the discharge sound would be directed to a person present forward or obliquely forward of the indoor unit, thereby reducing noises.

[0041] As shown in Fig. 8, the bypass discharge pipe 22d may be inclined with respect to the partition wall 46c at the junction with the main passage 20 so as to be directed upstream with respect to the air flow in the main passage 20. This configuration is effective to further reduce noises caused by the discharge sound.

[0042] Even if the bypass discharge pipe 22d is connected to the partition wall 46c so as to be directed downstream with respect to the air flow in the main passage 20, it is sufficient if an extension of the bypass discharge pipe 22d does not extend outside through the discharge opening 10. By so doing, the amount of the discharge sound emerging outside from the discharge opening 10 becomes small, and only a lesser amount of discharge sound directly reaches user's ears, thus resulting in a reduction in noise.

[0043] As described hereinabove, the main passage 20 and the bypass passage 22 are separated from each other by the partition wall 46c, and the electrostatic atomizing device 18 for generating the electrostatic mist is provided in the bypass passage 22 that bypasses the heat exchanger 6 and communicates with the main passage 20. Accordingly, the electrostatic atomizing device 18 is supplied with air that does not pass the heat exchanger 6 and is accordingly not controlled in temperature and humidity, and dew condensation on the whole Peltier elements 36 of the electrostatic atomizing unit 30 is effectively prevented during cooling, thereby enhancing safety, while the electrostatic mist can be positively generated even during heating, thus making it possible to steadily generate the electrostatic mist irrespective of the mode of operation of the air conditioner, i.e., at any time of year.

[0044] Fig. 9 depicts a state, as viewed from a side of the indoor unit body 2, in which the electrostatic atomizing device 30 has been mounted thereto. The electrostatic atomizing device 30 has a shape corresponding to a space positioned rearwardly of the ventilation fan unit 16 and is accommodated within such a space.

[0045] Fig. 10 depicts an electrostatic atomizing device 18A having no casing. This electrostatic atomizing device 18A is incorporated in the indoor unit body 2, as shown in Fig. 11. Alternatively, the electrostatic atomizing device 18A is incorporated in a space 18B as indicated by a dotted line in Fig. 11 (substantially the same position as the electrostatic atomizing device 18 and the silencer 32 provided downstream of the bypass passage 22 in the electrostatic atomizing device 18 shown in Fig. 9). The electrostatic atomizing device 18A is placed at a position overlapping with the ventilation fan unit 16 as viewed from above or from the front of the indoor unit, and such position is a position in proximity to an opening 62 and a damper 64 of the ventilation fan unit 16, through which position air induced by the ventilation fan unit 16 flows.

[0046] More specifically, in the electrostatic atomizing device 18A of Fig. 10, the electrostatic atomizing unit 30 having the radiating portion 28 is integrated with the silencer 32, and the electrostatic atomizing unit 30 excluding the radiating portion 28 and the silencer 32 are accommodated within respective housings (a unit housing 66 and a silencer housing 68). The silencer housing 68 has an opening 68a defined therein, to which one end of the bypass discharge pipe 22d is connected. The other end of the bypass discharge pipe 22d is connected to the main passage 20. In this case, a storage space 22e, which is separated from the main passage 20 by the partition wall 46c and formed between the partition wall 46c and a left side wall of the main body cover, and in which the ventilation fan unit 16, the electrostatic atomizing device 18A, and the like are accommodated, acts in place of the bypass suction pipe 22c and the casing 34 both referred to above. The storage space 22e also accommodates the bypass discharge pipe 22d and acts as the bypass passage 22.

[0047] Although the noise reduction by the direction of the bypass discharge pipe 22d with respect to the air flow in the main passage 20 is discussed above, the bypass discharge pipe 22d is not always required, and the silencer housing 68 may be directly connected to the bypass discharge port 22b, thereby making it possible to further simplify the construction of the electrostatic atomizing device 18A. However, attention to the direction of the silencer housing 68 for noise reduction must be paid, as is the case with the bypass discharge pipe 22d.

[0048] By this construction, air drawn into the main body 2 through the filter 5 is sucked into the storage space 22e through the bypass suction port 22a positioned downstream of the filter 5. Such air flows through the storage space 22e in a direction parallel to an air flow in the main passage 20 as viewed from the front of the main body 2 of the indoor unit. The air flowing through the storage space 22e cools the radiating portion 28 and is drawn into the electrostatic atomizing unit 30 through an opening or openings (not shown) defined in the unit housing 66.

[0049] The above-described construction causes a space formed around and juxtaposed with the ventilation fan unit 16 in an overlapping manner as viewed from above or from the front of the indoor unit to act as the bypass passage 22, and a reduction in the mounting space can be accomplished by making effective use of the storage space 22e for the ventilation fan unit 16, the electrostatic atomizing device 18A, and the like. In this construction, the high voltage transformer 24 is placed at an arbitrary position in the storage space 22e accommodating the ventilation fan unit 16, the electrostatic atomizing device 18A, and the like, and the bypass fan 26 is dispensed with.

[0050] As described above, the bypass passage 22 is separated from the main passage 20 merely by the partition wall 46c so that an air flow in the bypass passage 22 may become parallel to an air flow in the main passage 20 as viewed from the front of the main body 2 of the indoor unit, thus making it possible to easily provide the bypass passage

22 and reduce the number of component parts.

[0051] Further, the above-described construction enables a single filter 5 to be shared between the main passage 20 and the electrostatic atomizing device 18A.

[0052] It is to be noted here that an opening 46d may be formed in the vicinity of a lower portion of the frame 46 positioned rearwardly of the ventilation fan unit 16 so that pipes (not shown) for connecting the indoor unit and the outdoor unit may be installed through the opening 46d. The bypass suction port 22a referred to above is an opening defined in the partition wall 46c (side wall 46b of the frame) to suck air into the storage space 22e therethrough, and the bypass suction port 22a communicates with the outside of the indoor unit through the filter 5. However, the opening 46d defined in the lower portion of the frame 46 is an opening through which the storage space 22e communicates directly with the outside of the indoor unit to suck ambient air. In this case, the storage space 22e is a bypass passage that also bypasses the filter 5. Accordingly, air sucked into the electrostatic atomizing device 18A passes through the opening 46d and not through the filter 5 and, hence, another filter for the electrostatic atomizing device 18A may be provided as occasion demands. Even if the opening 46d is provided, the fact remains that the electrostatic atomizing device 18A is juxtaposed with the ventilation fan unit 16 in an overlapping manner as viewed from above or from the front of the indoor unit, and a reduction in the mounting space can be accordingly similarly accomplished by making effective use of the storage space 22e.

[0053] As described above, because the indoor fan 8 imparts a predetermined speed to an air flow on the side of the main passage 20 with respect to the bypass discharge port 22b, a pressure difference is created between respective sides of the partition wall 46c. That is, the pressure on the side of the main passage 20 becomes negative and, hence, even if the bypass fan 26 is not provided, the radiating portion 28 is cooled by air that is introduced from the storage space 22e, being the bypass passage, toward the main passage 20 through the bypass discharge pipe 22d, and the electrostatic mist generated by the electrostatic atomizing unit 30 is introduced into the main passage 20 and discharged into the room to be air conditioned. Also, because the radiating portion 28 is positioned in the vicinity of the opening 62 and the damper 64 and at a location where air flows before it is sucked through the opening 62, the radiating portion 28 is also cooled by the suction air into the ventilation fan unit 16, thereby promoting radiation from the electrostatic atomizing unit 30.

[0054] If a fan dedicated for ventilation is used for the ventilation fan unit 16, the damper 64 is not provided, but an arrangement in which the radiating portion 28 is positioned in the vicinity of a suction portion of the ventilation fan unit 16 can effectively cool the radiating portion 28.

[0055] In the construction referred to above, the main passage 20 and the storage space 22e being the bypass passage are separated by the partition wall 46c, and the electrostatic atomizing device 18A for generating the electrostatic mist is provided in the storage space 22e. Accordingly, the electrostatic atomizing device 18A is supplied with air that does not pass the heat exchanger 6 and is accordingly not controlled in temperature and humidity, and dew condensation on the whole Peltier elements 36 of the electrostatic atomizing unit 30 is effectively prevented during cooling, thereby enhancing safety, while the electrostatic mist can be positively generated even during heating, thus making it possible to steadily generate the electrostatic mist irrespective of the mode of operation of the air conditioner, i.e., at any time of year.

(Control of operation of electrostatic atomizing device)

[0056] For this control, a plurality of parameters are set as authorization conditions for operation of the electrostatic atomizing device 18, 18A. Only when all the parameters indicate permission of operation of the electrostatic atomizing device 18, 18A, operation of the electrostatic atomizing device 18, 18A is permitted.

[0057] On the other hand, when at least one of the parameters does not indicate permission of operation, operation of the electrostatic atomizing device 18, 18A is prohibited. By so doing, unnecessary operation of the electrostatic atomizing device 18, 18A is avoided in terms of energy saving or the life of the Peltier elements 36, and abnormal operation is also avoided.

[0058] In this embodiment, the following parameters are set as the authorization conditions for operation of the electrostatic atomizing device 18, 18A.

(i) The temperature and humidity of indoor air are within an operation permission region of the electrostatic atomizing device 18, 18A.
(ii) The speed of the indoor fan 8 exceeds a predetermined value.
(iii) The electrostatic atomizing device 18, 18A is not abnormal.

[0059] The operation permission region of the electrostatic atomizing device 18, 18A indicated in (i) is explained first.

[0060] The indoor unit includes a suction temperature sensor 92 provided in the vicinity of the suction openings (front suction openings 2a and upper suction openings 2b) to detect the temperature of air sucked thereinto (see Fig. 13), and also includes a humidity sensor 94 provided on, for example, an power source substrate of the indoor unit to detect the humidity of the air sucked thereinto (see Fig. 13). The operation permission region of the electrostatic atomizing device 18, 18A is determined based on the temperature and humidity of the air sucked into the indoor unit. If the temperature detected by the suction temperature sensor 92 and the humidity detected by the humidity sensor 94 are both within the operation permission region, operation of the electrostatic atomizing device 18, 18A is permitted, while if any one of the detected temperature and the detected humidity is out of the operation permission region, operation of the electrostatic atomizing device 18, 18A is prohibited.

[0061] This construction does not require any means for detecting the temperature of the cooling surface 36b of the Peltier elements 36 and is accordingly a simple one that does not cause an increase in cost. If any one of the detected temperature and the detected humidity is out of the operation permission region, not only can generation of an abnormal sound or ozone be avoided by prohibiting operation of the electrostatic atomizing device 18, 18A, but the life of the electrostatic atomizing device 18, 18A can also be prolonged or energy saving can be attained.

[0062] The operation permission region of the electrostatic atomizing device 18, 18A is explained with reference to a graph of Fig. 12.

[0063] As shown in Fig. 12, an excessive dew condensation region, a first out-of-performance region, and a below-freezing region are defined depending on the temperature and humidity of air sucked into the indoor unit, and a region excluding these regions is defined as the operation permission region. That is, the excessive dew condensation region, the first out-of-performance region, and the below-freezing region are defined out of the operation permission region. The excessive dew condensation region is a region in which the humidity is high (over a first predetermined value), and a reduction in the distance between water condensed on the discharge electrode 38 and the opposing electrode 40 causes a state similar to short circuit, in which a short-circuit current generates an abnormal sound or an electrostatic mist of a desired size in particle diameter is not generated.

[0064] The first out-of-performance region is a region in which the humidity is low (below a second predetermined value less than the first predetermined value referred to above), and even if the Peltier elements 36 show a maximum capacity thereof, the dew-point temperature is not reached. In this region, electric discharge occurs between the discharge electrode 38 and the opposing electrode 40 and not between dew condensation water and the opposing electrode 40, thus giving rise to a possibility of generation of ozone. The below-freezing region is a region in which the dew-point temperature obtained from a psychrometric chart is below the freezing point.

[0065] That is, by prohibiting operation of the electrostatic atomizing device 18, 18A in the excessive dew condensation region, it is possible to avoid generation of an abnormal sound, which would be caused by a high humidity inside a room, followed by a reduction in the distance between water excessively condensed on the high voltage electrode and the opposing electrode, thus making it possible to generate an electrostatic mist of a desired size in particle diameter.

[0066] Also, by prohibiting operation of the electrostatic atomizing device 18, 18A in the first out-of-performance region, it is possible to avoid generation of ozone, even when the humidity inside the room is low and, hence, the dew-point temperature is not reached, even if the Peltier elements 36 show a maximum capacity thereof.

[0067] In addition, by prohibiting operation of the electrostatic atomizing device 18, 18A in the below-freezing region, it is possible to avoid unnecessary operation of the electrostatic atomizing device 18, 18A when the dew-point temperature is below the freezing point, thus making it possible to avoid a reduction in the life of the electrostatic atomizing device 18, 18A and to achieve energy saving.

[0068] In the graph of Fig. 12, an upper limit temperature is set, and because a region over the upper limit temperature depends on the size of the radiating portion 28, this region can be defined as a second out-of-performance region. As described above, when electric current is applied to the Peltier elements 36, heat is transferred from the cooling surface 36b toward the radiating surface 36a. As a result, the temperature of the discharge electrode 38 lowers to cause dew condensation on the discharge electrode 38, and heat transferred to the radiating surface 36a is dissipated therefrom. However, there are various restrictions on the size of the radiating portion 28 in terms of storage of the electrostatic atomizing unit 30. The size of the radiating portion 28 is generally determined on ground that the electrostatic atomizing unit 30 works positively and normally at a maximum setting temperature (for example, 30°C) during heating, and that the electrostatic atomizing unit 30 works almost normally even at temperatures (for example, 32-35°C) over the maximum setting temperature. However, it is likely that the normal operation of the electrostatic atomizing unit 30 would be hindered over the maximum setting temperature with an increase in temperature. Accordingly, a region in which the detected temperature exceeds the upper limit temperature, i.e., the maximum setting temperature during heating is defined as the second out-of-performance region in which the normal operation of the electrostatic atomizing unit 30 would be hindered. Even during cooling, the normal operation of the electrostatic atomizing unit 30 is similarly restricted by the size of the radiating portion 28, and after the room temperature has reduced below the upper limit temperature, e.g., 30°C, the electrostatic atomizing device 18, 18A is brought into operation.

[0069] That is, by setting the second out-of-performance region out of the operation permission region, it is possible to prevent the electrostatic atomizing device 18, 18A from operating in an unstable state of the Peltier elements 36 over the upper limit temperature.

[0070] The speed of the indoor fan 8 as indicated in (ii) is explained next.

[0071] Although heat transferred from the cooling surface 36b to the radiating surface 36a of the Peltier elements 36 is dissipated from the radiating portion 28, if the speed of the indoor fan 8 detected by a speed detecting means 96 (see Fig. 13) is less than a predetermined speed (for example, 400rpm), heat dissipation from the radiating portion 28 is insufficient and, hence, the Peltier elements 36 cannot show a desired cooling ability. Accordingly, operation of the electrostatic atomizing device 18, 18A is permitted if the speed of the indoor fan 8 is greater than or equal to the predetermined speed, while operation of the electrostatic atomizing device 18, 18A is prohibited if the speed of the indoor fan 8 is less than the predetermined speed.

[0072] Such setting can avoid unstable operation of the Peltier elements 36 due to insufficient heat dissipation or generation of ozone due to an insufficient amount of dew condensation water that would be caused when the Peltier elements 36 cannot show a desired cooling ability. Also, when the speed of the indoor fan 8 is low, a discharge sound from the electrostatic atomizing device 18, 18A may become noticeable, but generation of such a sound can be avoided by stopping operation of the electrostatic atomizing device 18, 18A when the speed of the indoor fan 8 is less than a predetermined value.

[0073] Abnormal conditions of the electrostatic atomizing device 18, 18A as indicated in (iii) include a failure of the high voltage transformer 24 (abnormal output voltage) and a failure of the Peltier drive power source 44 (abnormal output voltage). If an abnormality detecting means (see Fig. 13) provided in the controller 42 of the electrostatic atomizing device 18, 18A does not detect the failure of the high voltage transformer 24 or the Peltier drive power source 44, operation of the electrostatic atomizing device 18, 18A is permitted, while if the abnormality detecting means detects the failure of the high voltage transformer 24 or the Peltier drive power source 44, operation of the electrostatic atomizing device 18, 18A is prohibited, thereby making it possible to prevent the electrostatic atomizing device 18, 18A from operating in an abnormal state.

[0074] Fig. 13 is a block diagram of a controller 72 of the indoor unit and the controller 42 of the electrostatic atomizing device 18, 18A, depicting transfer of signals therebetween.

[0075] As shown in Fig. 13, an output of the suction temperature sensor 92, that of the humidity sensor 94, and that of the speed detecting means 96 are all inputted to the controller 72 of the indoor unit, and the controller 42 of the electrostatic atomizing device 18, 18A watches an output value of the high voltage transformer 24 and that of the Peltier drive power source 44. A temperature sensor and a humidity sensor used for control of the refrigerating cycle during air conditioning, i.e., during cooling or heating and during dehumidifying are also used as the suction temperature sensor 92 and the humidity sensor 94, respectively.

[0076] Only when the temperature detected by the suction temperature sensor 92 and the humidity detected by the humidity sensor 94 are both within the operation permission region of the electrostatic atomizing device 18, 18A, the speed of the indoor fan 8 detected by the speed detecting means 96 is greater than or equal to the predetermined speed, and an abnormal signal from the controller 42 of the electrostatic atomizing device 18, 18A is not inputted to the controller 72 of the indoor unit, the controller 72 outputs an operation permission signal to the controller 42 of the electrostatic atomizing device 18, 18A, and upon receipt of the operation permission signal, the controller 42 of the electrostatic atomizing device 18, 18A controls the high voltage transformer 24 and the Peltier drive power source 44.

[0077] On the other hand, when the temperature detected by the suction temperature sensor 92 or the humidity detected by the humidity sensor 94 is out of the operation permission region of the electrostatic atomizing device 18, 18A, the speed of the indoor fan 8 detected by the speed detecting means 96 is less than the predetermined speed, or an abnormal signal from the controller 42 of the electrostatic atomizing device 18, 18A is inputted to the controller 72 of the indoor unit, the controller 72 does not output an operation permission signal to the controller 42 of the electrostatic atomizing device 18, 18A, thereby prohibiting operation of the electrostatic atomizing device 18, 18A.

[0078] Although the block diagram of Fig. 13 shows that the operation permission signal is outputted from the controller 72 of the indoor unit to the controller 42 of the electrostatic atomizing device 18, 18A, a power-on signal may be outputted in place of the operation permission signal.

[0079] The above-described construction is a simple one that does not require any cooling surface temperature detecting means for detecting the temperature of the cooling surface of the Peltier elements, and the detecting means used for the air conditioning operation other than the operation of the electrostatic atomizing device 18, 18A can be also used for the suction temperature sensor 92 and the humidity sensor 94, thus making it possible to avoid an increase in cost.

[0080] Although in the above-described embodiment the parameters (i)-(iii) have been set as the authorization conditions for operation of the electrostatic atomizing device 18, 18A, electric power consumption of the indoor unit excluding the electrostatic atomizing device 18, 18A may be set in addition to such parameters.

[0081] In this case, the controller 72 calculates the electric power consumption of the indoor unit excluding the electrostatic atomizing device 18, 18A, and if the calculated electric power consumption is less than or equal to an allowable power value, operation of the electrostatic atomizing device 18, 18A is permitted, while if the calculated electric power consumption exceeds the allowable power value, operation of the electrostatic atomizing device 18, 18A is prohibited.

[0082] This parameter is explained in detail with reference to Table 1.

Table 1

	Power consumption
Steady power consumption	10W
Drive of vertical wind direction changing blade	2W
Drive of horizontal wind direction changing blade	2W
Electrostatic atomizing device	High voltage transformer: 2W
	Peltier element: max. 5W
Other	3W

[0083] Table 1 indicates an example of the power consumption of the indoor unit. Assuming that the allowable power consumption of the indoor unit is 18W, if the power steadily consumed by a microcomputer (controller 72) and the like is 10W, it is necessary to simultaneously drive the electrostatic atomizing device 18, 18A, the vertical wind direction changing blade 12, the horizontal wind direction changing blades 14, and other movable members using the remaining 8W. Accordingly, if a total value of the power consumption calculated excluding the electrostatic atomizing device 18, 18A is less than the allowable power value (for example, 14W), operation of the electrostatic atomizing device 18, 18A is permitted, while if the total value of the power consumption exceeds the allowable power value, operation of the electrostatic atomizing device 18, 18A is prohibited. Such setting can prevent the power consumption of the indoor unit from exceeding the allowable power value.

[0084] A human body detecting device mounted on the indoor unit body 2 to detect the position of a person and an air conditioning control to be performed based on the position of a person detected by the human body detecting device are explained hereinafter.

[0085] Figs. 14A to 14C, Figs. 15A and 15B, and Fig. 16 depict an indoor unit of an air conditioner according to the present invention having the human body detecting device. Figs. 14A to 14C depict a state in which front suction openings 2a have been closed by a front panel 4, and Figs. 15A and 15B depict a state in which the front suction openings 2a have been opened by the front panel 4.

[0086] As shown in Fig. 16, the main body 2 includes a middle blade 114 mounted thereto below the front suction openings 2a via a middle blade drive mechanism 116 so as to swing on a side of a discharge opening 10 with respect to the front suction openings 2a, in addition to a vertical wind direction changing blade 12 operable to vertically change the direction of air blown out from the main body 2 and horizontal wind direction changing blades 14 operable to horizontally change the direction of air. The front panel 4 is connected at an upper portion thereof to an upper portion of the main body 2 via two arms 118, 120 provided on respective side portions thereof. The arm 118 is connected to a drive motor (not shown), and when the air conditioner is brought into operation, the front panel 4 is moved forward and obliquely upward from a position (where the front suction openings 2a are closed) during a halt of the air conditioner by driving the drive motor. The vertical wind direction changing blade 12 is connected to a lower portion of the main body 2 via two arms 122, 124 provided on respective side portions thereof, and a method of driving the same is explained later.

(Construction of human body detecting device)

[0087] As shown in Figs. 14B and 14C, a plurality of (for example, five) sensor units 126, 128, 130, 132, 134 are mounted as the human body detecting device on an upper portion of the front panel 4 so as to protrude from a principal plane of the front panel 4. These sensor units 126, 128, 130, 132, 134 are held by a sensor holder 136, as shown in Figs. 17A to 17C. The human body detecting device is covered with a cover 100, as shown in Fig. 14A, and Fig. 14B depicts a state in which the cover 100 has been removed.

[0088] The reason for the provision of the sensor units 126, 128, 130, 132, 134 on the upper portion of the front panel 4 is that a field of view (human position discriminating region discussed later) of each sensor unit 126, 128, 130, 132, 134 can be enlarged to ensure a maximum distant field of view, as shown in Fig. 18A. Also, as shown in Fig. 18B, a long-distance field of view can be ensured by moving the front panel 4 forward from its stop position at the start of operation of the air conditioner, and as shown in Fig. 18C, the field of view can be further enlarged by moving the front panel 4 obliquely upward from its stop position. However, the position of each sensor unit 126, 128, 130, 132, 134 is not limited to the upper portion of the front panel 4. Even if the front panel 4 is not movable, the field of view can be enlarged by mounting the human body detecting device on an upper portion thereof or an upper portion of the main body, as compared with the case where the human body detecting device is mounted on a lower portion of the front panel or the main body.

[0089] Because each sensor unit 126, 128, 130, 132, 134 is mounted so as to protrude from the principal plane of the front panel 4, as shown in Fig. 18D, each sensor unit 126, 128, 130, 132, 134 can be positioned further forward, thereby minimizing a dead space as shown in Figs. 18B to 18D, which may be created by the component parts of the indoor unit (for example, the vertical wind direction changing blade 14, the front panel 4 when opening the front suction openings 2a, or the like), and enlarging the field of view.
[0090] In this embodiment, each sensor unit 126, 128, 130, 132, 134 is mounted on the front panel 4, and when the front panel 4 opens the front suction openings 2a, each sensor unit 126, 128, 130, 132, 134 moves further forward with the front panel 4.
[0091] The sensor unit 126 includes a circuit board 126a, a lens 126b mounted on the circuit board 126a, and a human body detecting sensor (not shown) mounted inside the lens 126b. The same applies to other sensor units 128, 130, 132, 134. The human body detecting sensor is, for example, an infrared sensor for detecting the presence or absence of a person by detecting infrared rays emitted from a human body. The presence or absence of a person is determined by the circuit board 126a based on a pulse signal outputted depending on a change in the amount of infrared rays that is detected by the infrared sensor. That is, the circuit board 126a acts as a determination means for determining whether a person is present or absent.

(Estimation of human position by human body detecting device)

[0092] Fig. 19 depicts a plurality of human position discriminating regions, in each of which the presence or absence of a person is determined by the sensor units 126, 128, 130, 132, 134. The regions in which the presence or absence of a person is detected by the sensor units 126, 128, 130, 132, 134 are as follows.

Sensor unit 126: Regions A+C+D
Sensor unit 128: Regions B+E+F
Sensor unit 130: Regions C+G
Sensor unit 132: Regions D+E+H
Sensor unit 134: Regions F+I

[0093] In the indoor unit of the air conditioner according to the present invention, the regions that can be detected by the sensor units 126, 128 overlap partially with the regions that can be detected by the sensor units 130, 132, 134, and the presence or absence of a person is detected in each region A-I using the sensor units fewer than the number of the regions A-I.
[0094] If at least three human body detecting sensors are mounted on the upper portion of the indoor unit, the position of a person inside a room can be determined in directions depthwise and widthwise of the room as viewed from the indoor unit, i.e., where the person is on the floor can be determined two-dimensionally. Fig. 20 depicts regions that can be detected by three human body detecting sensors. In the example of Fig. 20, the presence or absence of a person in a region adjacent the indoor unit is detected by one of the three human body detecting sensors, while the presence or absence of a person in regions remote from the indoor unit is detected by two of the three human body detecting sensors.
[0095] Returning to Fig. 19, this embodiment is further discussed, but in the discussion below, the sensor units 126, 128, 130, 132, 134 are referred to as a first sensor 126, a second sensor 128, a third sensor 130, a fourth sensor 132, and a fifth sensor 134, respectively. Also, the regions C, D, E, F are referred to as overlapping regions because they are detected by two sensors, while the regions A, B, G, H, I other than the overlapping regions are referred to as general regions because they are detected by one sensor. The overlapping regions are divided into left-side overlapping regions C, D and right-side overlapping regions E, F.
[0096] Fig. 21 is a flowchart for setting region property (explained later) to each of the regions A-I using the first to fifth sensors 126, 128, 130, 132, 134, and Fig. 22 is a flowchart for determining the presence or absence of a person in each region A-I using the first to fifth sensors 126, 128, 130, 132, 134. A method of determining the position of a person is explained hereinafter with reference to these flowcharts.
[0097] At step S1, the presence or absence of a person in each left-side overlapping region is first determined at predetermined intervals T1 (for example, 5 seconds), and sensor outputs satisfying predetermined conditions are cleared at step S2.
[0098] Table 2 indicates a method of determining in the left-side overlapping regions. When the sensor outputs correspond to any one of three response results as indicated in Table 2, outputs of the first sensor 126 and the third sensor 130 are cleared. In this table, "1" means the presence of a response, and "0" means no response. The term "clear" is defined as rendering "1→0".

Table 2 (Determination in left-side overlapping regions)

Sensor	First sensor	Third sensor	Fourth sensor	Position determination
Response result	1	1	1	C · D
	1	1	0	C
	1	0	1	D

[0099] At step S3, the presence or absence of a person in each right-side overlapping region is next determined at the predetermined intervals T1 referred to above, and sensor outputs satisfying predetermined conditions are cleared at step S4.

[0100] Table 3 indicates a method of determining in the right-side overlapping regions. When the sensor outputs correspond to any one of three response results as indicated in Table 3, outputs of the second sensor 128 and the fifth sensor 134 are cleared.

Table 3 (Determination in right-side overlapping regions)

Sensor	Second sensor	Fourth sensor	Fifth sensor	Position determination
Response result	1	1	1	E · F
	1	1	0	E
	1	0	1	F

[0101] When the sensor outputs correspond to any one of the six response results as indicated in Tables 2 and 3, an output of the fourth sensor 132 is also cleared, and the program advances to step S5, at which the presence or absence of a person in each general region is determined at the predetermined intervals T1 based on Table 4. All the sensor outputs are cleared at step S6.

Table 4 (determination in general regions)

Sensor	Response result	Position determination
First sensor	1	A
Second sensor	1	B
Third sensor	1	G
Fourth sensor	1	H
Fifth sensor	1	I

[0102] This method of determination is explained with reference to Fig. 23, taking the case where the presence or absence of a person in the regions A, B and C is determined using only the outputs from the first to third sensors 126, 128, 130.

[0103] As shown in Fig. 23, when all the first to third sensors 126, 128, 130 are in an OFF state (no pulse) during a period T1 immediately before a time t1, it is determined at the time t1 that nobody is present in the regions A, B and C (A=0, B=0, C=0). When only the first sensor 126 outputs an ON signal (presence of a pulse) and the second and third sensors 128, 130 are in an OFF state during a subsequent period T1 from the time t1 to a time t2, it is determined at the time t2 that a person is present in the region A and nobody is present in the regions B and C (A=1, B=0, C=0). When the first and third sensors 126, 130 output an ON signal and the second sensor 128 is in an OFF state during a subsequent period T1 from the time t2 to a time t3, it is determined at the time t3 that a person is present in the region C, and nobody is present in the regions A and B (A=0, B=0, C=1). Thereafter, the presence or absence of a person in the regions A, B and C is similarly determined during each period T1.

[0104] In practice, in which region of the regions A-I a person is present is determined using the first to fifth sensors 126, 128, 130, 132, 134, and Table 5 indicates determination results of the presence or absence of a person in each region A-I using the outputs of all the sensors 126, 128, 130, 132, 134.

Table 5

Sensor	First sensor	Second sensor	Third sensor	Fourth sensor	Fifth sensor	Position Determination
Response result	0	0	0	0	0	absent
	1	0	0	0	0	A
	0	1	0	0	0	B
	1	1	0	0	0	A · B
	1	0	1	0	0	C
	1	1	1	0	0	B · C
	1	0	0	1	0	D
	1	0	1	1	0	C · D
	0	1	0	1	0	E
	1	1	0	1	0	D · E
	1	1	1	1	0	C · D · E
	0	1	0	0	1	F
	1	1	0	0	1	A · F
	1	1	1	0	1	C · F
	0	1	0	1	1	E · F
	1	1	0	1	1	D · E · F
	0	0	1	0	0	G
	0	1	1	0	0	B · G
	0	1	1	1	0	E · G
	0	1	1	0	1	F · G
	0	1	1	1	1	E · F · G
	0	0	0	1	0	H
	0	0	1	1	0	G · H
	0	0	0	0	1	I
	1	0	0	0	1	A · I
	1	0	1	0	1	C · I
	1	0	0	1	1	D · I
	1	0	1	1	1	C · D · I
	0	0	1	0	1	G · I
	0	0	0	1	1	H · I
	0	0	1	1	1	G · H · I
	1	1	1	1	1	C · D · E · F

[0105] In Table 5, the position determination other than those shown in Tables 2 to 4 is made by combining the determination results obtained at steps S1, S3, and S5.

[0106] Based on the above-described determination results, the regions A-I are classified into a first region in which a person is frequently present (place of frequent presence), a second region in which a person is present during a short period of time (transit region such as a region through which the person merely passes, a region in which the person stays for a short period of time, or the like), and a third region in which a person is present during a considerably short period of time (non-living region such as walls, windows, or the like in which nobody is present very often). The first, second and third regions are hereinafter sometimes referred to as living sections I, II and III, respectively, which are hereinafter sometimes referred to as a region of region property I, a region of region property II, a region of region property III, respectively. The living sections may be broadly classified depending on the frequency of the presence or absence of a person by referring to the living section I (region property I) and the living section II (region property II) as a living region (region in which a person(s) lives) and referring to the living section III (region property III) as a non-living region (region in which nobody lives).

[0107] This determination is made after step S7 in the flowchart of Fig. 21 and explained hereinafter with reference to Figs. 24 and 25.

[0108] Fig. 24 depicts a layout of a house called "1LDK" consisting of a Japanese-style room, an LD (living and dining room), and a kitchen, with the indoor unit of the air conditioner according to the present invention installed in the LD. Regions indicated by ovals in Fig. 24 indicate places where a subject is frequently present, which was reported by the subject.

[0109] As described hereinabove, a determination is made as to whether a person is present or absent in each region A-I for every period T1. A response result of 1 (presence of response) or 0 (no response) is outputted after a lapse of each period T1 and, upon repetition of this a plurality of times, a determination is made at step S7 as to whether or not a predetermined cumulative period of time of operation of the air conditioner has elapsed. If it is determined at step S7 that the predetermined period of time has not elapsed, the program returns to step S1, but if it is determined that the predetermined period of time has elapsed, each region A-1 is determined as one of the living sections I, II, and III by comparing the response results of each region A-I accumulated for the predetermined period of time with two threshold values.

[0110] Detailed explanation is made with reference to Fig. 25 indicating long-term cumulative results. A first threshold value and a second threshold value less than the first threshold value are set with which the long-term cumulative results are compared. A determination is made at step S8 whether or not the long-term cumulative results of each region A-I are greater than the first threshold value. If it is determined that the long-term cumulative results are greater than the first threshold value, the region having such long-term cumulative results is determined as the living section I at step S9. On the other hand, if it is determined at step S8 that the long-term cumulative results of each region A-I are not greater than the first threshold value, a determination is made at step S10 whether or not the long-term cumulative results of each region A-I are greater than the second threshold value. If it is determined that the long-term cumulative results are greater than the second threshold value, the region having such long-term cumulative results is determined as the living section II at step S11, and if not, the region is determined as the living section III at step S12.

[0111] In the example of Fig. 25, the regions E, F and I are determined as the living section I, the regions B and H as the living section II, and the regions A, C, D and G as the living section III.

[0112] Fig. 26 depicts a layout of another house having an LD in which the indoor unit of the air conditioner according to the present invention has been installed, and Fig. 27 indicates long-term cumulative results of each region A-I. In the example of Fig. 26, the regions C, E and G are determined as the living section I, the regions A, B, D and H as the living section II, and the regions F and I as the living section III.

[0113] Although the determination for the region property (living section) referred to above is repeated for every predetermined period of time, the results of determination hardly change unless sofas, tables and the like disposed inside the room to be determined are moved.

[0114] A final determination of the presence or absence of a person in each region A-I is explained hereinafter with reference to the flowchart of Fig. 22.

[0115] Because steps S21 to S26 are the same as steps S1 to S6 in the flowchart of Fig. 21, explanation thereof is omitted. It is determined at step S27 whether or not response results for a predetermined number M of (for example, 15) periods T1 have been obtained. If it is determined that the period T1 does not reach the predetermined number M, the program returns to step S21, while if it is determined that the period T1 has reached the predetermined number M, the number of a series of cumulative responses equal to a total of response results during periods $T1 \times M$ is calculated at step S28. The calculation of the number of a series of cumulative responses is repeated a plurality of times, and it is determined at step S29 whether or not calculation results of a predetermined number of (for example, N=4) series of cumulative responses have been obtained. If it is determined that the calculation does not reach the predetermined number, the program returns to step S21, while it is determined that the calculation has reached the predetermined number, the presence or absence of a person in each region A-I is estimated at step S30 based on the region property that has been already determined and the predetermined number of series of cumulative responses.

[0116] It is to be noted here that because the program returns to step S21 from step S31 at which 1 is subtracted from the number (N) of the series of cumulative responses, the calculation of the plurality of series of cumulative responses is repeated.

[0117] Table 6 indicates a record of a newest series of cumulative responses (periods $T1 \times M$). In Table 2, $\Sigma A0$ means the number of a series of cumulative responses in the region A.

Table 6

Region	A	B	C	D	E	F	G	H	I	Time
Response results	0	0	1	0	0	0	0	0	1	T1
	0	0	0	0	1	0	1	0	1	T1×2
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	0	0	1	0	1	0	0	0	1	T1×M
	ΣA0	ΣB0	ΣC0	ΣD0	ΣE0	ΣF0	ΣG0	ΣH0	ΣI0	

[0118] When the number of a series of cumulative responses immediately before E A0 is Σ A1, and the number of a series of cumulative responses immediately before ΣA1 is ΣA2 ···, if N=4, the presence or absence of a person is determined based on the past four records (ΣA4, ΣA3, ΣA2, ΣA1). In the case of the living section I, if the past four records reveal that at least a series of cumulative responses exceeds 1, it is determined that a person is present. In the case of the living section II, if the past four records reveal that more than two series of cumulative responses exceed 1, it is determined that a person is present. In the case of the living section III, if the past four records reveal that more than three series of cumulative responses exceed 2, it is determined that a person is present.

[0119] After the period T1×M from the determination of the presence or absence of a person referred to above, a subsequent determination of the presence or absence of a person is similarly made based on the next four records, the region property, and the predetermined number of series of cumulative responses.

[0120] That is, in the indoor unit of the air conditioner according to the present invention, because the presence or absence of a person is estimated using the sensors fewer than the number of the discriminating regions A-I, estimation for each predetermined period may result in an erroneous determination of the position of a person. Whether or not the region is an overlapping one, human position estimation for a single predetermined period is avoided, and the present invention tries to obtain human position estimation results having a high probability by estimating the human position using the region property, which is obtained upon long-term accumulation of the region determination results for each predetermined period, and the past records indicating the number of N series of cumulative responses in each region, each series indicating the region determination results for a predetermined number of periods.

[0121] When the presence or absence of a person is determined in a manner as described above, if T1=5 seconds and M=12, a period of time required for estimation of the presence of a person and that required for estimation of the absence of a person are indicated in Table 7.

Table 7

Living section	Estimation of presence	Estimation of absence
I	60 seconds (short)	240 seconds (long)
II	120 seconds (standard)	180 seconds (standard)
III	180 seconds (long)	120 seconds (short)

[0122] After an area to be air conditioned by the indoor unit of the air conditioner according to the present invention has been classified into a plurality of regions A-I in the above-described manner using the first to fifth sensors 126, 128, 130, 132, 134, the region property (living section I-III) of each region A-I is determined, and the period of time required for estimation of the presence of a person and that required for estimation of the absence of a person are changed.

[0123] That is, after the setting for air conditioning has been changed, about one minute is needed before wind reaches and, hence, if the setting for air conditioning is changed within a short period of time (for example, several seconds), comfort is lost. In addition, it is preferred in terms of energy saving that a place that would be soon empty is not much air conditioned. For this reason, the presence or absence of a person in each region A-I is first detected, and air conditioning is optimize particularly in a region where a person is present.

[0124] More specifically, the period of time required for estimation of the presence or absence of a person in a region determined as the living section II is set as a standard one, and the presence of a person is estimated within a shorter period of time in a region determined as the living section I than in the region determined as the living section II, while when the person has disappeared from the region, the absence of a person is estimated in a longer period of time in the region determined as the living section I than in the region determined as the living section II. In other words, the period of time required for estimation of the presence of a person is set shorter and that required for estimation of the absence of a person is set longer with respect to the region determined as the living section I. On the other hand, the presence of a person is estimated in a longer period of time in a region determined as the living section III than in the region determined as the living section II, while when the person has disappeared from the region, the absence of a person is estimated within a shorter period of time in the region determined as the living section III than in the region determined as the living section II. In other words, the period of time required for estimation of the presence of a person is set longer and that required for estimation of the absence of a person is set shorter with respect to the region determined as the living section III. Further, as described above, the living section set to each region changes depending on the long-term cumulative results, and the period of time required for estimation of the presence of a person and that required for estimation of the absence of a person are both variably set.

(Wind direction control)

[0125] A speed control of the indoor fan 8, a wind direction control of the vertical wind direction changing blade 12, and a wind direction control of the horizontal wind direction changing blades 14 are conducted depending on the air conditioning setting in each region A-I. These controls are explained hereinafter.

[0126] The wind direction control during heating is set such that warm air reaches an area adjacent to person's feet by controlling the wind direction ahead of the person's feet in a region that has been determined that the person is present. The wind direction control during cooling is set such that cold air reaches above a person's head by controlling the wind direction toward a space above the person's head. The wind direction is controlled by the speed of the indoor fan 8, the angle of the vertical wind direction changing blade 12, and the angle of the horizontal wind direction changing blades 14.

[0127] Fig. 28 depicts a control of the vertical wind direction changing blade 12. As shown in Fig. 28(a), when the air conditioner is not in operation, the front panel 4, the vertical wind direction changing blade 12, and the middle blade 114 are controlled so as to close the front suction openings 2a.

[0128] During cooling, in order for air (cold air) discharged from the indoor unit to reach a space above a person's head (ceiling air current), the front panel 4, the vertical wind direction changing blade 12, and the middle blade 114 are controlled to move from a state (a) to a state (c) via a state (b). The arms 118, 120 are driven to move the front panel 4 away from the front suction openings 2a, and the arms 122, 124 are driven to move the vertical wind direction changing blade 12 away from the discharge opening 10.

[0129] In the state (c), air discharged from the discharge opening 10 is directed horizontally by the vertical wind direction changing blade 12, but an upwardly curved configuration of a downstream end portion of the vertical wind direction changing blade 12 can convey the air far within a room. At this moment, the middle blade 114 closes an area above the discharge opening 10, i.e., below the front panel 4 and, hence, the air discharged from the discharge opening 10 is never introduced into the front suction openings 2a.

[0130] On the other hand, during heating, in order for air (warm air) discharged from the indoor unit to reach an area adjacent to person's feet (air current toward the person's feet), the front panel 4, the vertical wind direction changing blade 12, and the middle blade 114 are controlled to move from the state (a) to a state (d) via the state (b). In the state (d), air discharged from the discharge opening 10 is directed obliquely downward by the vertical wind direction changing blade 12, but the downstream end portion of the vertical wind direction changing blade 12 is curved toward the indoor unit body and, hence, warm air that is apt to flow upwardly inside the room can be directed downwardly.

[0131] It is to be noted that a state (e) is employed during cooling before a stable state, and air discharged from the indoor unit is directed to a human body (air current toward a human body).

[0132] Fig. 29 depicts the set speeds of the indoor fan 8 when each of the regions A-I is air conditioned. Speeds A1, A2 and A3 are reference speeds for short-distance regions, intermediate-distance regions, and long-distance regions, respectively, as viewed from the indoor unit. A speed difference A4 is set depending on a difference in the position of the regions when the distance from the indoor unit is the same. The speeds A1, A2 and A3 and the speed difference A4 are set, for example, as follows.

A1: 800rpm (during heating), 700rpm (during cooling)
A2: 1000rpm (during heating), 900rpm (during cooling)
A3: 1200rpm (during heating), 1100rpm (during cooling)
A4: 100rpm (during heating and cooling)

[0133] An expression "relative position" is employed here as an expression indicating a positional relationship between each region and the indoor unit such as, for example, a distance of each region from the indoor unit, an angle of each region from the front of the indoor unit, a vertical difference between each region and the indoor unit, or the like.

[0134] Also, an expression "degree of demand of air conditioning" is used here to indicate the level of difficulty of air conditioning in each region. The higher the degree of demand of air conditioning is, the more difficult the air conditioning is, and the lower the degree of demand of air conditioning is, the easier the air conditioning is. By way of example, as the distance between a region and the indoor unit increases, air discharge from the latter is harder to reach the former, thus resulting in an increase in the degree of demand of air conditioning. That is, there is a close relationship between the degree of demand of air conditioning and the relative position from the indoor unit, and in this embodiment, the degree of demand of air conditioning is determined depending on the relative position from the indoor unit.

[0135] Accordingly, when each region A-I is air conditioned, the speed of the indoor fan 8 is set higher with an increase in the degree of demand of air conditioning. That is, the speed of the indoor fan 8 is set higher with an increase in the distance between a region to be air conditioned and the indoor unit. If the distance from the indoor unit is the same, the speed of the indoor fan 8 is set higher in a region shifted from the front of the indoor unit than in a region positioned in front of the indoor unit. Also, if the number of regions to be air conditioned is one, the speed of the indoor fan 8 is set to the set speed for such a region, and if the number of regions to be air conditioned is two or more, the speed of the indoor fan 8 is set to the set speed for the region having a higher degree of demand of air conditioning.

[0136] Fig. 30 depicts the set angles of the vertical wind direction changing blade 12 and those of the horizontal wind direction changing blades 14 during heating. Angles B1, B2 and B3 are reference angles of the vertical wind direction changing blade 12 for the short-distance regions, the intermediate-distance regions, and the long-distance regions, respectively, as viewed from the indoor unit. A difference B4 in the angle of the vertical wind direction changing blade 12 is set depending on a difference in the position of the regions when the distance from the indoor unit is the same. On the other hand, angles C1 and C2 are reference angles of the horizontal wind direction changing blades 14 (positive in a counterclockwise direction). Differences C3 and C4 in the angle of the horizontal wind direction changing blades 14 are each set depending on a difference in the position of the regions.

[0137] These angles are set, for example, as follows, but it is to be noted here that the angle of the vertical wind direction changing blade 12 is an angle measured in the counterclockwise direction from a reference position of an angle of 0° where a line connecting front and rear ends of the blade extends horizontally with the blade being upwardly convex.

B1: 70°
B2: 55°
B3: 45°
B4: 10°
C1: 0°
C2: 15°
C3: 30°
C4: 45°

[0138] More specifically, when the region A or B close to the indoor unit is heated, the angle of the vertical wind direction changing blade 12 is set to a first angle (for example, 70°), and the speed of the indoor fan 8 is set to a first speed (for example, 800rpm) so that the wind direction may be directed toward an edge portion of the region A or B on the indoor unit side (ahead of person's feet) to thereby make warm air reach an area adjacent to the person's feet. When the region C, D, E or F positioned at an intermediate distance from the indoor unit is heated, the angle of the vertical wind direction changing blade 12 is set to a second angle (for example, 55°) less than the first angle, and the speed of the indoor fan 8 is set to a second speed (for example, 1000rpm) higher than the first speed so that the wind direction may be directed toward an edge portion of the region C, D, E or F on the indoor unit side (ahead of person's feet) to thereby make warm air reach an area adjacent to the person's feet. Further, when the region G, H or I remote from the indoor unit is heated, the angle of the vertical wind direction changing blade 12 is set to a third angle (for example, 45°) less than the second angle, and the speed of the indoor fan 8 is set to a third speed (for example, 1200rpm) higher than the second speed so that the wind direction may be directed toward an edge portion of the region G, H or I on the indoor unit side (ahead of person's feet) to thereby make warm air reach an area adjacent to the person's feet.

[0139] Fig. 31 depicts the set angles of the vertical wind direction changing blade 12 and those of the horizontal wind direction changing blades 14 during rising or in an instable state. Angles E1, E2 and E3 are reference angles of the vertical wind direction changing blade 12 for the short-distance regions, the intermediate-distance regions, and the long-distance regions, respectively, as viewed from the indoor unit. A difference E4 in the angle of the vertical wind direction changing blade 12 is set depending on a difference in the position of the regions when the distance from the indoor unit is the same. On the other hand, angles F1 and F2 are reference angles of the horizontal wind direction changing blades 14 (positive in a counterclockwise direction). Differences F3 and F4 in the angle of the horizontal wind direction changing blades 14 are each set depending on a difference in the position of the regions.

[0140] These angles are set, for example, as follows, but it is to be noted here that the term "during rising" means at the time of start of operation of the air conditioner, and the term "instable state" means a state in which current air conditioning inside a room does not meet the set conditions (for example, a set temperature).

E1: 50°
E2: 35°
E3: 25°
E4: 10°
F1: 0°
F2: 15°
F3: 25°
F4: 35°

[0141] Fig. 32 depicts the set angles of the vertical wind direction changing blade 12 and those of the horizontal wind direction changing blades 14 in a stable state during cooling. An angle H1 is a reference angle of the vertical wind direction changing blade 12 in the case of the "ceiling air current." An angle H2 is a reference angle of the vertical wind direction changing blade 12 in the case of a shunt air current. A difference H3 in the angle of the vertical wind direction changing blade 12 is set depending on a difference in the position of the regions when the distance from the indoor unit is the same. On the other hand, angles I1 and I2 are reference angles of the horizontal wind direction changing blades 14 (positive in a counterclockwise direction). Differences I3 and I4 in the angle of the horizontal wind direction changing blades 14 are each set depending on a difference in the position of the regions.

[0142] These angles are set, for example, as follows, but it is to be noted here that the term "stable state" means a state in which current air conditioning inside a room meets the set conditions (for example, the set temperature).

H1: 180°
H2: 190°
H3: 5°
I1: 0°
I2: 15°
I3: 25°
I4: 35°

[0143] It is also to be noted here that the "ceiling air current "is an air current inside a room when the vertical wind direction changing blade 12 is positioned at a lower portion of the discharge opening 10 to receive whole air discharged from the discharge opening 10 on a concave surface of the blade, as shown in Fig. 28(c), and that the "shunt air current" is an air current discharged from the discharge opening 10 when the vertical wind direction changing blade 12 has been shifted slightly upwardly from the position creating the "ceiling air current "to allow air to partially (a small amount) flow along a convex surface (lower surface) of the blade so that dew condensation may not occur on the convex surface of the blade.

[0144] When the region A or B close to the indoor unit is cooled, the vertical wind direction changing blade 12 is set downward by a predetermined angle (for example, 5°) from the horizontal, and the speed of the indoor fan 8 is set to a first speed (for example, 700rpm less than the first speed during heating) so that cold air may reach a space above the region A or B to fall thereon in the form of a shower. When the region C, D, E or F positioned at an intermediate distance from the indoor unit is cooled, the vertical wind direction changing blade 12 is set so as to extend substantially horizontally, and the speed of the indoor fan 8 is set to a second speed (for example, 900rpm less than the second speed during heating) higher than the first speed so that cold air may reach a space above the region C, D, E or F. Further, when the region G, H or I remote from the indoor unit is cooled, the vertical wind direction changing blade 12 is set upward by a predetermined angle (for example, 5°) from the horizontal, and the speed of the indoor fan 8 is set to a third speed (for example, 1100rpm less than the third speed during heating) higher than the second speed so that cold air may reach a space above the region G, H or I.

[0145] A wind direction control conducted depending on the number of regions to be air conditioned is explained hereinafter with reference to a flowchart of Fig. 33.

[0146] At the start of operation of the air conditioner, a determination is made at step S41 as to whether a person is present or absent in each region A-I. If it is determined at step S42 that the number of regions in which a person is present is one, i.e., the number of regions to be air conditioned is one, the one region is air conditioned at step S43 based on the amount of air and the wind direction set thereto. If it is determined at step S42 that the regions to be air conditioned is not one, a determination is made at step S44 as to whether or not the regions to be air conditioned is two. If the regions to be air conditioned is two, the program advances to step S45.

[0147] A step S45, the amount of air is set to an amount set to a region having a higher degree of demand of air conditioning, and the arrangement of the two regions is discriminated by selecting any one of five modes as shown in

Figs. 34A-34E. At subsequent step S46, the wind direction control is conducted as shown in Table 8 depending on the mode selected.

Table 8

Mode	Arrangement	Vertical wind direction		Horizontal wind direction	
Mode 1	Center contiguity	Fixed	Heating: lower degree of demand Cooling: higher degree of demand	Fixed	Center
Mode 2	Fore-aft contiguity	Fixed	Heating: lower degree of demand Cooling: higher degree of demand	Fixed	Higher degree of demand
Mode 3	Fore-aft separation	Fixed	Heating: lower degree of demand Cooling: higher degree of demand	Fixed	Higher degree of demand
Mode 4	Right-left arrangement	Fixed	Heating: lower degree of demand Cooling: higher degree of demand	Swing with pause	
Mode 5	Diagonal arrangement	Swing with pause		Swing with pause	

[0148] Mode 1 indicates a case where two regions are positioned at an intermediate distance from the indoor unit and contiguous in front of the indoor unit. Mode 2 indicates a case where two regions are positioned substantially at the same angle as viewed from the indoor unit and contiguous in a front-back direction. Mode 3 indicates a case where two regions are positioned substantially at the same angle as viewed from the indoor unit and spaced away from each other in a front-back direction. Mode 4 indicates a case where two regions are positioned substantially at the same distance from the indoor unit, but differ in the angle from the indoor unit. Mode 5 indicates a case where two regions are not contiguous and differ in both the angle and distance from the indoor unit.

[0149] The vertical wind direction in modes 1-4 is fixed to a region having a lower degree of demand of air conditioning during heating and to a region having a higher degree of demand of air conditioning during cooling. The vertical wind direction in mode 5 is first fixed to a first region of two regions (first and second regions) for a predetermined period of time (fixed in angle), subsequently changed toward the second region, then fixed to the second region for the predetermined period of time, and thereafter changed toward the first region. This motion is repeatedly conducted by controlling the vertical wind direction changing blade 12. The predetermined period of time during which the vertical wind direction is fixed to each region is set depending on, for example, the distance from the indoor unit, and it is preferred that such predetermined period of time be prolonged with an increase in the distance from the indoor unit..

[0150] The horizontal wind direction in mode 1 is fixed to a center between two regions contiguous to each other. In the case of mode 2 or 3, the horizontal wind direction is fixed to a region having a higher degree of demand of air conditioning because the two regions can be regarded as being positioned substantially in the same direction as viewed from the indoor unit, though the distance from the indoor unit differs. In mode 4 or mode 5 indicating a spaced arrangement of two regions, the horizontal wind direction is controlled by controlling the horizontal wind direction changing blades 14 in a manner similar to the control of the vertical wind direction changing blade 12. That is, the horizontal wind direction is first fixed to a first region for a predetermined period of time, subsequently changed toward a second region, then fixed to the second region for the predetermined period of time, and thereafter changed toward the first region. This motion is repeatedly conducted. The predetermined period of time during which the horizontal wind direction is fixed to each region is set depending on the relative position thereof with respect to the indoor unit such as, for example, the angle from the front of the indoor unit. It is preferred that such predetermined period of time be prolonged with an increase in the angle from the front of the indoor unit..

[0151] At step S44, if it is determined that the regions to be air conditioned is not two, an arrangement of three or more regions to be air conditioned is determined at step S47 as being any one of two modes, a normal mode and a special mode. The special mode indicates a case where there are a total of three regions including two regions positioned at an intermediate distance from the indoor unit and being contiguous to each other in front of the indoor unit, and also including one region positioned remote from and in front of the indoor unit. The normal mode indicates a case where there are three or more regions, excluding the case of the special mode. If there are three or more regions to be air conditioned, the amount of air is set to an mount set to a region having a highest degree of demand of air conditioning. At step S47, if it is determined that the arrangement of the regions corresponds to the special mode as shown in Fig. 35A (center contiguity), the wind direction is set at step S48 in a manner similar to mode 1 of Fig. 34A.

[0152] On the other hand, if it is determined at step S47 that the arrangement of the regions does not correspond to the special mode, a control in the normal mode as shown in Fig. 35B or 35C is conducted at step S49 such that the angle of the vertical wind direction changing blade 12 is changed between an angle set to a region closest to the indoor unit and an angle set to a region farthest from the indoor unit.

[0153] In the normal mode, the angle of the horizontal wind direction changing blades 14 is changed between an angle of a left-side edge of a leftmost region (region C in Figs. 35B and 35C) and an angle of a right-side edge of a rightmost region (region I in Fig. 35B and region H in Fig. 35C). A control of the horizontal wind direction changing blades 14 in the normal mode is conducted by repeating such movement that after the blades have been fixed to the angle of the left-side edge of the leftmost region for a predetermined period of time, they change the wind direction toward the rightmost region (swing) and are fixed to the right-side edge of the rightmost region for the predetermined period of time, and they again change the wind direction toward the leftmost region (swing). The swinging speed of the horizontal wind direction changing blades 14 is lower than that of the horizontal wind direction changing blades 14 in mode 4 or 5. The predetermined period of time, during which the horizontal wind direction changing blades 14 are fixed at the left-side edge of the leftmost region or the right-side edge of the rightmost region, is determined depending on, for example, the angle from the front of the indoor unit, and it is preferred that such predetermined period of time be increased with an increase in the angle from the front of the indoor unit.

[0154] After each air conditioning control has been conducted at step S43, S46, S48 or S49, the program returns to step S41.

(Skin or room care control)

[0155] A method of effectively utilizing the electrostatic mist by combining the electrostatic atomizing device 18, 18A and the wind direction control with the use of the human body detecting device (sensor units 126, 128, 130, 132, 134), both referred to above. The electrostatic mist has a skin improvement effect in addition to a deodorization effect for removing odorous components, as described above. When the electrostatic mist reaches the skin of a person present in a room, the skin improvement effect moisturizes the skin, though there are differences in the effectiveness among individuals.

[0156] In this embodiment, a skin care mode refers to a control in which the electrostatic mist is generated, when a person is present in a room, for the purpose of exerting the skin improvement effect on the person, and a room care mode refers to a control in which the electrostatic mist is generated, when nobody is present in the room, for the purpose of exerting the deodorization effect on the interior of the room. If the electrostatic mist generated in the skin care mode reacts with odorous components within the room, the electrostatic mist comes to exert the deodorization effect.

[0157] The air conditioner in this embodiment is provided with an indoor unit that includes a plurality of human body detecting sensors employed as the human body detecting device (sensor units 126, 128, 130, 132, 134) to detect the presence or absence of a person, and an electrostatic atomizing device 18, 18A operable to generate an electrostatic mist, and the indoor unit has two control modes, i.e., the skin care mode to be performed when someone is present in a room and the room care mode to be performed when nobody is present in the room. That is, if a determination has been made that a person is present in a region within a range that can be detected by the human body detecting sensors, the control in the skin care mode is conducted in which the wind direction is controlled toward such a region to render the electrostatic mist to reach the person or the region so detected.

[0158] On the other hand, if a determination has been made that nobody is present in the range that can be detected by the human body detecting sensors, the control in the room care mode is conducted in which the electrostatic mist is directed upward or rendered to reach a region remote from the indoor unit.

[0159] Although the wind direction control during heating or cooling is intended to control the wind direction in view of a room temperature or a sensible temperature of a person inside a room, the electrostatic mist may be generated during heating or cooling, or during operation of the indoor fan when the refrigerating cycle is not in operation.

[0160] By this construction, the skin of a person is moisturized by the electrostatic mist in the skin care mode. In the room care mode, because nobody is present in the room, no attention must be paid to the wind direction from the indoor unit, and it is sufficient if the electrostatic mist is spread over the interior of the room to efficiently or effectively sterilize and remove odorous components adhering to a ceiling, walls, curtains, and the like, thus making it possible to realize comfortable indoor conditions.

[0161] A detailed control method upon detection of a direction or a region in which a person is present with the use of the human body detecting sensors is explained hereinafter.

[0162] In the skin care mode to be performed when a person is present in a room, a speed control of the indoor fan 8, a wind direction control of the vertical wind direction changing blade 12, and a wind direction control of the horizontal wind direction changing blades 14 are conducted in a manner similar to those discussed above depending on the air conditioning setting in each region A-I. That is, the wind direction during heating is controlled toward an area ahead of person's feet in a region that has been determined that the person is present, while the wind direction during cooling is controlled to direct air (cold air) discharged from the discharge opening toward a space above a person's head. At the same time, upon operation of the electrostatic atomizing device 18, 18A, an electrostatic mist generated by the electrostatic atomizing device 18, 18A is caused to reach the person along with warm air or cold air for skin care.

[0163] In the skin care mode, the speed control of the indoor fan 8, the wind direction control of the vertical wind direction changing blade 12, and the wind direction control of the horizontal wind direction changing blades 14 may be conducted so that the electrostatic mist may reach a region (region of region property I) having a high frequency of presence of a person without controlling the wind direction toward a region where the person is present.

[0164] On the other hand, in the room care mode to be performed when nobody is present in a room, the indoor fan 8 and the electrostatic atomizing device 18, 18A are operated to remove odorous components adhering to walls, curtains, a floor, and a ceiling, and the vertical wind direction changing blade 12 and the horizontal wind direction changing blades 14 are controlled so that the electrostatic mist may reach the regions A, B, C, F, G, H and I in that order for a predetermined period of time using a ceiling air current that is generally created during cooling as shown in Figs. 29 and 32.

[0165] Of the nine regions divided, the regions A, B, C, F, G, H and I are outer regions that are assumed that walls or curtains are present there. Also, by employing the ceiling air current in which air is blown upwardly, the electrostatic mist can be caused to reach the ceiling that is assumed that odor of cigarettes or tobaccos adheres thereto. Further, because the electrostatic mist flowing along the ceiling impinges on walls and then flows downward, it can sterilize and deodorize a floor.

[0166] However, it is unlikely that the ceiling air current can satisfactorily sterilize and deodorize a mounting surface (wall surface) of the indoor unit, because the regions A, B are positioned close to the mounting surface of the indoor unit. For this reason, in place of the wind direction control shown in Fig. 32, the wind direction control may be conducted by setting the angle of the vertical wind direction changing blade 12 and that of the horizontal wind direction changing blades 14 in a manner as shown in Fig. 36.

J1: 0° ~ 25°
J2: 25° ~ 50°
J3: 50° ~ 90°
K1: -5° ~ 5°
K2: 0° ~ 15°
K3: 0° ~ 60°
K4: 5° ~ 20°
K5: 15° ~ 45°

[0167] Next, a control of the indoor fan 8, that of the vertical wind direction changing blade 12, and that of the horizontal wind direction changing blades 14 are conducted in consideration of region properties I, II, III referred to above. A region of region property I is a region having a high frequency of presence of a person, and the frequency of presence of a person decreases in order of region properties I, II and III. Accordingly, the electrostatic mist is caused to reach each region for a predetermined period of time in order of region properties I, II and III, i.e., in order of decreasing the frequency of presence of a person by controlling the indoor fan 8, the vertical wind direction changing blade 12, and the horizontal wind direction changing blades 14. Also, because it is likely that odor adheres to the region having a high frequency of presence of a person, the predetermined period of time during which the electrostatic mist reaches each region may be increased in order of region properties III, II and I. The wind direction control conducted in the above-describe manner can remove odorous components.

[0168] On the other hand, it is conceivable that the region having a high frequency of presence of a person is fully supplied with the electrostatic mist in the skin care mode when someone is present in a room. Accordingly, the electrostatic mist may be caused to reach each region for a predetermined period of time in order of region properties III, II and I, i.e., in order of increasing the frequency of presence of a person by controlling the indoor fan 8, the vertical wind direction changing blade 12, and the horizontal wind direction changing blades 14. It is also conceivable that in the skin care mode, odor is not fully removed in a region having a low frequency of presence of a person. Accordingly, the predetermined period of time during which the electrostatic mist reaches each region may be increased in order of region properties I, II and III. The wind direction control conducted in this way can remove odorous components that remains in each region without being fully removed.

[0169] Alternatively, a time measuring means for measuring a period of time during which a person is present may be provided. In this case, in the skin care mode, the predetermined period of time during which the electrostatic mist reaches each region is changed depending on the period of time measured by the time measuring means. That is, it is conceivable that odor remains with an increase in the period of time measured and, hence, the deodorization effect or sterilization effect can be further enhanced by increasing the predetermined period of time during which the electrostatic mist reaches each region in the room care mode.

[0170] The example of Fig. 29 indicates that the maximum speed of the indoor fan 8 during air conditioning is set to 1200rpm, but because no attention must be paid to noises when nobody is present, the speed of the indoor fan 8 may be determined in a manner as shown in Fig. 37 in consideration of air resistance of the wind direction changing means (vertical wind direction changing blade 12 and horizontal wind direction changing blades 14) to thereby increase a reachable range of the electrostatic mist.

L1: 1200rpm
L2: 1300rpm
L3: 1400rpm

[0171] Further, if indoor air is discharged outside by operating the ventilation fan unit 16, purification of the indoor air is promoted.

[0172] If entry of a person is detected by any one of the first to fifth sensors 126, 128, 130, 132, 134 in the room care mode, the speed control of the indoor fan 8, the wind direction control of the vertical wind direction changing blade 12, and the wind direction control of the horizontal wind direction changing blades 14 are returned to the controls referred to above that are conducted, when a person is present in a room, depending on the air conditioning setting in a region detected.

[0173] The absence of a person is considered to be a temporary case during operation of the air conditioner or a case of a person exit after a stop of operation of the air conditioner. If a room becomes temporarily empty during operation of the air conditioner, the room care mode may be initiated depending on a length of absence of a person with the heating or cooling operation kept under present conditions, or an energy saving operation (explained later) may be performed in the room care mode. It the room becomes empty due to a person exit, the control in the room care mode may be conducted for a predetermined period of time with operation of only the indoor fan 8.

(Energy saving control in the absence of a person and control when a user has forgotten turning off air conditioner)

[0174] The indoor unit is provided with a timer. When nobody is present in an area to be air conditioned, an energy saving control or a control when a user has forgotten turning off the air conditioner is conducted using the timer. Such controls in the room care mode are discussed hereinafter.

[0175] Fig. 38 depicts an example for performing an energy saving operation by controlling, when nobody is present in a room, the capacity (speed) of the indoor fan 8 and the power of a compressor provided in an outdoor unit.

[0176] More specifically, the heat exchanging efficiency of the heat exchanger 6 increases with an increase in the capacity of the indoor fan 8, and if the frequency of the compressor is the same, the heating or cooling performance increases. Accordingly, in order to maintain the room temperature at a set temperature, the frequency of the compressor can be reduced, thus reducing necessary electric power consumption. Also, even if the capacity of the indoor fan 8 is increased when nobody is present, a strong air current or increased noises from the indoor fan 8 do not cause feeling of discomfort. Accordingly, by blowing out air together with an electrostatic mist, the electrostatic mist can be spread far and wide within the room for deodorization and sterilization.

[0177] As shown in Fig. 38, when the first to fifth sensors 126, 128, 130, 132, 134 detect that nobody is present in each region A-I (time t0), the timer starts counting. After the start of counting by the timer, when it has been confirmed at time t1 (for example, 10 minutes) that nobody is present, the capacity of the indoor fan 8 is increased, and the frequency of the compressor is reduced step by step until time t2 (for example, 30 minutes after the start of counting). After a lapse of time t2, the frequency of the compressor is maintained constant (limit value). If it has been successively confirmed at time t2, time t3 (for example, one hour after the start of counting), time t4 (for example, two hours after the start of counting), and time t5 (for example, four hours after the start of counting) that nobody is present, the operation of the air conditioner is stopped at time t5 after the user has forgotten turning off the air conditioner.

[0178] If the presence of a person is detected from time t1 to time t5, the capacity of the indoor fan 8 and the frequency of the compressor are returned to those set before time t1.

[0179] A method of changing a set room temperature to a target temperature depending on time elapsed to achieve another energy saving operation is next explained with reference to Table 9 and Fig. 39. A control during heating is first discussed.

Table 9

Set temp.	Temperature shift width				OFF
~20°C	present temperature is maintained				
21°C~	1/2ΔT	ΔT			
23°C~	1/3ΔT	2/3ΔT	ΔT		
27°C~	1/4ΔT	2/4ΔT	3/4ΔT	ΔT	
time t1	t2	t3	t4	t5	

[0180] Fig. 39 depicts an example of temperature shifts, in which a temperature of 28°C is a set temperature Tset, and a temperature of 20°C (lower limit) is a target temperature. ΔT represents a temperature difference between the set temperature Tset and the target temperature. The target temperature is a limit value when the heating capacity is lowered for energy saving in the absence of any person.

[0181] When the first to fifth sensors 126, 128, 130, 132, 134 detect that nobody is present in each of the regions A-I, the timer starts counting. After the start of counting by the timer, when it has been confirmed at time t1 (for example, 10 minutes) that nobody is present, the set temperature Tset is automatically reduced by 2°C (1/4 ΔT). Thereafter, when it has been confirmed at time t2 (for example, 30 minutes after the start of counting) that nobody is present, the set temperature Tset is again automatically reduced by 2°C (1/4 ΔT). Similarly, when it has been confirmed at time t3 (for example, one hour after the start of counting) or time t4 (for example, two hours after the start of counting) that nobody is present, the set temperature Tset is automatically reduced by 2°C (1/4 ΔT), respectively. With such an automatic reduction in the set temperature Tset, the heating capacity is reduced by reducing the frequency of the compressor. By way of example, the frequency of the compressor is gradually reduced from time t2 to time t4 by a frequency that is reduced from time t1 to time t2.

[0182] At time t4, the initial set temperature Tset is reduced by 8°C in total and becomes equal to 20°C. Although the set temperature Tset is maintained at the target temperature until time t5 (for example, four hours after the start of counting), if it has been confirmed at time t5 that nobody is still present, the operation of the air conditioner is stopped on the assumption that the user has forgotten turning off the air conditioner. The energy saving control conducted in this way in the absence of any person avoids an uneconomical heating operation to thereby reduce electric power consumption. At this time, by increasing the capacity of the indoor fan 8 and blowing out air together with an electrostatic mist, the electrostatic mist can be spread far and wide within a room for deodorization and sterilization in the room care mode.

[0183] When the presence of a person is detected during a period of time from time t1 to time t5, the set temperature Tset is returned to the initial one set before time t1.

[0184] The temperature shift width (temperature decrement) is set based on Table 9 depending on the temperature difference ΔT between the set temperature Tset and the target temperature. The smaller the temperature difference ΔT, the smaller the temperature shift width is. If the set temperature Tset is lower than the target temperature, the present temperature is maintained, but if it has been confirmed at time t5 that nobody is present, the operation of the air conditioner is stopped, as in the example of Fig. 39.

[0185] A control during cooling is discussed hereinafter with reference to Table 10 and Fig. 40.

Table 10

Set temp.	Temperature shift width				OFF
28°C~	present temperature is maintained				
~26C	1/2ΔT	ΔT			
~22°C	1/3ΔT	2/3ΔT	ΔT		
~21°C	1/4ΔT	2/4ΔT	3/4ΔT	ΔT	
time	t2	t3	t4	t5	

[0186] Fig. 40 depicts an example of temperature shifts, in which a temperature of 20°C is a set temperature Tset, and a temperature of 28°C (upper limit) is a target temperature. ΔT represents a temperature difference between the set temperature Tset and the target temperature.

[0187] When the first to fifth sensors 126, 128, 130, 132, 134 detect that nobody is present in each of the regions A-

I, the timer starts counting. After the start of counting by the timer, when it has been confirmed at time t1 (for example, 10 minutes) that nobody is present, the set temperature Tset is automatically increased by 2°C (1/4 ΔT). Thereafter, when it has been confirmed at time t2 (for example, 30 minutes after the start of counting) that nobody is present, the set temperature Tset is again automatically increased by 2°C (1/4 ΔT). Similarly, when it has been confirmed at time t3 (for example, one hour after the start of counting) or time t4 (for example, two hours after the start of counting) that nobody is present, the set temperature Tset is automatically increased by 2°C (1/4 ΔT), respectively.

[0188] At time t4, the initial set temperature Tset is increased by 8°C in total and becomes equal to 28°C. Although the set temperature Tset is maintained at the target temperature until time t5 (for example, four hours after the start of counting), if it has been confirmed at time t5 that nobody is still present, the operation of the air conditioner is stopped on the assumption that the user has forgotten turning off the air conditioner. The energy saving control conducted in this way in the absence of any person avoids an uneconomical cooling operation to thereby reduce electric power consumption. At this time, by increasing the capacity of the indoor fan 8 and blowing out air together with an electrostatic mist, the electrostatic mist can be spread far and wide within a room for deodorization and sterilization in the room care mode.

[0189] When the presence of a person is detected during a period of time from time t1 to time t5, the set temperature Tset is returned to the initial one set before time t1.

[0190] The temperature shift width (temperature increment) is set based on Table 10 depending on the temperature difference ΔT between the set temperature Tset and the target temperature. The smaller the temperature difference ΔT, the smaller the temperature shift width is. If the set temperature Tset is higher than the target temperature, the present temperature is maintained, but if it has been confirmed at time t5 that nobody is present, the operation of the air conditioner is stopped, as in the example of Fig. 40.

[0191] Each of the examples of Figs. 38 to 40 referred to above is intended to achieve, when nobody is present for a predetermined period of time during the normal operation, an energy saving operation that is smaller in power consumption than the normal operation. If nobody is present for a subsequent predetermined period of time, energy saving is achieved by stopping the air conditioner (the "normal operation" means an operation ordered by the user).

[0192] It is conceivable that if the human body detecting sensors erroneously detect some disturbance other than a person such as, for example, curtains that may cause a temperature change in spite of a state of continuous absence for a long period of time, the normal operation continues in such a state (no person being present). Accordingly, an uneconomical operation can be positively minimized by stopping the operation of the air conditioner after a lapse of time t6 (for example, 24 hours) longer than time t5. The main body of the indoor unit or the remote controller is preferably provided with a speaker or an indicator such as an LED so that a user may audibly or visually recognize the state of the air conditioner immediately before the stop of operation after a lapse of time t5 or time t6 longer than time t5. Alternatively, letters or characters may be indicated on a screen. Further, if an automatic stop selecting means for selecting whether or not an automatic stop of operation is conducted after a lapse of time t5 or time t6 is provided in the remote controller or the like, more convenience is provided to the user.

Industrial Applicability

[0193] The air conditioner according to the present invention permits operation of an electrostatic atomizing device only when the temperature and humidity of air sucked into an indoor unit are both within an operation permission region of the electrostatic atomizing device. Accordingly, the life of the electrostatic atomizing device can be prolonged or energy saving can be achieved without generating noises or ozone and, hence, the air conditioner according to the present invention is very useful for various air conditioners including those for home use. Also, an air conditioner having a skin care mode or a room care mode can realize comfortable indoor conditions by improving the skin of a person or cleaning a room depending on the presence or absence of the person, and is accordingly useful particularly for air conditioners for home use.

Claims

1. An air conditioner provided with an indoor unit having an air cleaning function for cleaning indoor air, comprising:

an electrostatic atomizing device for generating an electrostatic mist;
a suction temperature detecting means for detecting a temperature of air sucked into the indoor unit; and
a humidity detecting means for detecting a humidity of the air sucked into the indoor unit;
wherein an operation permission region of the electrostatic atomizing device is defined based on the temperature and humidity of the air sucked into the indoor unit, and when the temperature detected by the suction temperature detecting means and the humidity detected by the humidity detecting means fall within the operation permission region, operation of the electrostatic atomizing device is permitted, while when any one of the temperature

detected by the suction temperature detecting means and the humidity detected by the humidity detecting means is out of the operation permission region, the operation of the electrostatic atomizing device is prohibited; and

wherein an excessive dew condensation region is defined out of the operation permission region when the humidity of the air sucked into the indoor unit is higher than a first predetermined value.

2. The air conditioner according to claim 1, wherein a first out-of-performance region is defined as a region in which the humidity sucked into the indoor unit is lower than a second predetermined value less than the first predetermined value, and even if the electrostatic atomizing device shows a maximum capacity thereof, a dew-point temperature is not reached, wherein a below-freezing region is defined as a region in which the dew-point temperature obtained from a psychrometric chart is below a freezing point, and wherein the first out-of-performance region and the below-freezing region are out of the operation permission region.

3. The air conditioner according to claim 2, wherein a second out-of-performance region is defined as a region in which the temperature of the air sucked into the indoor unit exceeds a predetermined value, and normal operation of the electrostatic atomizing device is hindered, the second out-of-performance region being out of the operation permission region.

4. The air conditioner according to any one of claims 1 to 3, further comprising a fan speed detecting means for detecting a speed of an indoor fan mounted in the indoor unit, wherein when the speed of the indoor fan detected by the fan speed detecting means is greater than or equal to a predetermined speed, operation of the electrostatic atomizing device is permitted, while when the speed of the indoor fan detected by the fan speed detecting means is less than the predetermined speed, the operation of the electrostatic atomizing device is prohibited.

5. The air conditioner according to any one of claims 1 to 4, further comprising an abnormality detecting means for detecting an abnormality of the electrostatic atomizing device, wherein when the abnormality detecting means detects no abnormality of the electrostatic atomizing device, operation of the electrostatic atomizing device is permitted, while the abnormality detecting means detects an abnormality of the electrostatic atomizing device, the operation of the electrostatic atomizing device is prohibited.

6. The air conditioner according to any one of claims 1 to 5, further comprising an electric power consumption calculating means for calculating electric power consumption of the indoor unit excluding the electrostatic atomizing device, wherein when a total value of the electric power consumption calculated by the electric power consumption calculating means is less than or equal to an allowable power value, operation of the electrostatic atomizing device is permitted, while when the total value of the electric power consumption calculated by the electric power consumption calculating means exceeds the allowable power value, the operation of the electrostatic atomizing device is prohibited.

7. The air conditioner according to any one of claims 1 to 6, further comprising a human body detecting sensor for detecting presence or absence of a person, wherein there are provided a skin care mode and a room care mode, and when a determination is made that a person is present in a predetermined region in a range that can be detected by the human body detecting sensor, a wind direction control in the skin care mode is conducted to direct air discharged from the indoor unit toward the predetermined region to render an electrostatic mist to reach the predetermined region, while when a determination is made that nobody is present in the range that can be detected by the human body detecting sensor, a wind direction control in the room care mode is conducted to direct the electrostatic mist upward or render the electrostatic mist to reach a region remote from the indoor unit.

8. An air conditioner comprising:

an indoor unit;

a human body detecting sensor mounted to the indoor unit to detect presence or absence of a person; and

an electrostatic atomizing device mounted to the indoor unit to generate an electrostatic mist;

wherein there are provided a skin care mode and a room care mode, and when a determination is made that a person is present in a predetermined region in a range that can be detected by the human body detecting sensor, a wind direction control in the skin care mode is conducted to direct air discharged from the indoor unit toward the predetermined region to render an electrostatic mist to reach the predetermined region, while when a determination is made that nobody is present in the range that can be detected by the human body detecting sensor, a wind direction control in the room care mode is conducted to direct the electrostatic mist upward or render the electrostatic mist to reach a region remote from the indoor unit.

9. The air conditioner according to claim 7 or 8, wherein the room care mode is conducted during operation of the indoor fan when the refrigerating cycle is not in operation.

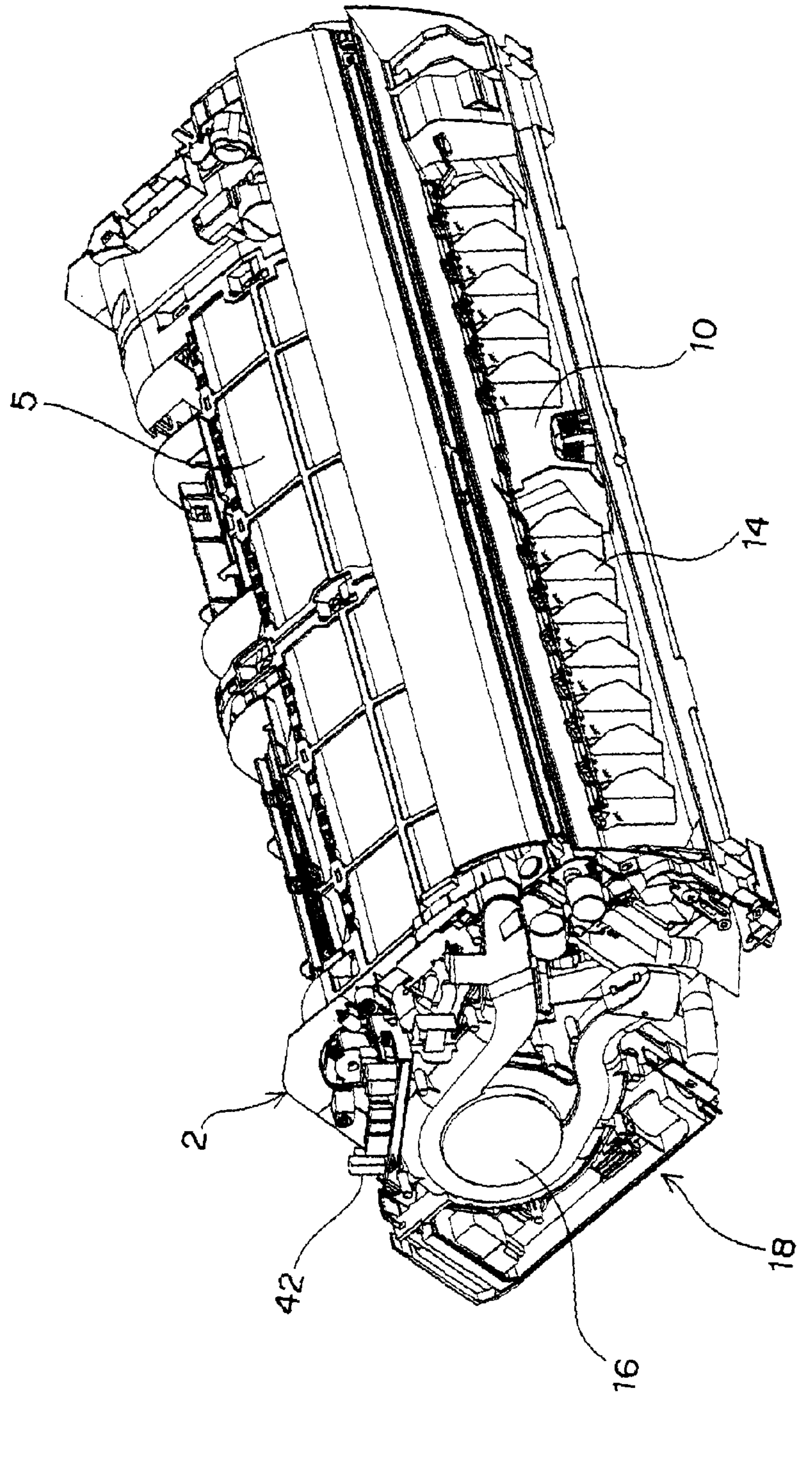


Fig. 1

Fig. 2

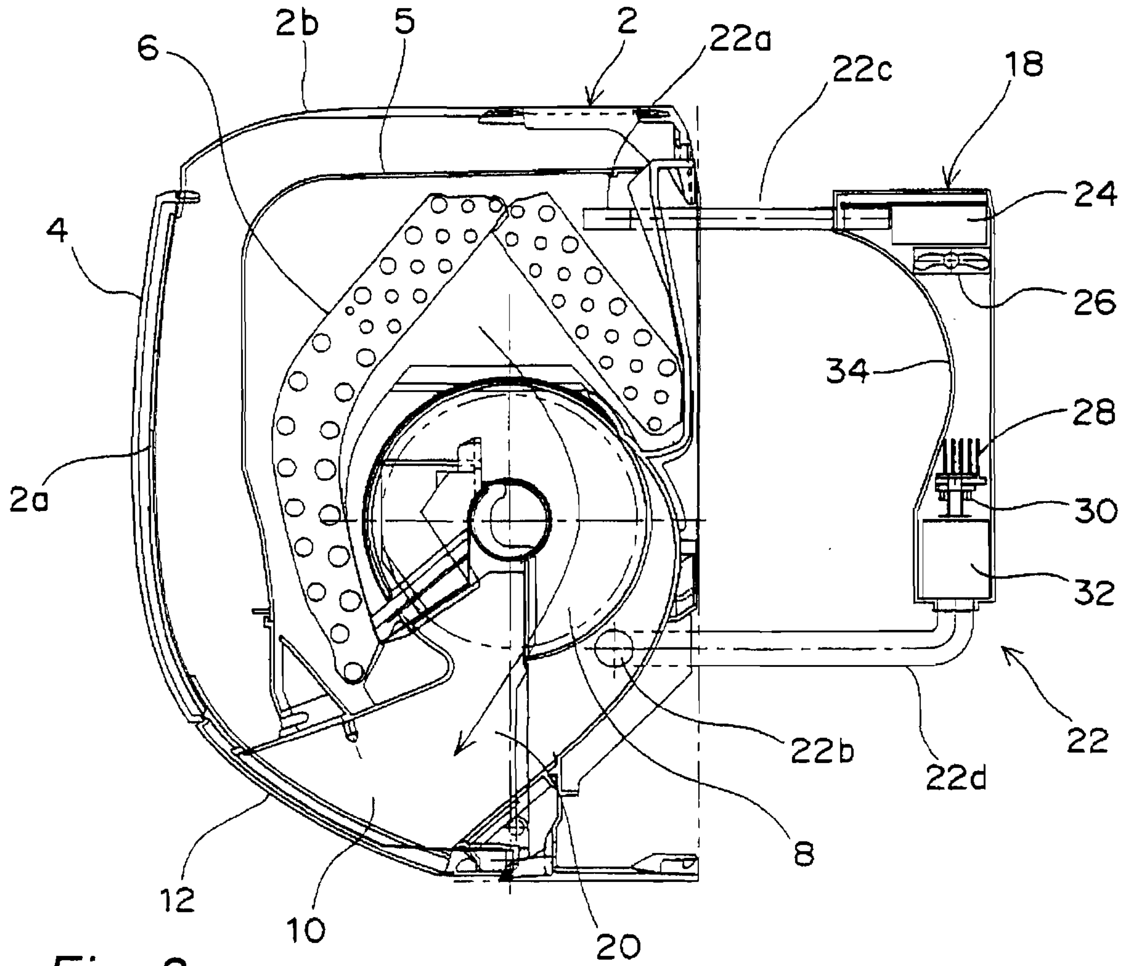

2b
5
2
22a
22c
18
6
24
4
26
34
28
2a
30
32
22b
22d
22
8
12
10
20

Fig. 3

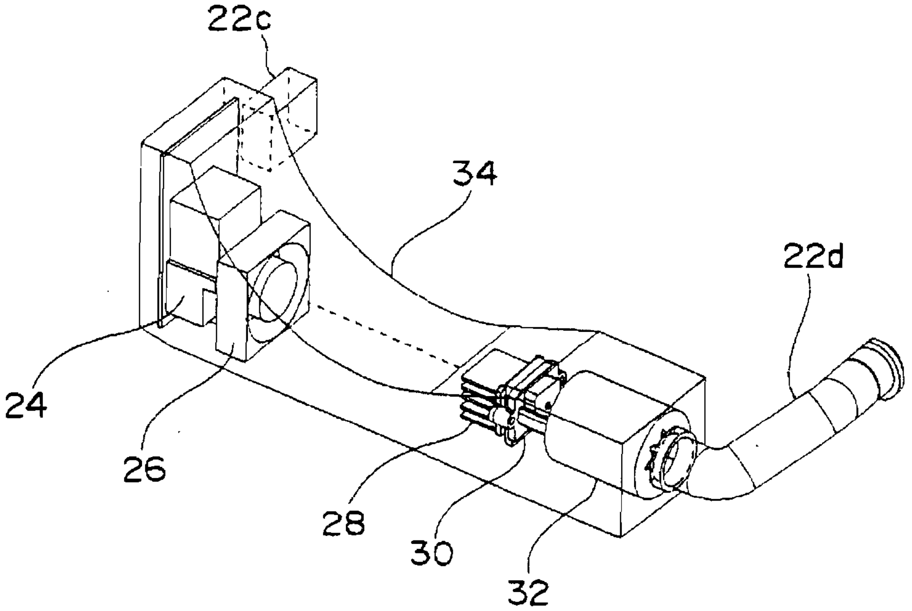
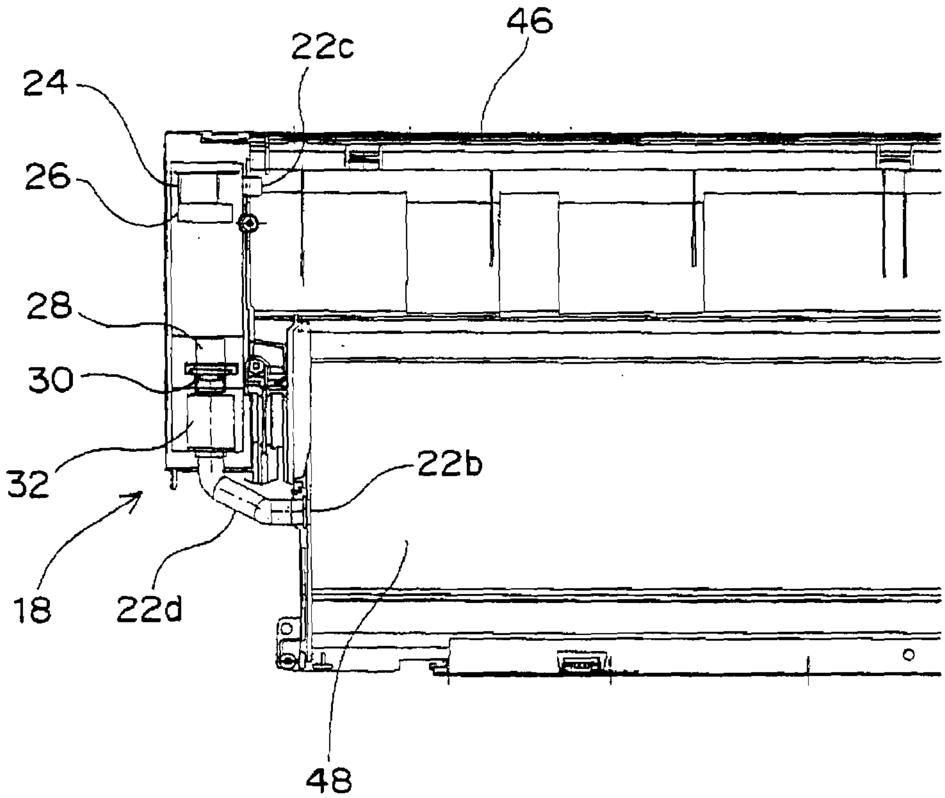

22c
34
22d
24
26
28
30
32

Fig. 4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22c
24
26
28
30
32
22b
18
22d
48

Fig. 5

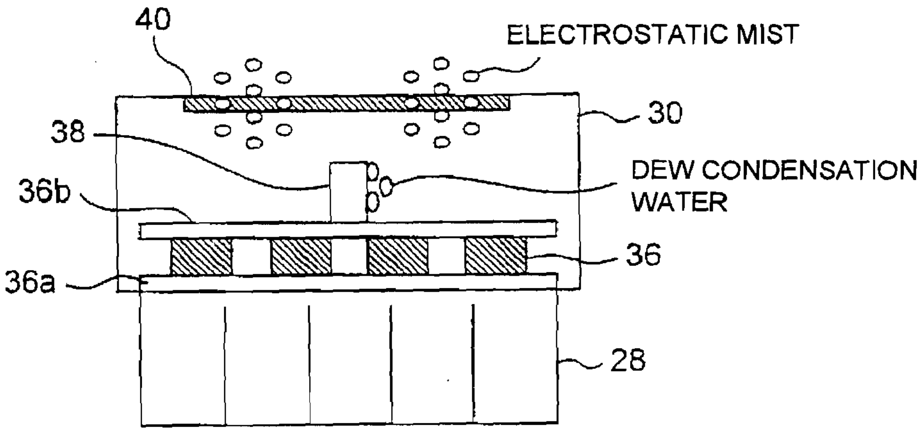

40
ELECTROSTATIC MIST
30
38
DEW CONDENSATION
WATER
36b
36
36a
28

Fig. 6

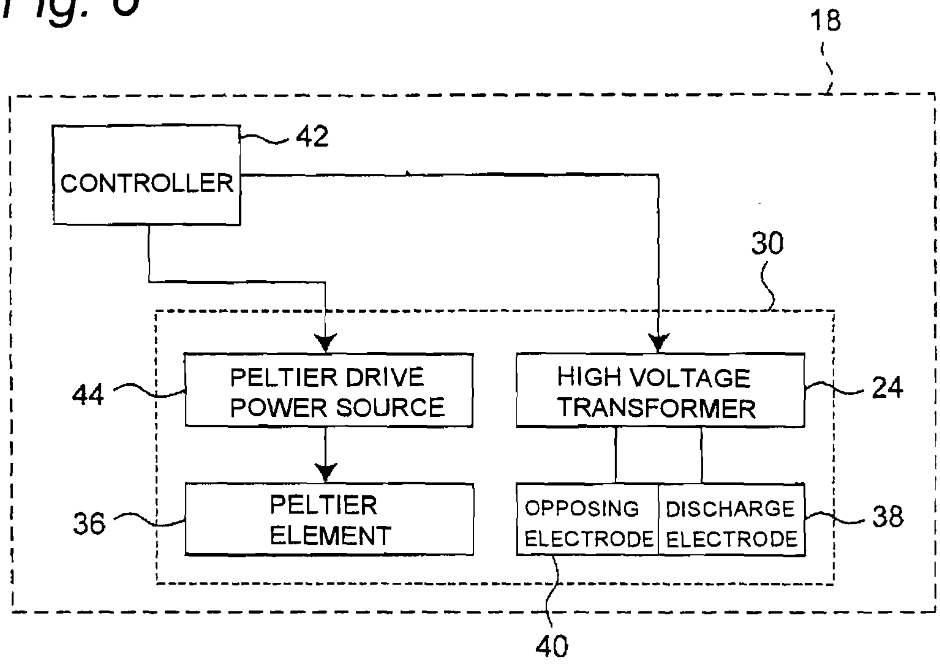

18
CONTROLLER
42
30
44
PELTIER DRIVE POWER SOURCE
HIGH VOLTAGE TRANSFORMER
24
36
PELTIER ELEMENT
OPPOSING ELECTRODE
DISCHARGE ELECTRODE
38
40

Fig. 7

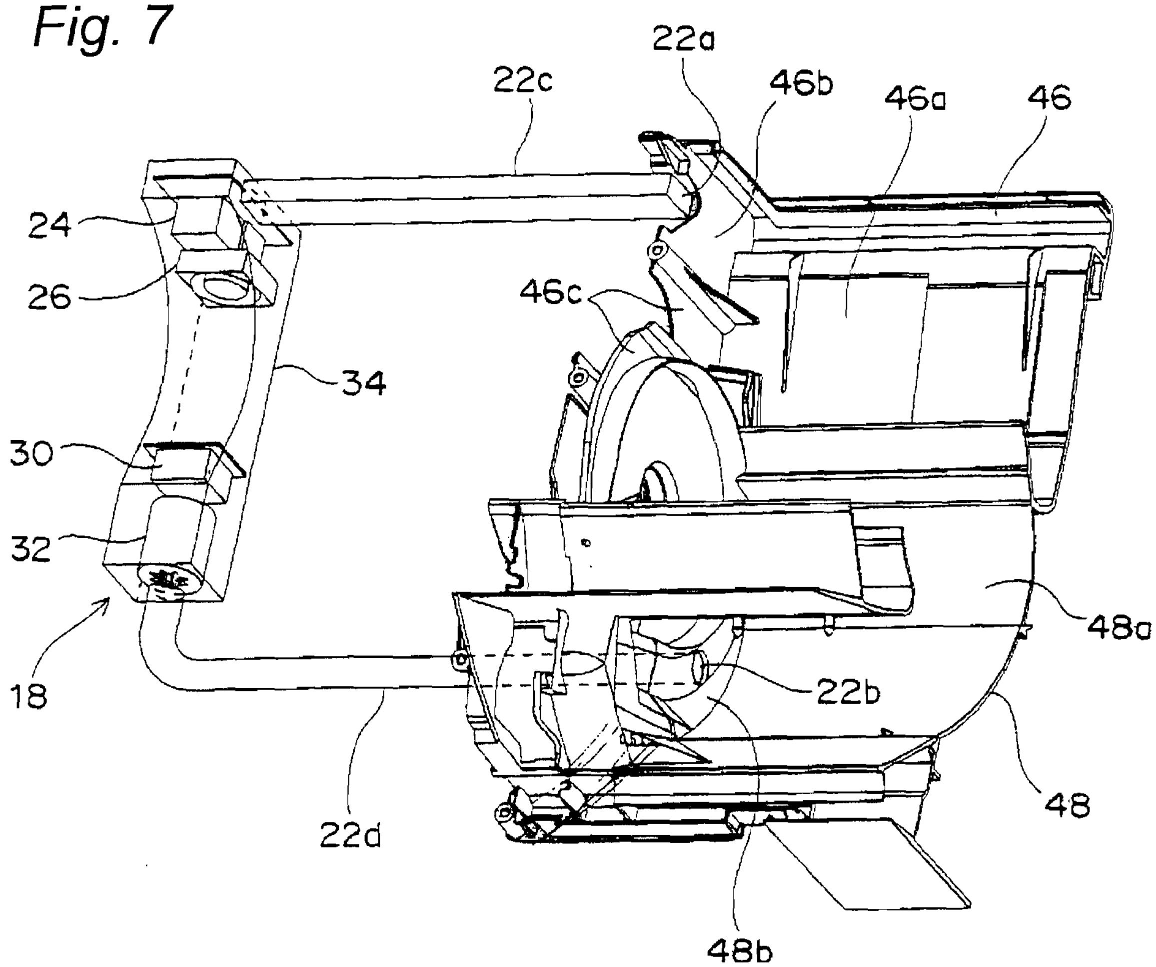

22a
22c
46b
46a
46
24
26
46c
34
30
32
18
48a
22b
22d
48
48b

Fig. 8

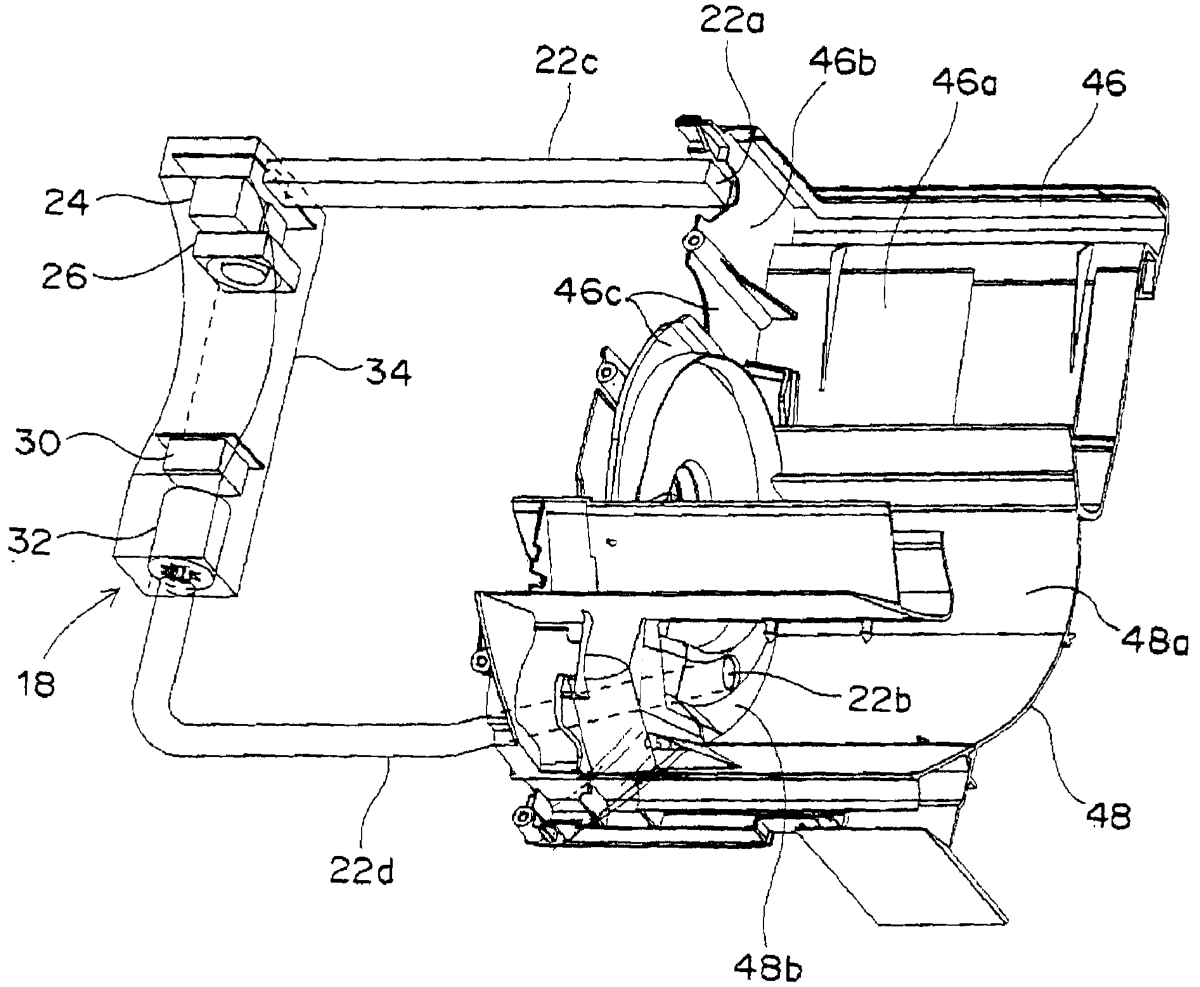


Fig. 9

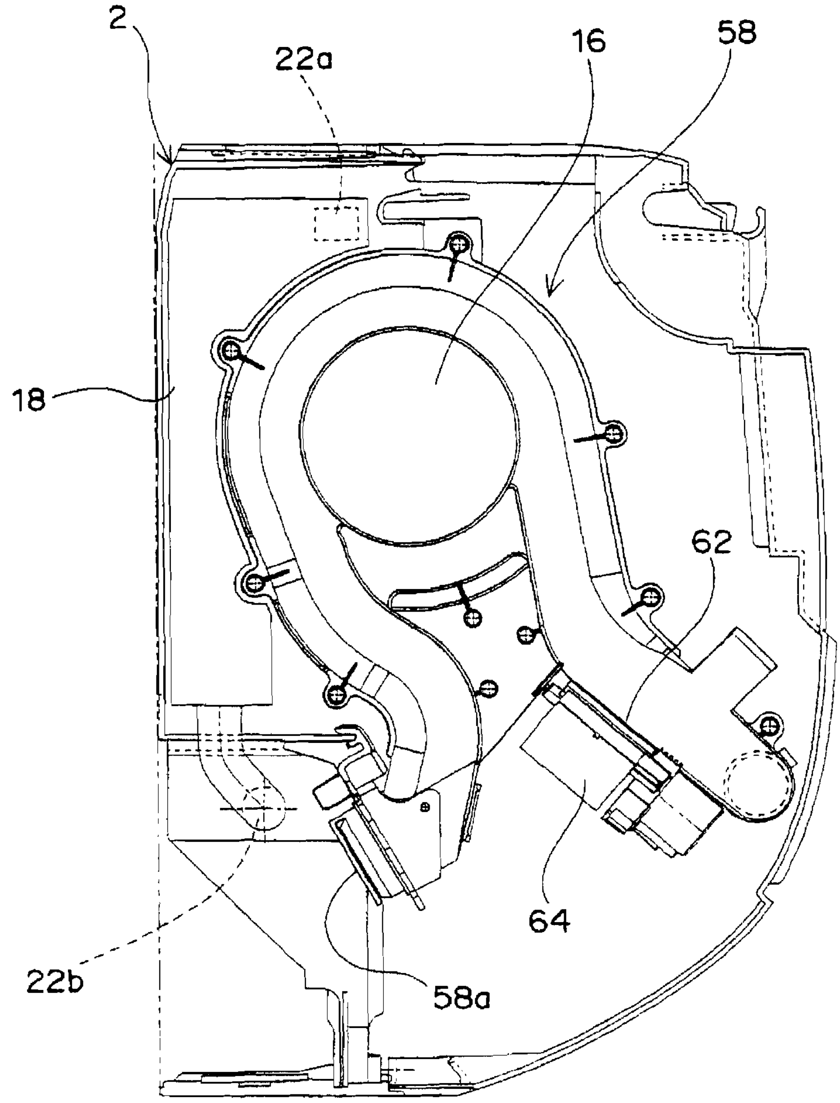


Fig. 10

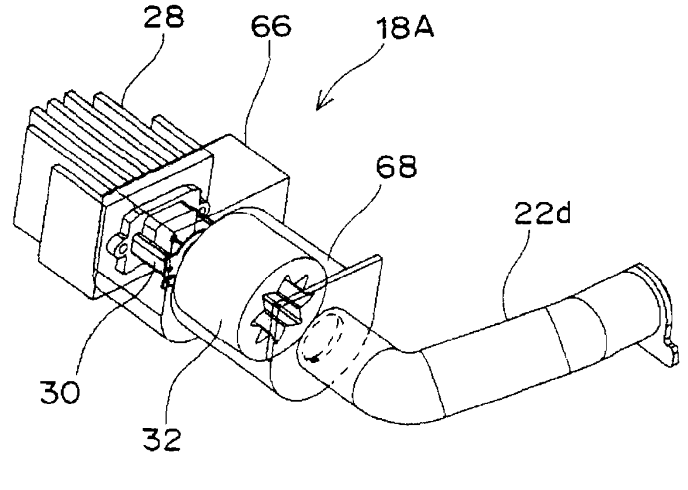


Fig. 11

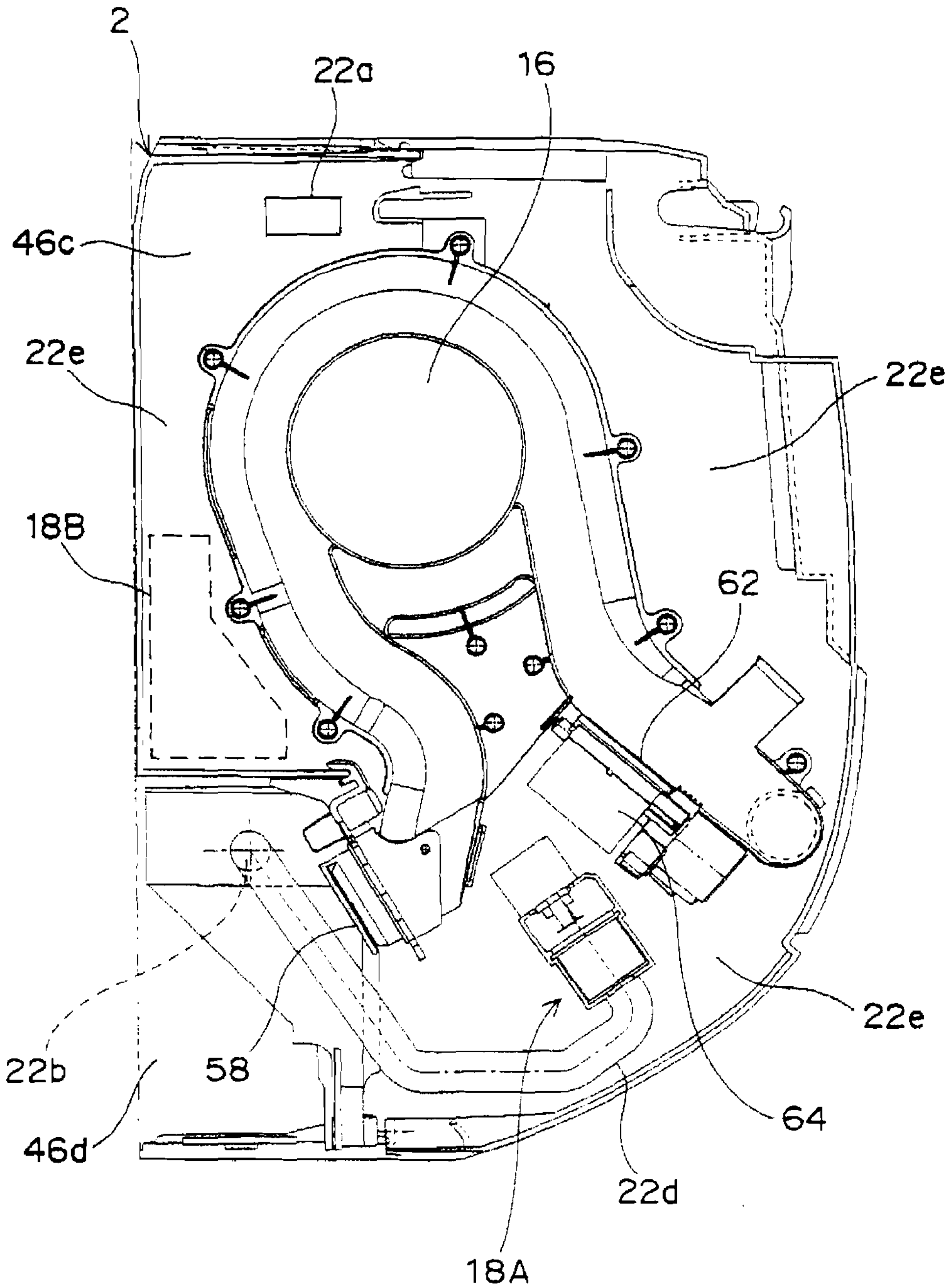


Fig. 12

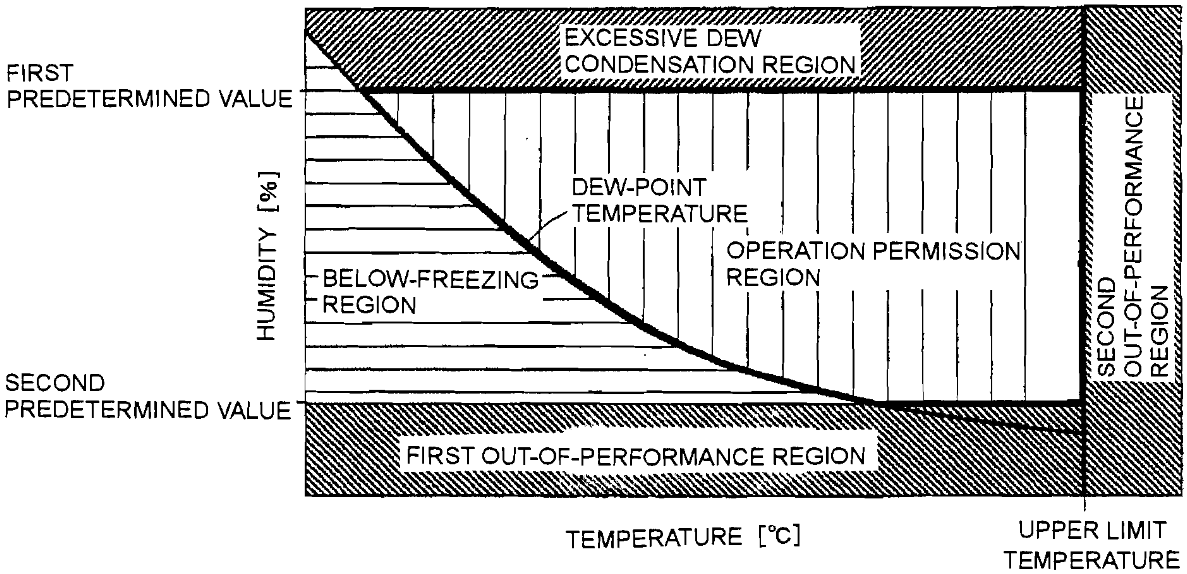

EXCESSIVE DEW
CONDENSATION REGION
FIRST
PREDETERMINED VALUE
DEW-POINT
TEMPERATURE
HUMIDITY [%]
OPERATION PERMISSION
REGION
BELOW-FREEZING
REGION
SECOND
OUT-OF-PERFORMANCE
REGION
SECOND
PREDETERMINED VALUE
FIRST OUT-OF-PERFORMANCE REGION
TEMPERATURE [°C]
UPPER LIMIT
TEMPERATURE

Fig. 13

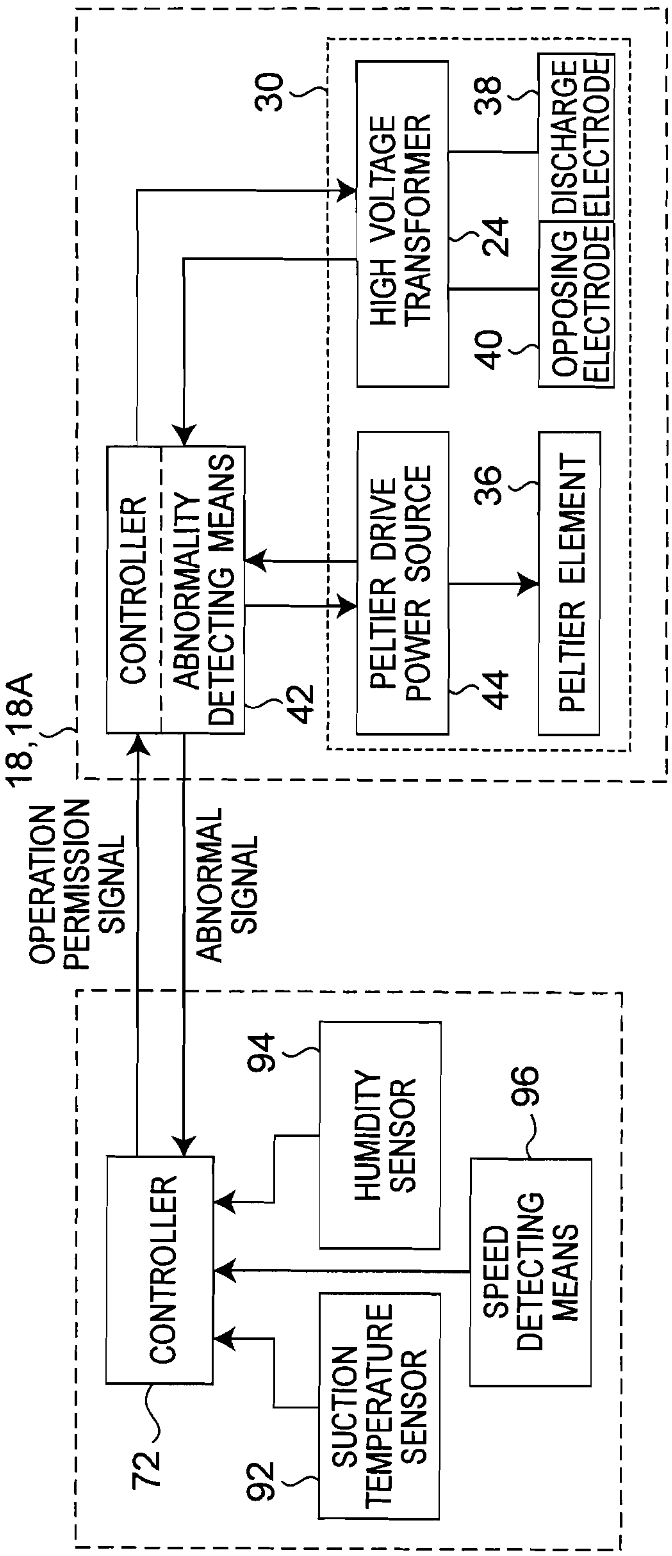

18,18A
30
HIGH VOLTAGE TRANSFORMER
24
38
DISCHARGE ELECTRODE
40
OPPOSING ELECTRODE
CONTROLLER
ABNORMALITY DETECTING MEANS
42
PELTIER DRIVE POWER SOURCE
44
36
PELTIER ELEMENT
OPERATION PERMISSION SIGNAL
ABNORMAL SIGNAL
CONTROLLER
72
94
HUMIDITY SENSOR
96
SPEED DETECTING MEANS
92
SUCTION TEMPERATURE SENSOR

Fig. 14A

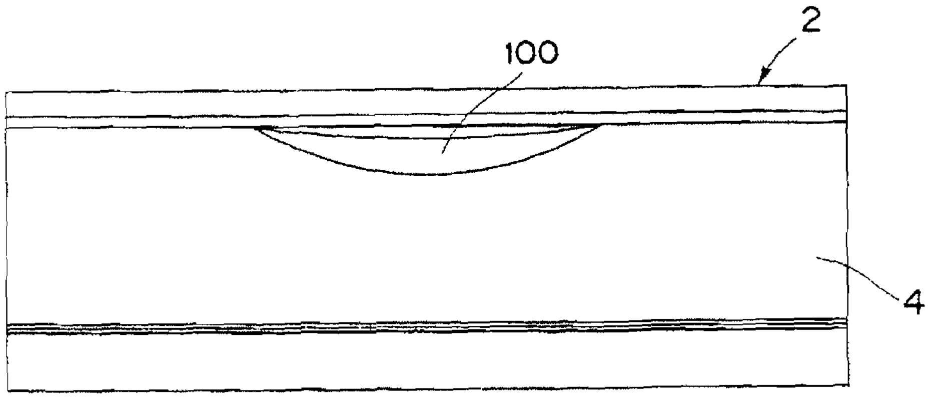


Fig. 14B

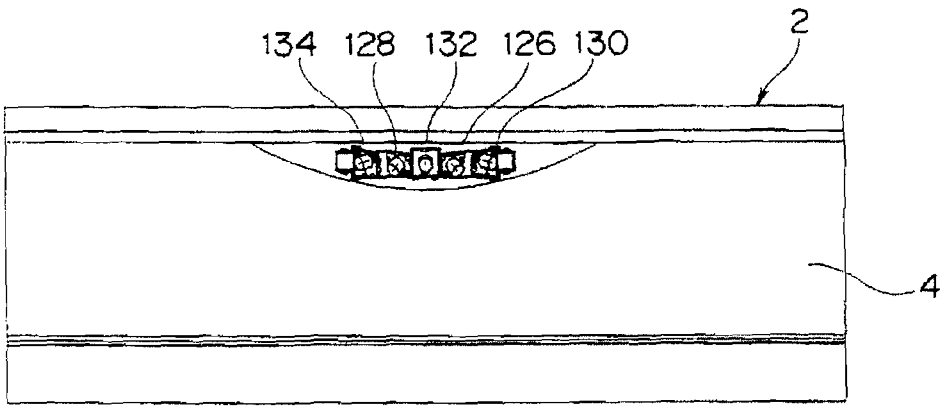


Fig. 14C

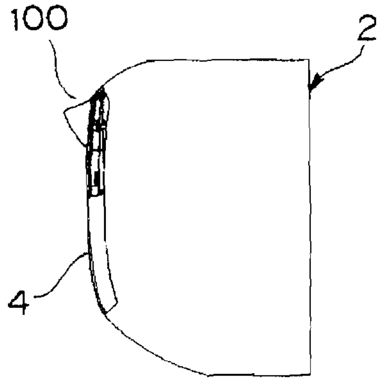


Fig. 15A

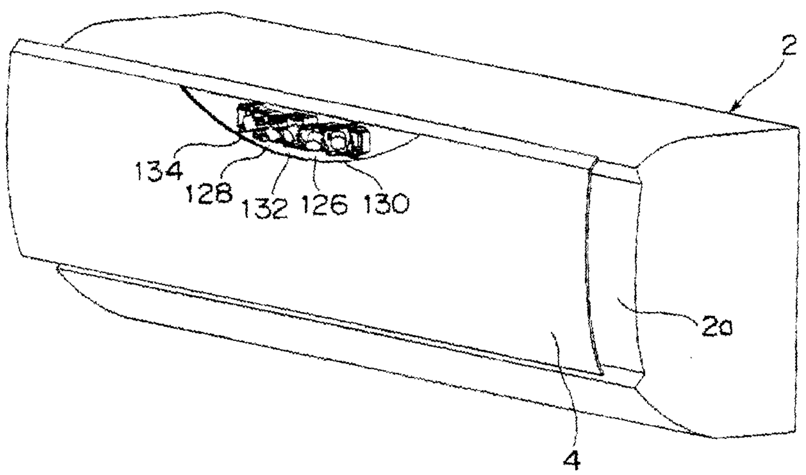


Fig. 15B

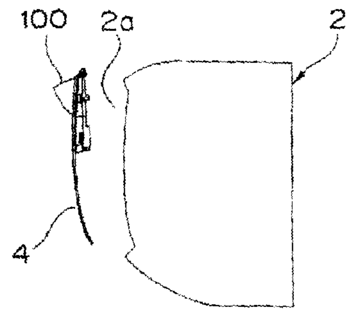


Fig. 16

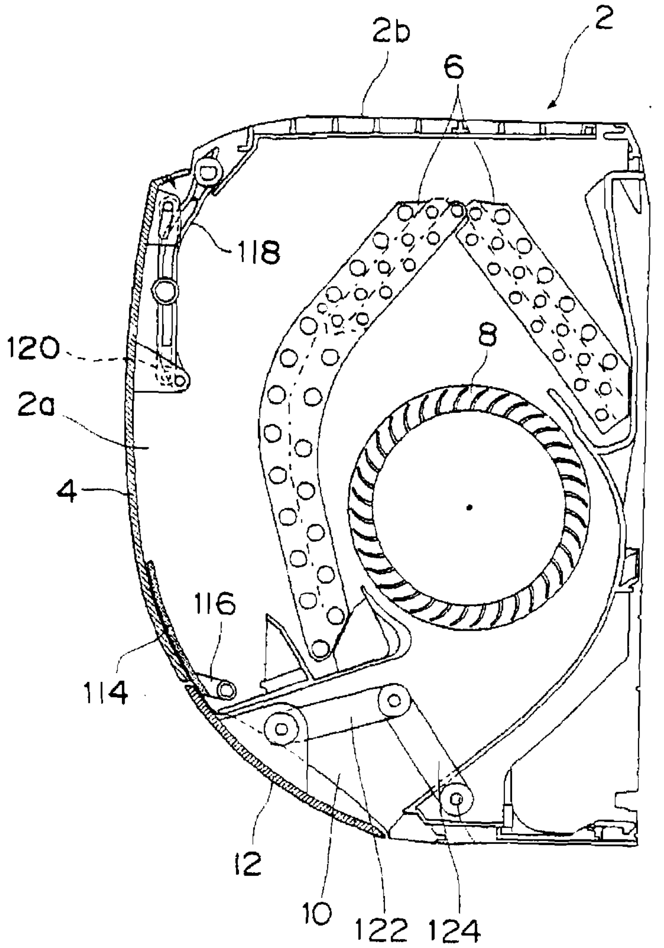


Fig. 17A

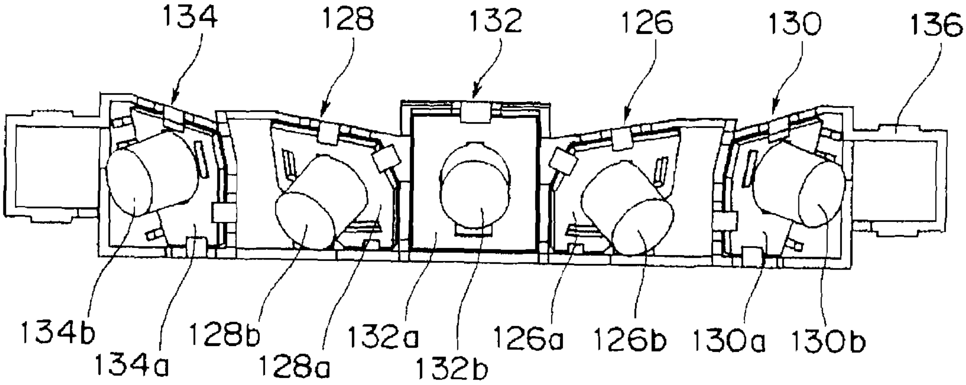


Fig. 17B

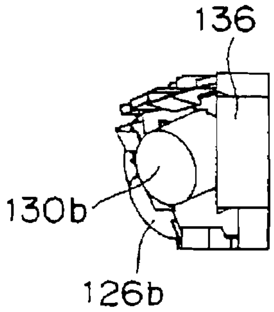


Fig. 17C

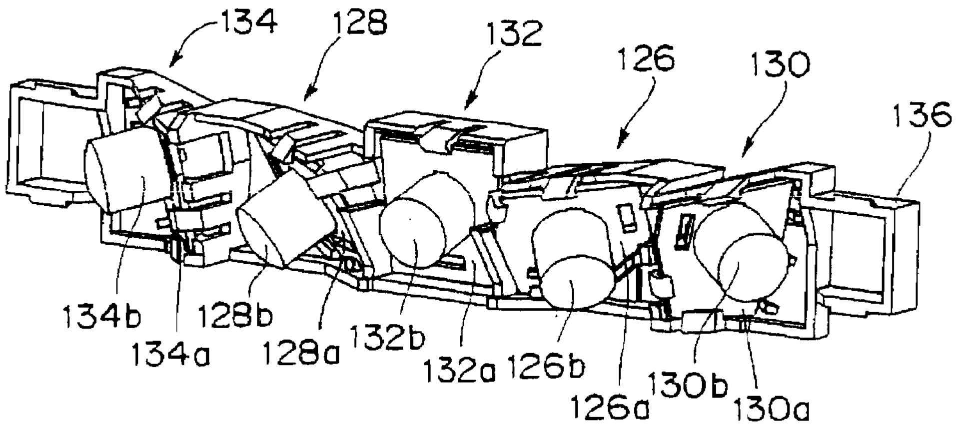


Fig. 18A

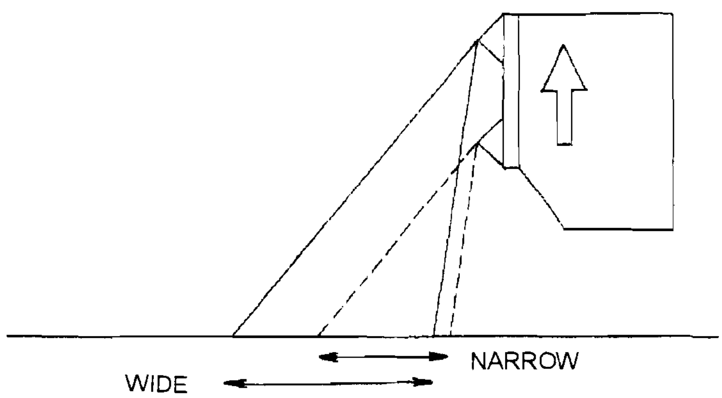


Fig. 18B

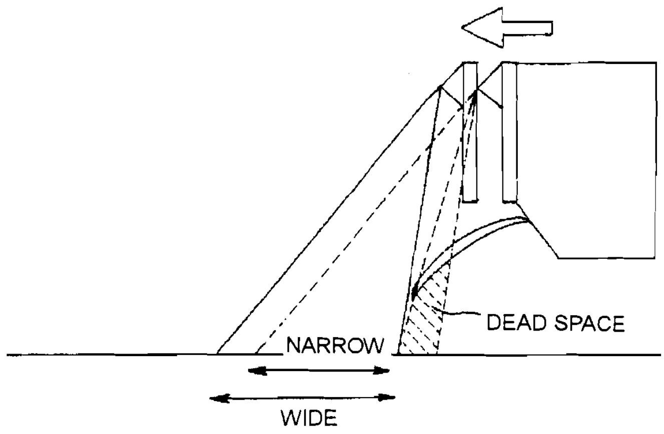


Fig. 18C

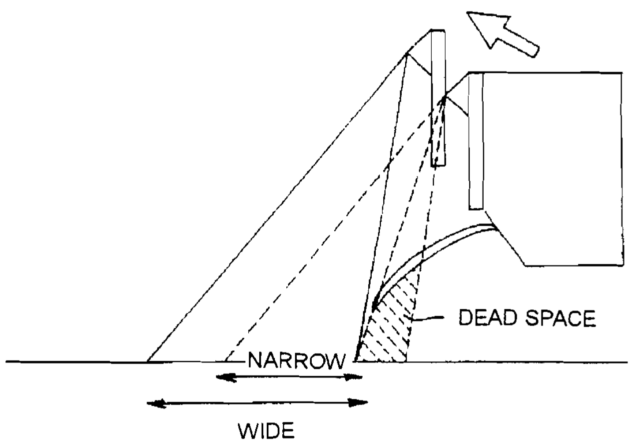


Fig. 18D

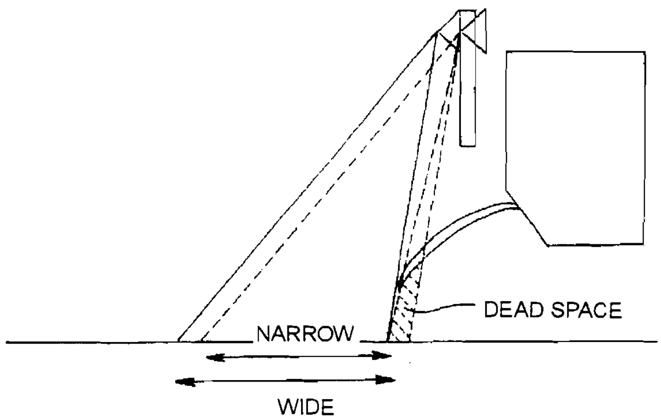


Fig. 19

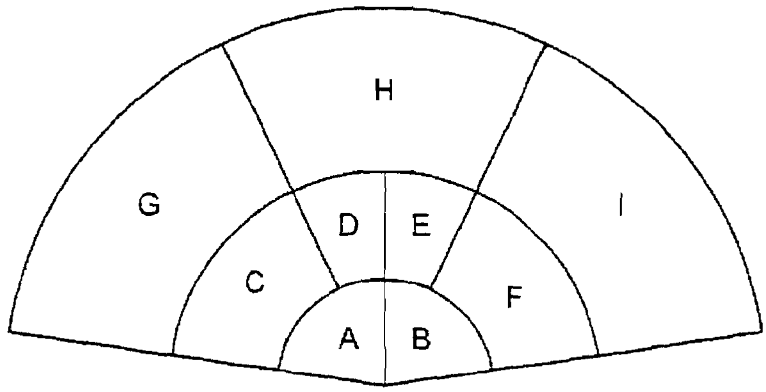

H
G
D
E
I
C
F
A
B

Fig. 20

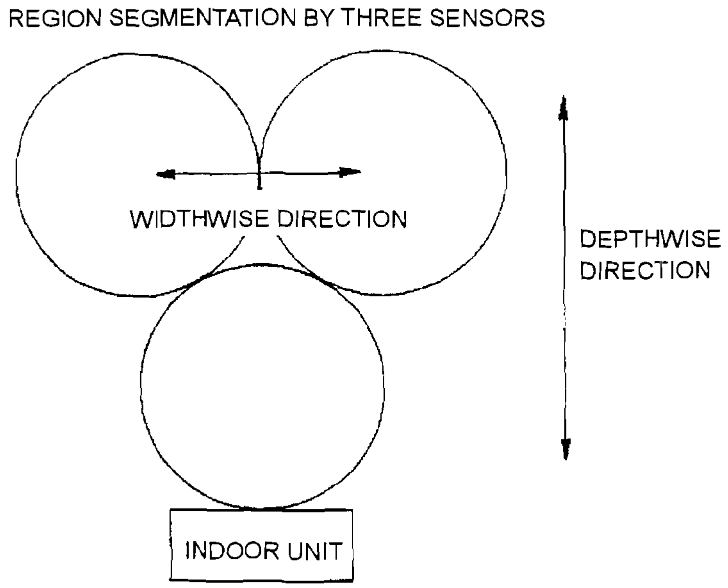

REGION SEGMENTATION BY THREE SENSORS
WIDTHWISE DIRECTION
DEPTHWISE
DIRECTION
INDOOR UNIT

Fig.21

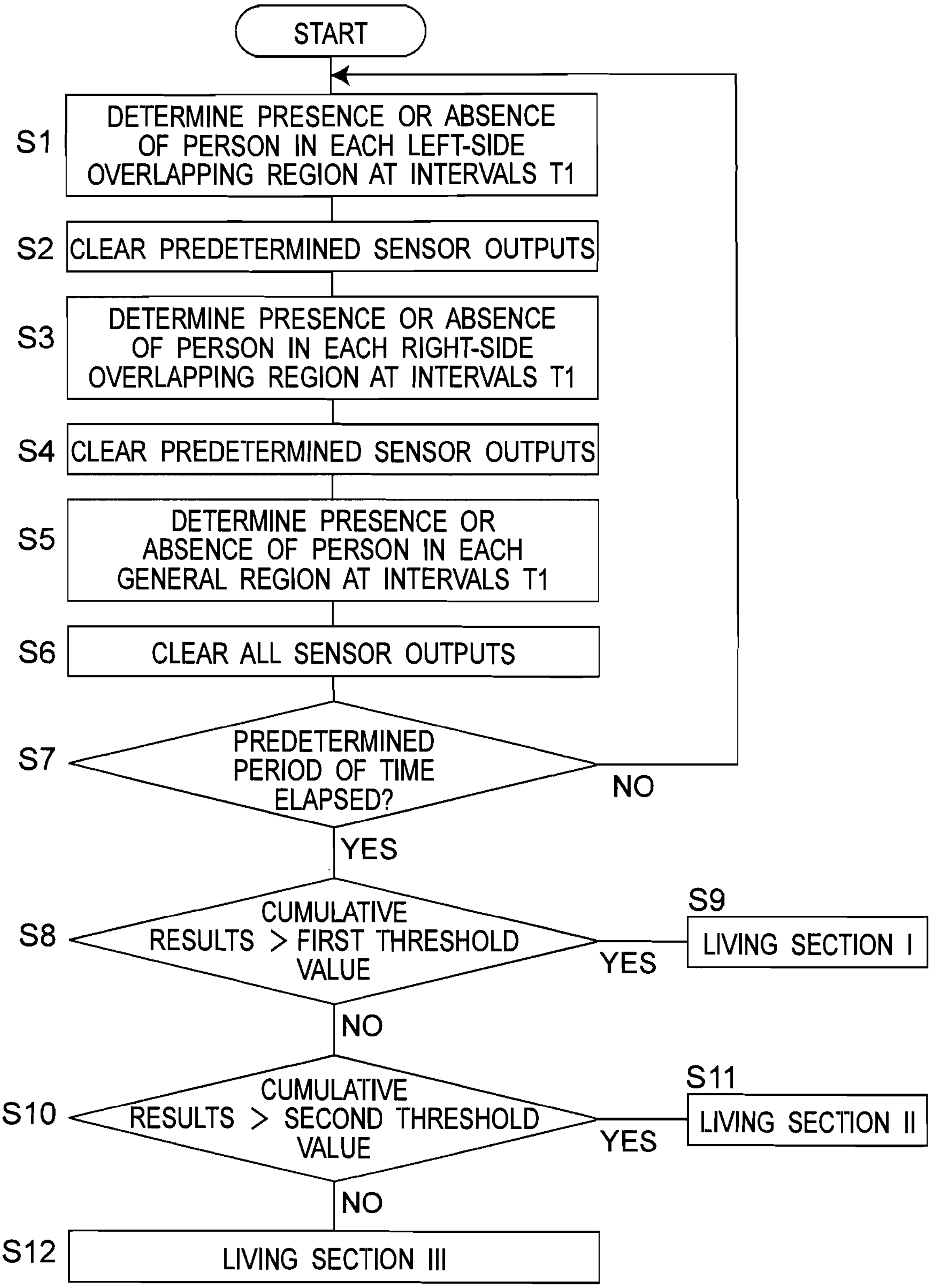

START
S1
DETERMINE PRESENCE OR ABSENCE OF PERSON IN EACH LEFT-SIDE OVERLAPPING REGION AT INTERVALS T1
S2
CLEAR PREDETERMINED SENSOR OUTPUTS
S3
DETERMINE PRESENCE OR ABSENCE OF PERSON IN EACH RIGHT-SIDE OVERLAPPING REGION AT INTERVALS T1
S4
CLEAR PREDETERMINED SENSOR OUTPUTS
S5
DETERMINE PRESENCE OR ABSENCE OF PERSON IN EACH GENERAL REGION AT INTERVALS T1
S6
CLEAR ALL SENSOR OUTPUTS
S7
PREDETERMINED PERIOD OF TIME ELAPSED?
NO
YES
S8
CUMULATIVE RESULTS > FIRST THRESHOLD VALUE
YES
S9
LIVING SECTION I
NO
S10
CUMULATIVE RESULTS > SECOND THRESHOLD VALUE
YES
S11
LIVING SECTION II
NO
S12
LIVING SECTION III

Fig.22

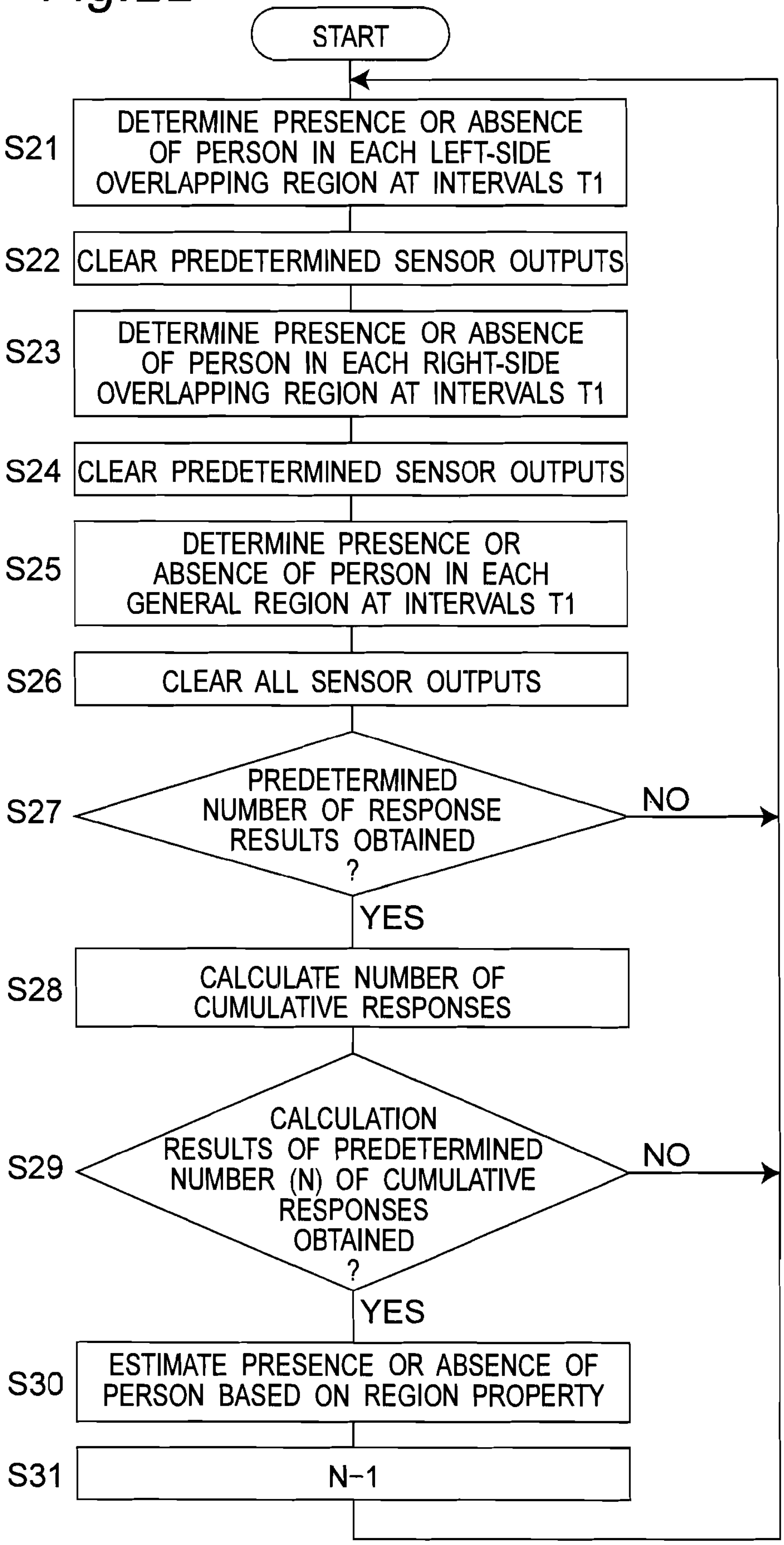

START
S21
DETERMINE PRESENCE OR ABSENCE OF PERSON IN EACH LEFT-SIDE OVERLAPPING REGION AT INTERVALS T1
S22
CLEAR PREDETERMINED SENSOR OUTPUTS
S23
DETERMINE PRESENCE OR ABSENCE OF PERSON IN EACH RIGHT-SIDE OVERLAPPING REGION AT INTERVALS T1
S24
CLEAR PREDETERMINED SENSOR OUTPUTS
S25
DETERMINE PRESENCE OR ABSENCE OF PERSON IN EACH GENERAL REGION AT INTERVALS T1
S26
CLEAR ALL SENSOR OUTPUTS
S27
PREDETERMINED NUMBER OF RESPONSE RESULTS OBTAINED ?
NO
YES
S28
CALCULATE NUMBER OF CUMULATIVE RESPONSES
S29
CALCULATION RESULTS OF PREDETERMINED NUMBER (N) OF CUMULATIVE RESPONSES OBTAINED ?
NO
YES
S30
ESTIMATE PRESENCE OR ABSENCE OF PERSON BASED ON REGION PROPERTY
S31
N-1

Fig.23

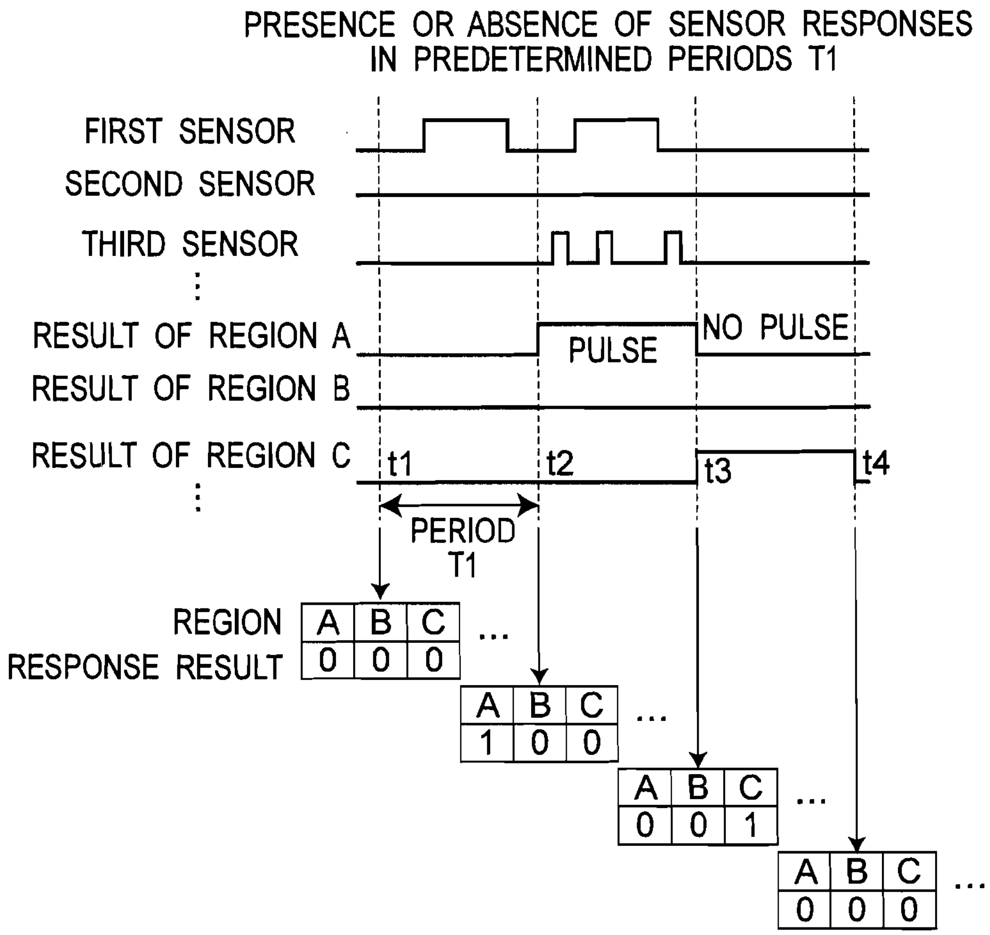

PRESENCE OR ABSENCE OF SENSOR RESPONSES
IN PREDETERMINED PERIODS T1
FIRST SENSOR
SECOND SENSOR
THIRD SENSOR
RESULT OF REGION A
PULSE
NO PULSE
RESULT OF REGION B
RESULT OF REGION C
t1
t2
t3
t4
PERIOD
T1
REGION
RESPONSE RESULT
A B C
0 0 0
A B C
1 0 0
A B C
0 0 1
A B C
0 0 0

Fig. 24

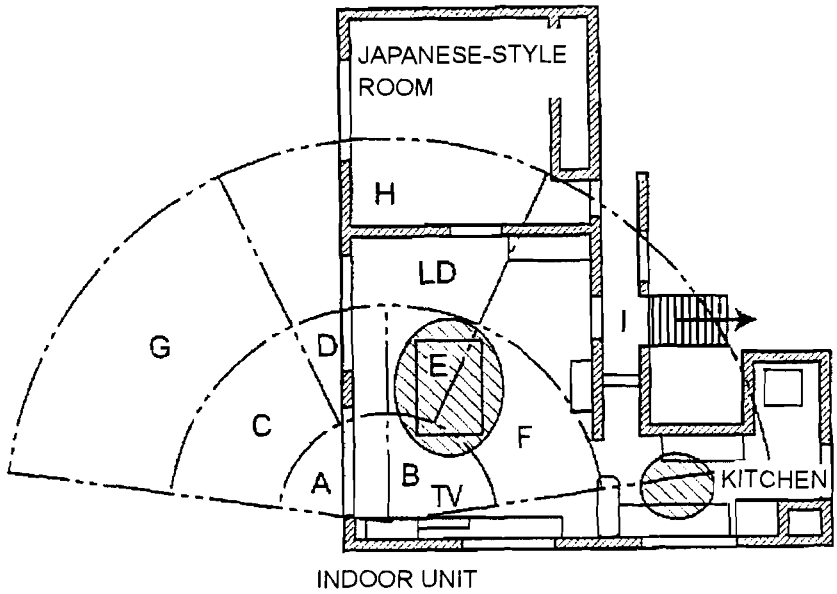

JAPANESE-STYLE ROOM
H
LD
G
D
E
C
F
A
B
TV
I
KITCHEN
INDOOR UNIT

Fig. 25

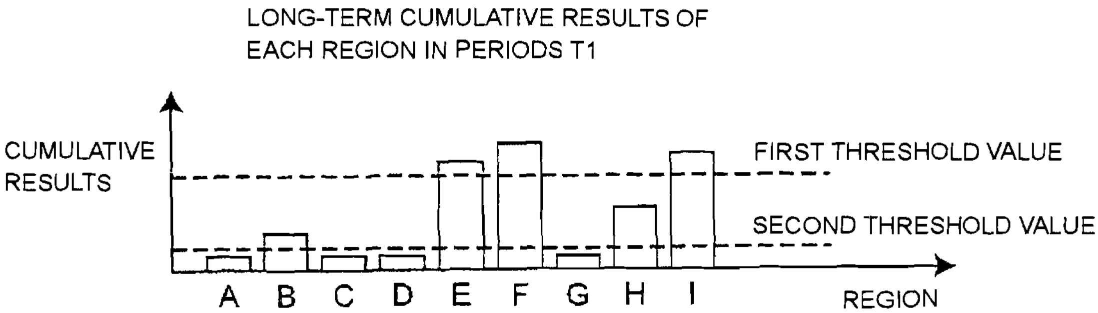

LONG-TERM CUMULATIVE RESULTS OF EACH REGION IN PERIODS T1
CUMULATIVE RESULTS
FIRST THRESHOLD VALUE
SECOND THRESHOLD VALUE
A B C D E F G H I
REGION

Fig. 26

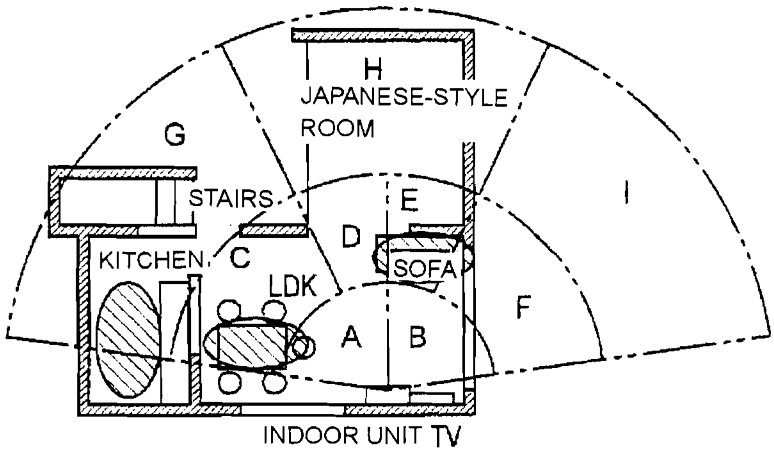

H
JAPANESE-STYLE ROOM
G
STAIRS
E
I
D
KITCHEN
C
SOFA
LDK
F
A
B
INDOOR UNIT
TV

Fig. 27

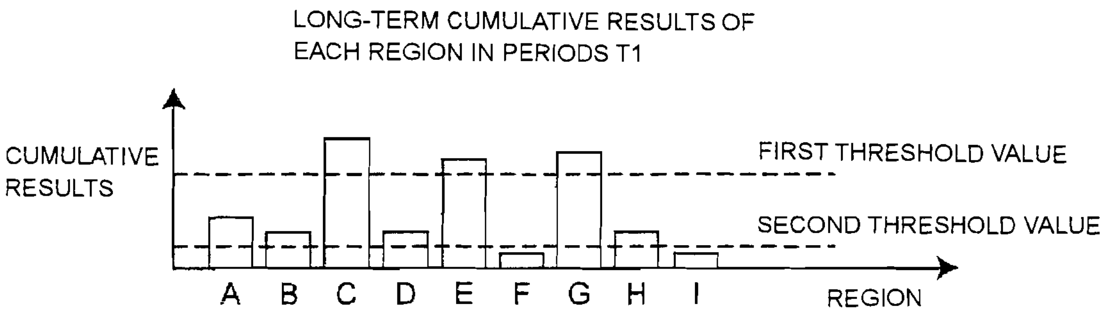

LONG-TERM CUMULATIVE RESULTS OF EACH REGION IN PERIODS T1
CUMULATIVE RESULTS
FIRST THRESHOLD VALUE
SECOND THRESHOLD VALUE
A B C D E F G H I
REGION

Fig. 28

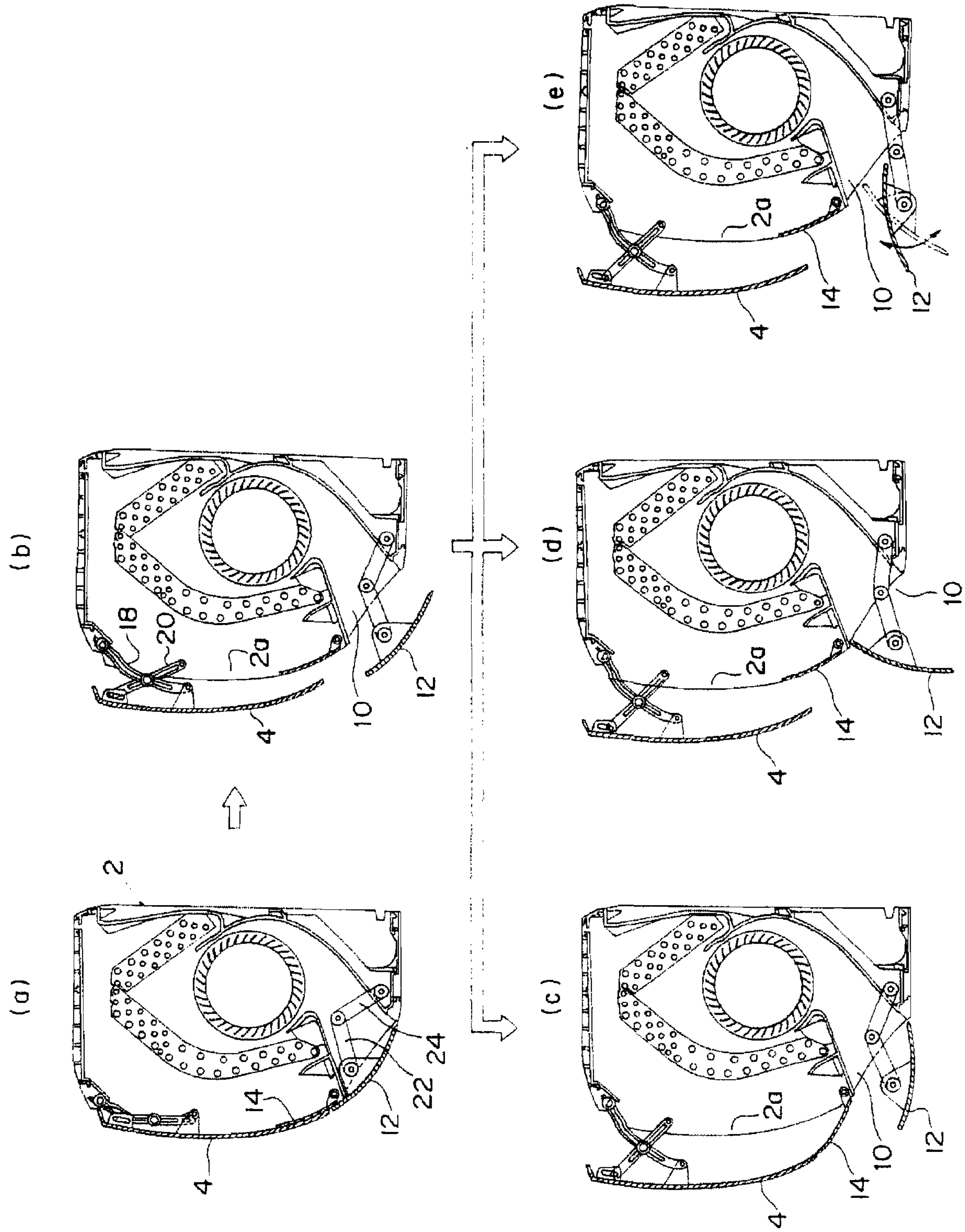


Fig. 29

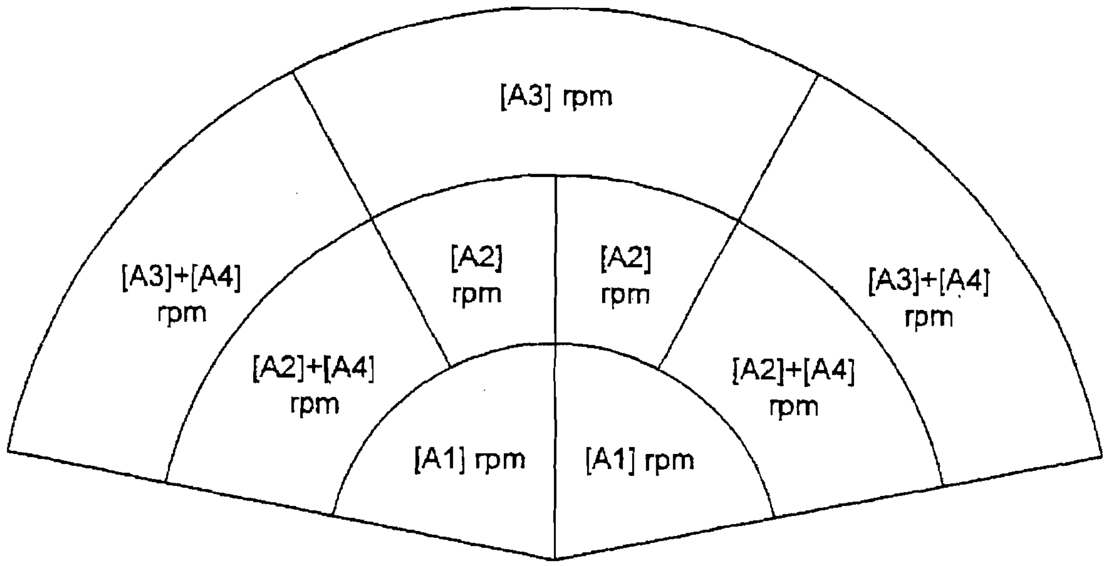
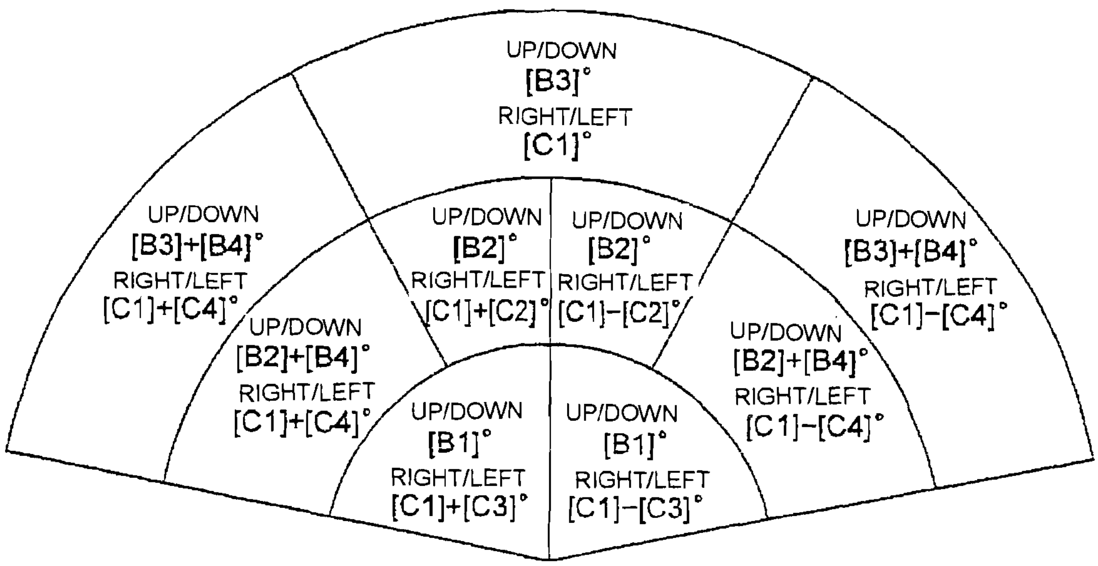

[A3] rpm
[A3]+[A4]
rpm
[A2]
rpm
[A2]
rpm
[A3]+[A4]
rpm
[A2]+[A4]
rpm
[A2]+[A4]
rpm
[A1] rpm
[A1] rpm

Fig. 30


UP/DOWN
[B3]°
RIGHT/LEFT
[C1]°
UP/DOWN
[B3]+[B4]°
RIGHT/LEFT
[C1]+[C4]°
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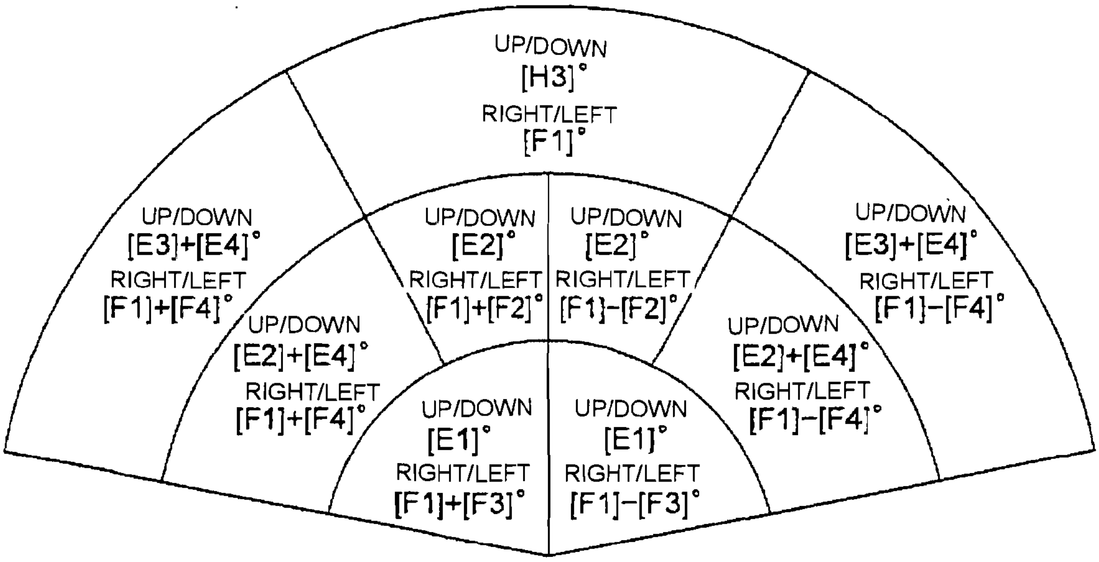
[B2]°
RIGHT/LEFT
[C1]+[C2]°
UP/DOWN
[B2]°
RIGHT/LEFT
[C1]−[C2]°
UP/DOWN
[B3]+[B4]°
RIGHT/LEFT
[C1]−[C4]°
UP/DOWN
[B2]+[B4]°
RIGHT/LEFT
[C1]+[C4]°
UP/DOWN
[B2]+[B4]°
RIGHT/LEFT
[C1]−[C4]°
UP/DOWN
[B1]°
RIGHT/LEFT
[C1]+[C3]°
UP/DOWN
[B1]°
RIGHT/LEFT
[C1]−[C3]°

Fig. 31


UP/DOWN
[H3]°
RIGHT/LEFT
[F1]°
UP/DOWN
[E3]+[E4]°
RIGHT/LEFT
[F1]+[F4]°
UP/DOWN
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RIGHT/LEFT
[F1]+[F2]°
UP/DOWN
[E2]°
RIGHT/LEFT
[F1]-[F2]°
UP/DOWN
[E3]+[E4]°
RIGHT/LEFT
[F1]-[F4]°
UP/DOWN
[E2]+[E4]°
RIGHT/LEFT
[F1]+[F4]°
UP/DOWN
[E1]°
RIGHT/LEFT
[F1]+[F3]°
UP/DOWN
[E1]°
RIGHT/LEFT
[F1]-[F3]°
UP/DOWN
[E2]+[E4]°
RIGHT/LEFT
[F1]-[F4]°

Fig. 32

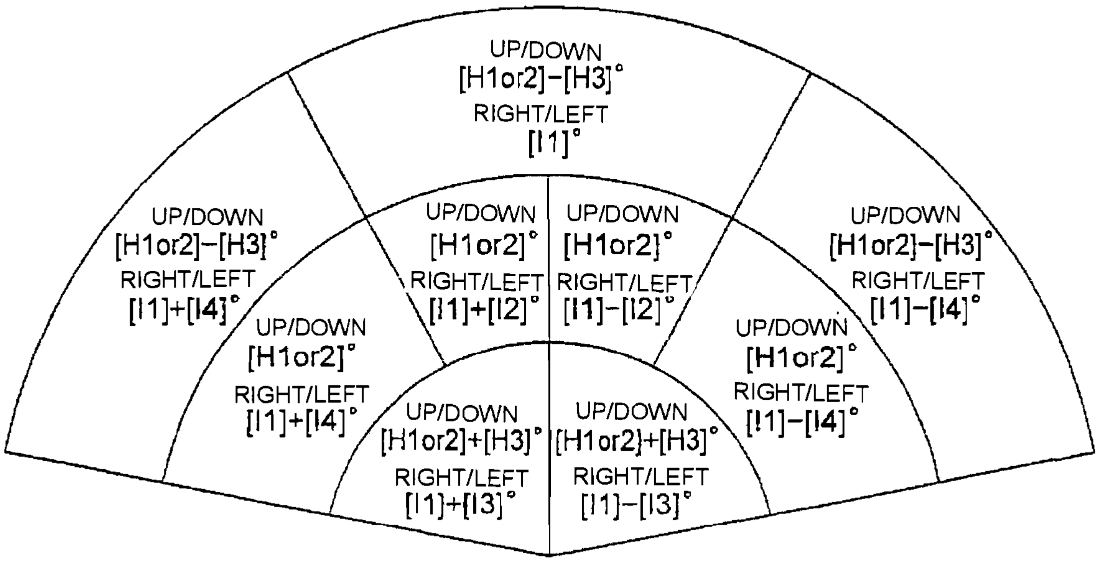

UP/DOWN
[H1or2]-[H3]°
RIGHT/LEFT
[I1]°
UP/DOWN
[H1or2]-[H3]°
RIGHT/LEFT
[I1]+[I4]°
UP/DOWN
[H1or2]°
RIGHT/LEFT
[I1]+[I2]°
UP/DOWN
[H1or2]°
RIGHT/LEFT
[I1]-[I2]°
UP/DOWN
[H1or2]-[H3]°
RIGHT/LEFT
[I1]-[I4]°
UP/DOWN
[H1or2]°
RIGHT/LEFT
[I1]+[I4]°
UP/DOWN
[H1or2]+[H3]°
RIGHT/LEFT
[I1]+[I3]°
UP/DOWN
[H1or2]+[H3]°
RIGHT/LEFT
[I1]-[I3]°
UP/DOWN
[H1or2]°
RIGHT/LEFT
[I1]-[I4]°

Fig.33

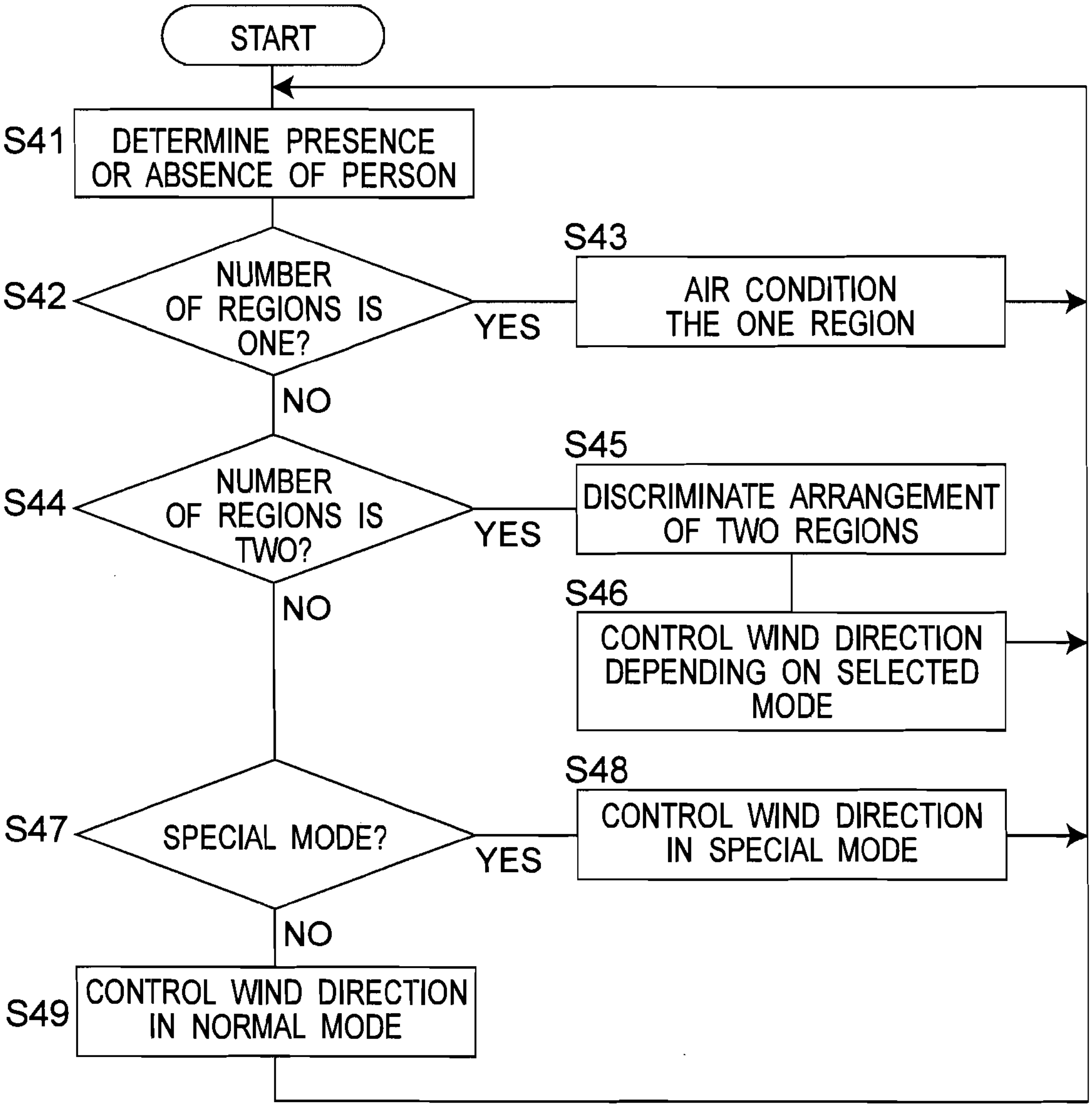

START
S41
DETERMINE PRESENCE OR ABSENCE OF PERSON
S42
NUMBER OF REGIONS IS ONE?
YES
S43
AIR CONDITION THE ONE REGION
NO
S44
NUMBER OF REGIONS IS TWO?
YES
S45
DISCRIMINATE ARRANGEMENT OF TWO REGIONS
S46
CONTROL WIND DIRECTION DEPENDING ON SELECTED MODE
NO
S47
SPECIAL MODE?
YES
S48
CONTROL WIND DIRECTION IN SPECIAL MODE
NO
S49
CONTROL WIND DIRECTION IN NORMAL MODE

Fig. 34A

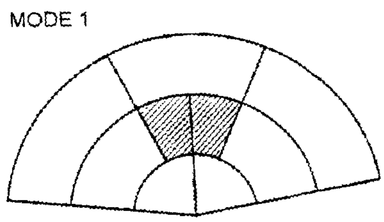


Fig. 34B

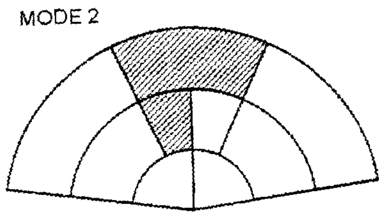


Fig. 34C

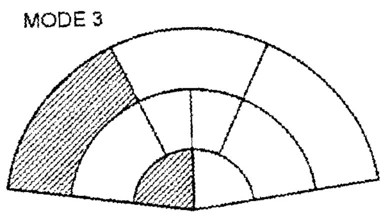


Fig. 34D

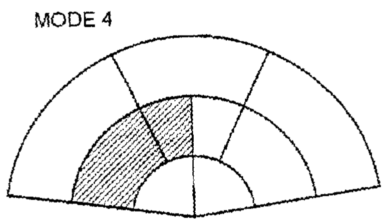


Fig. 34E

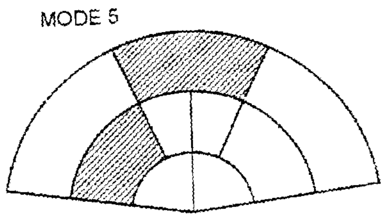


Fig. 35A

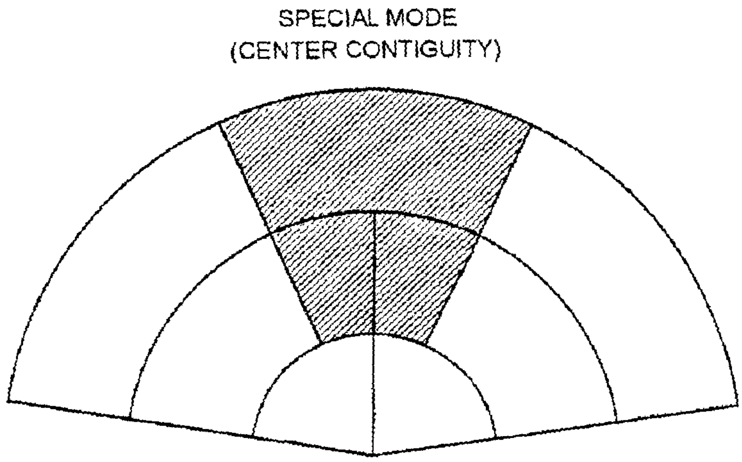


Fig. 35B

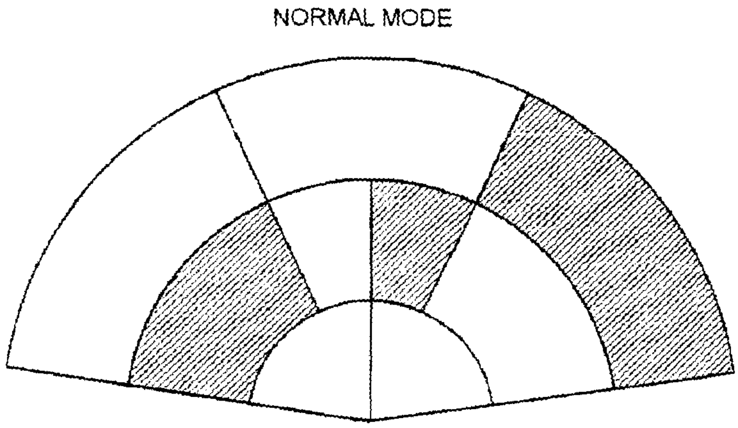


Fig. 35C

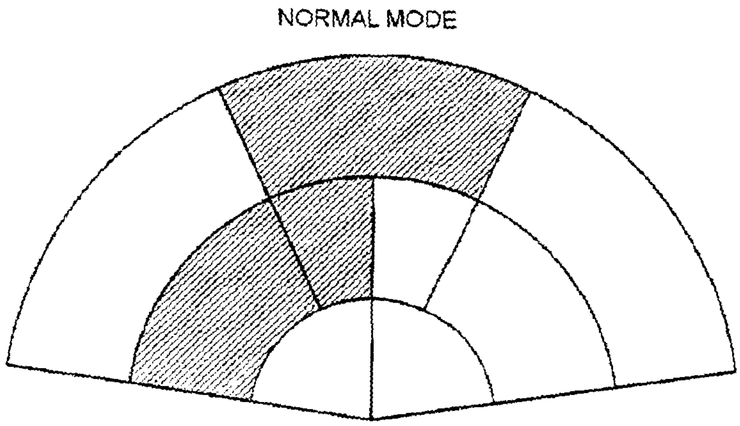
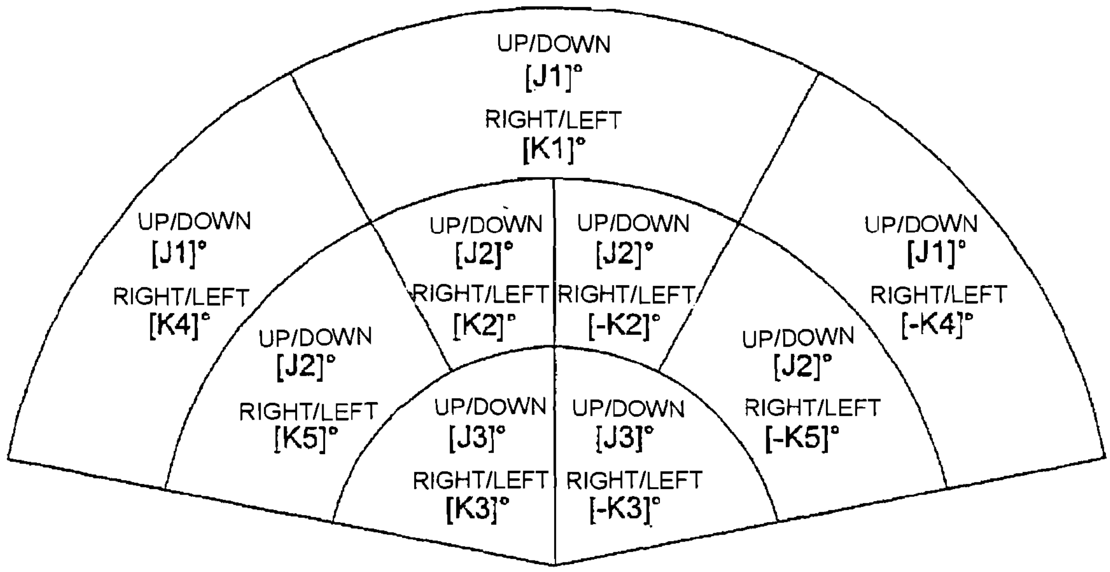


Fig. 36


UP/DOWN
[J1]°
RIGHT/LEFT
[K1]°
UP/DOWN
[J1]°
RIGHT/LEFT
[K4]°
UP/DOWN
[J2]°
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[J2]°
RIGHT/LEFT
[-K2]°
UP/DOWN
[J1]°
RIGHT/LEFT
[-K4]°
UP/DOWN
[J2]°
RIGHT/LEFT
[K5]°
UP/DOWN
[J2]°
RIGHT/LEFT
[-K5]°
UP/DOWN
[J3]°
RIGHT/LEFT
[K3]°
UP/DOWN
[J3]°
RIGHT/LEFT
[-K3]°

Fig. 37

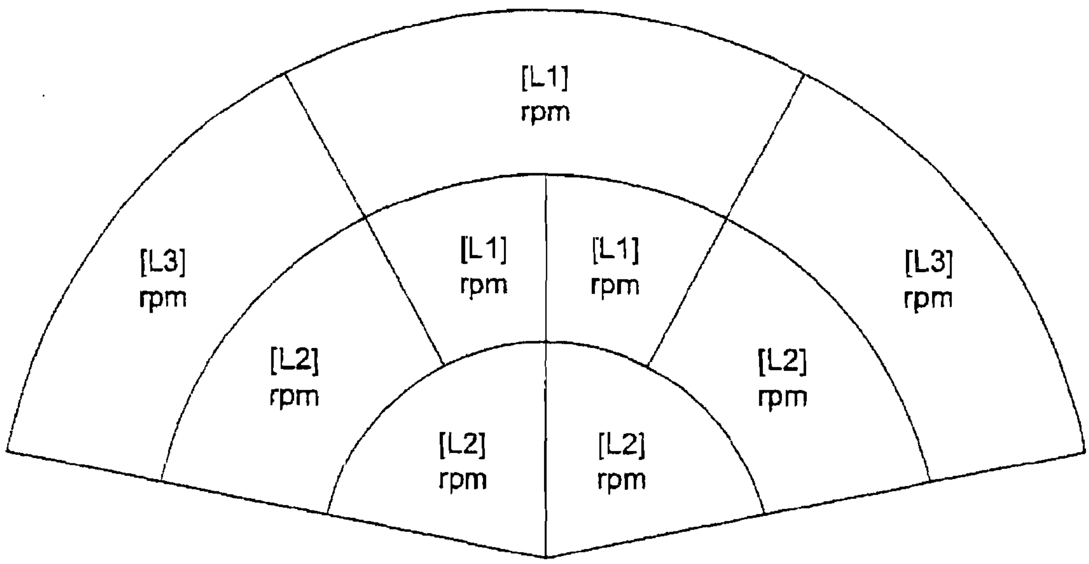

[L1]
rpm
[L3]
rpm
[L1]
rpm
[L1]
rpm
[L3]
rpm
[L2]
rpm
[L2]
rpm
[L2]
rpm
[L2]
rpm

Fig. 38

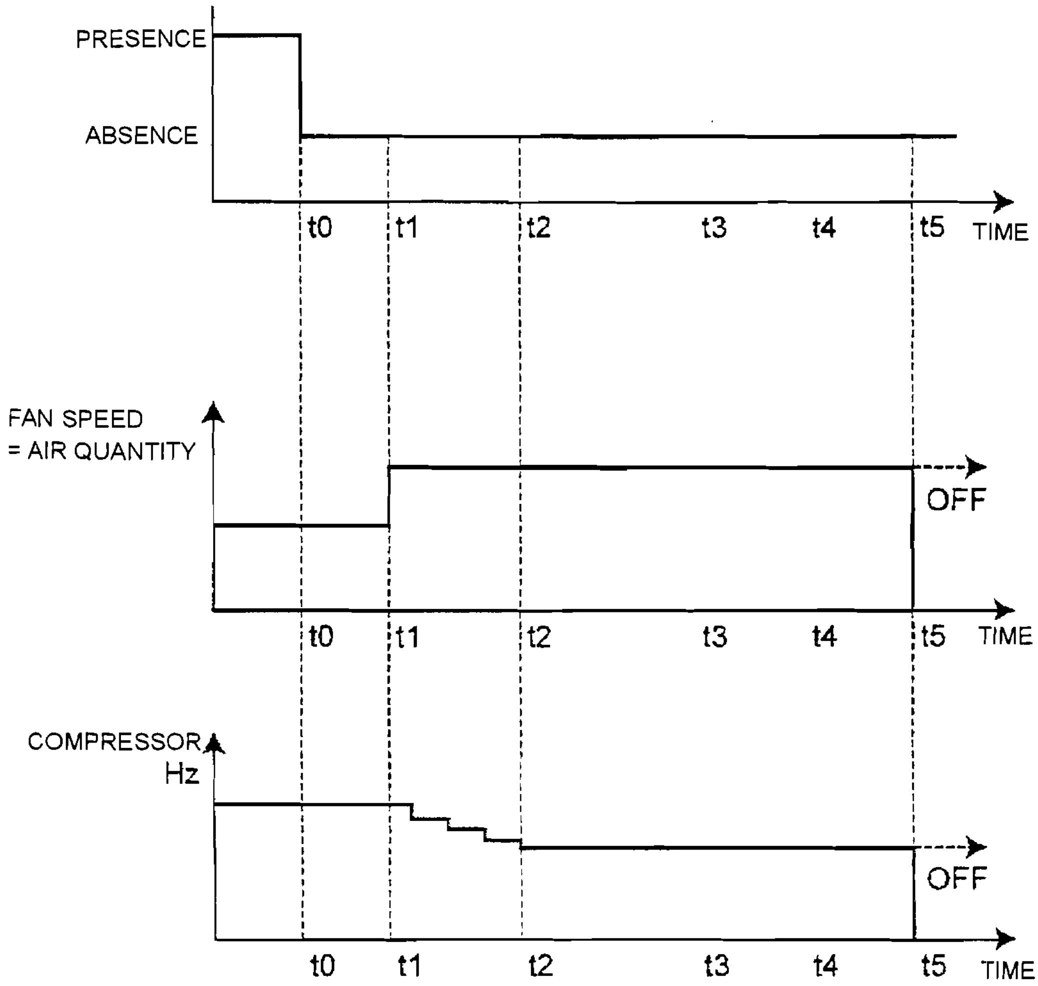

PRESENCE
ABSENCE
t0
t1
t2
t3
t4
t5
TIME
FAN SPEED
= AIR QUANTITY
OFF
t0
t1
t2
t3
t4
t5
TIME
COMPRESSOR
Hz
OFF
t0
t1
t2
t3
t4
t5
TIME

Fig. 39

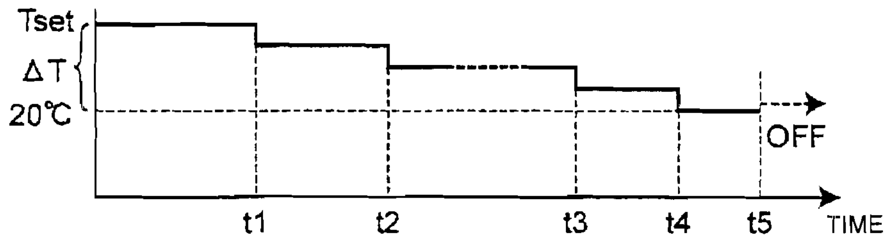
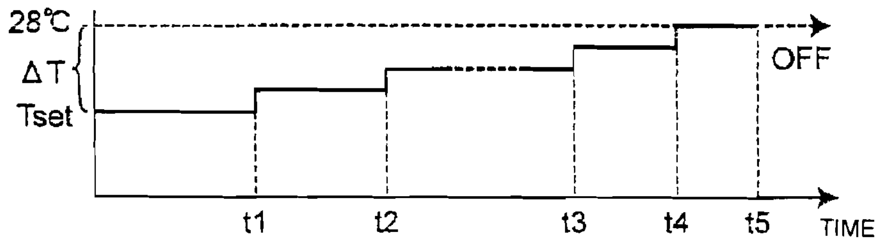

Tset
ΔT
20℃
OFF
t1
t2
t3
t4
t5
TIME

Fig. 40


28℃
ΔT
Tset
OFF
t1
t2
t3
t4
t5
TIME

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/003807

A. CLASSIFICATION OF SUBJECT MATTER
F24F13/28(2006.01)i, *F24F1/00*(2006.01)i, *F24F11/02*(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)
F24F13/28, F24F1/00, F24F11/02

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	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

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	JP 2007-24390 A (Matsushita Electric Industrial Co., Ltd.), 01 February, 2007 (01.02.07), Full text; all drawings (Family: none)	1-9
A	JP 2007-137282 A (Japan Climate Systems Corp.), 07 June, 2007 (07.06.07), Full text; all drawings (Family: none)	1-9
A	JP 2008-101875 A (Matsushita Electric Industrial Co., Ltd.), 01 May, 2008 (01.05.08), Full text; all drawings (Family: none)	1-9

☐ 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
16 March, 2009 (16.03.09)	31 March, 2009 (31.03.09)

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

Form PCT/ISA/210 (second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2005282873 A **[0006]**
- JP 2006234245 A **[0006]**
- JP 2006149538 A **[0006]**
- JP 2007021373 A **[0006]**