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(54) **AIR CONDITIONING INDOOR UNIT**

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(73) Proprietor: **Daikin Industries, Ltd.**
Osaka-shi, Osaka 530-8323 (JP)

(72) Inventors:
• **MORI, Takashige**
Kita-ku, Osaka-shi,
Osaka 530-8323 (JP)
• **FUJIOKA, Yuuki**
Kita-ku, Osaka-shi,
Osaka 530-8323 (JP)

• **NAKATA, Takahiro**
Kita-ku, Osaka-shi,
Osaka 530-8323 (JP)
• **MATSUBARA, Atsushi**
Kita-ku, Osaka-shi,
Osaka 530-8323 (JP)

(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

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Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] Generally, at the initial stage during a cooling operation, temperature distribution within the room is uneven. To solve this, in the case for example of the air conditioner apparatus disclosed in patent document 1 (Japanese Laid-open Patent Application No. 2004-108652), conditioned air is blown out forward and downward as a "strong" quantity of wind, causing airflow to reach every corner within the room.

[0003] In EP 2 484 986 A1 a control device for controlling the wing action of an air conditioning apparatus is described, wherein the control device comprises an operation mode determining section, a wing pattern storage area and a control command generator. The control command generator generates a control command of the air conditioning apparatus on the basis of a wing pattern corresponding to the result determined by the operation mode determining section from among the plurality of swing patterns.

SUMMARY OF THE INVENTION

<Technical Problem>

[0004] However, the temperature of the conditioned air at that initial stage is low, and the forward and downwardly directed blow directly applied to a person gives the occupant an unpleasant feeling, which is not desirable.

[0005] On the other hand, a condition arises in which once the room temperature stabilizes, the temperature of the conditioned air having risen, the conditioned air does not hit the person at all, which does not fulfill the wishes of the occupant, who seeks a feeling of coolness.

[0006] An object of the present invention is to provide an air conditioner indoor unit that, in the initial stage during the cooling operation, prevents wind hitting an occupant, and after the room temperature stabilizes, gives the occupant a feeling of coolness.

<Solution to Problem>

[0007] The present invention is defined by the appended independent claim 1. The respective dependent claims describe optional features and preferred embodiments.

[0008] An air conditioner indoor unit according to a first aspect of the present invention is capable of changing the direction of conditioned air blown out from an outlet port of said air conditioning unit, to a predetermined direction, and is provided with a wind direction adjusting

blade and a control portion. The wind direction adjusting blade changes the blowout angle of conditioned air in relation to a horizontal plane. The control portion is set to be able to choose wind direction automatic control changing the direction of the conditioned air automatically via the wind direction adjusting blade. This wind direction automatic control includes at least an upper airflow mode and an upward and downward wind direction mode. The upper airflow mode controls the direction of conditioned air to be horizontal or upward. The upward and downward wind direction mode applies conditioned air to a person, while causing the wind direction of the conditioned air to change upwardly and downwardly. Further, the control portion, when wind direction automatic control is selected in the cooling operation, is for implementing the upper airflow mode in the state in which room temperature is not in the stable region, and is for implementing the upward and downward wind direction mode in the state in which room temperature is in the stable region, wherein the stable region is within a target temperature range based on temperatures as set, the air conditioner indoor unit is further provided with a Coanda blade provided in the vicinity of the outlet port, for forming the conditioned air into a Coanda airflow caused to follow the lower face of the blade itself, guided in a predetermined direction, wherein, in the upper airflow mode, the Coanda blade is configured to form the conditioned air into an upwardly directed Coanda airflow, and in the upward and downward wind direction mode, said air conditioner indoor unit is configured to generate fluctuating airflow by mixing a plurality of patterns of wind direction change and while generating fluctuating airflow the air conditioner indoor unit is further configured to mix timeslots for generating the Coanda airflow and timeslots for not generating the Coanda airflow.

[0009] With this air conditioner indoor unit, when the room temperature is not in the stable region, the upper airflow mode is implemented in order to cause airflow to reach into all the corners of the room. Then, as the temperature of conditioned air has risen when the room temperature has entered the stable region, by implementing the upward and downward wind direction mode, wind is applied to the occupant who can be given a feeling of coolness.

[0010] Furthermore, with this air conditioner indoor unit, the direction of airflow of conditioned air is caused to swing upward and downward by the wind direction adjusting blade, and as the pattern of conditioned air gradually approaching and gradually receding from the occupant changes each time, the occupant can be given a more comfortable feeling of coolness than when a fixed wind direction is applied. In the case in which the stable region is made the state in which the room temperature has become within the set temperatures, as there is a possibility that due to the outside air temperature and the like, the stable region cannot be attained, it is more reasonable that the stable region is made "within a target temperature range based on temperatures as set" that

is given some degree of leeway.

[0011] Additionally, with this air conditioner indoor unit, the conditioned air is formed by the Coanda effect into an upwardly directed Coanda airflow, and is able to reach further. Thus, even in the case in which there is a substantial distance in both the height from the outlet to the ceiling and the distance from the outlet to the opposing wall, conditioned air can be caused to reach uniformly through the space to be air-conditioned.

[0012] Yet, with this air conditioner indoor unit, when conditioned air is being applied to the occupant, the conditioned air stops being applied to the occupant simultaneous with Coanda airflow starting, while the conditioned air is applied to the occupant simultaneous with the Coanda effect stopping, such that the occupant feels wind close to "unexpectedly blowing, natural wind".

[0013] An air condition indoor unit according to a second aspect of the present invention is the air conditioner indoor unit according to the first aspect, wherein the stable region is within a target temperature range based on temperatures as set.

[0014] An air conditioner indoor unit according to a third aspect of the present invention is the air conditioner indoor unit according to the first aspect, further provided with a temperature sensor installed in the suction passage sucking in the inside air. When the temperature detected by the temperature sensor is within the target temperature range, the control portion is configured to determine that the room temperature is in the stable region.

[0015] With this air conditioner indoor unit, considering the fact that usually, a temperature sensor used for detecting room temperature is installed within the suction passage, it is reasonable to use that temperature sensor for judging whether or not the room temperature is within the stable region.

[0016] An air conditioner indoor unit according to a fourth aspect of the present invention is the air conditioner indoor unit according to the first aspect, in which in the upper airflow mode, the air conditioner indoor unit is configured to generate a cyclical airflow so that conditioned air cycles within the room.

[0017] With this air conditioner indoor unit, conditioned air is circulated along, in order, each surface being the ceiling surface, the wall surface and the floor surface, such that conditioned air reaches throughout the entire room, and temperature distribution readily becomes uniform.

<Advantageous Effects of Invention>

[0018] With the air conditioner indoor unit according to the first aspect of the present invention, when the room temperature is not in the stable region, the upper airflow mode is implemented in order to cause airflow to reach every corner within the room. As the temperature of the conditioned air has risen when the room temperature has entered the stable region, by implementing the upward

and downward wind direction mode, wind is applied to the occupant who can be given a feeling of coolness.

[0019] Furthermore, the direction of airflow of conditioned air is caused to swing upward and downward by the wind direction adjusting blade, and as the pattern of conditioned air gradually approaching and gradually receding from the occupant changes each time, the occupant can be given a more comfortable feeling of coolness than when a fixed wind direction is applied. In the case in which the stable region is made the state in which the room temperature has become within the set temperatures, as there is a possibility that due to the outside air temperature and the like, the stable region cannot be attained, it is more reasonable that the stable region is made "within a target temperature range based on temperatures as set" that is given some degree of leeway.

[0020] Additionally, with the air conditioner indoor unit of the present invention, the conditioned air is formed by the Coanda effect into an upwardly directed Coanda airflow, and is able to reach further. Thus, even in the case in which there is a substantial distance in both the height from the outlet to the ceiling and the distance from the outlet to the opposing wall, conditioned air can be caused to reach uniformly through the space to be air-conditioned.

[0021] Yet, with the air conditioner indoor unit of the present invention, when conditioned air is being applied to the occupant, the conditioned air stops being applied to the occupant simultaneous with Coanda airflow starting, while the conditioned air is applied to the occupant simultaneous with the Coanda effect stopping, such that the occupant feels wind close to "unexpectedly blowing, natural wind".

[0022] With the air conditioner indoor unit according to the second aspect of the present invention, the stable region is within a target temperature range based on temperatures as set.

[0023] With the air conditioner indoor unit according to the third aspect of the present invention, considering the fact that usually, a temperature sensor used for detecting room temperature is installed within the suction passage, it is reasonable to use that temperature sensor for judging whether or not the room temperature is within the stable region.

[0024] With the air conditioner indoor unit according to the fourth aspect of the present invention, conditioned air is circulated along, in order, each surface being the ceiling surface, the wall surface and the floor surface, such that conditioned air reaches throughout the entire room, and temperature distribution readily becomes uniform.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

FIG. 1 is a cross-sectional view of an air conditioner indoor unit according to an embodiment of the

present invention, during operation shutdown;
 FIG. 2 is a cross-sectional view of the air conditioner indoor unit during operation;
 FIG. 3A is a side view of the wind direction adjusting blade and the Coanda blade during normal forward blow of conditioned air;
 FIG. 3B is a side view of the wind direction adjusting blade and the Coanda blade during normal forward-downward blow of conditioned air;
 FIG. 3C is a side view of the wind direction adjusting blade and the Coanda blade during Coanda airflow forward blow;
 FIG. 3D is a side view of the wind direction adjusting blade and the Coanda blade during Coanda airflow ceiling directed blow;
 FIG. 4A is a conceptual diagram showing the direction of conditioned air and the direction of the Coanda airflow;
 FIG. 4B is a conceptual diagram showing an example of the opening angles of the wind direction adjusting blade and the Coanda blade;
 FIG. 5A is a comparative view showing, during Coanda airflow forward blow, the interior angle formed between the tangential line of scroll termination F and the Coanda blade, and the interior angle formed between the tangential line of scroll termination F and the wind direction adjusting blade;
 FIG. 5B is a comparative view showing, during Coanda airflow ceiling blow, the interior angle formed between the tangential line of scroll termination F and the Coanda blade, and the interior angle formed between the tangential line of scroll termination F and the wind direction adjusting blade;
 FIG. 6A is a side view of an air conditioner indoor unit installation space indicating the wind direction of conditioned air from the upward and downward swing of the wind direction adjusting blade;
 FIG. 6B is a side view of the air conditioner indoor unit installation space showing the wind direction of conditioned air when the wind direction adjusting blade is downwardly directed;
 FIG. 6C is a side view of the air conditioner indoor unit installation space showing the wind direction of the Coanda airflow when the posture of the Coanda blade is the ceiling blow posture;
 FIG. 7 is a flowchart showing the operation of the wind direction adjusting blade and the Coanda blade during fluctuating airflow control;
 FIG. 8 is a flowchart showing cyclical airflow control from the wind direction adjusting blade; and
 FIG. 9 is a flowchart showing cyclical airflow control from the wind direction adjusting blade and the Coanda blade.

DESCRIPTION OF EMBODIMENTS

[0026] An embodiment of the present invention will now be described with reference to the drawings, it being

understood that the embodiment described following is a basic example that is illustrative of the present invention and not intended to restrict the technical scope of the present invention.

(1) Overall configuration of the air conditioner indoor unit 10

[0027] FIG. 1 is a cross-sectional view of an air conditioner indoor unit 10 according to the first embodiment of the present invention during operation shutdown. FIG. 2 is a cross-sectional view of the air conditioner indoor unit 10 during operation. In FIG. 1 and FIG. 2 the air conditioner indoor unit 10 is a wall-mounted type, provided with a body casing 11, an indoor heat exchanger 13, an indoor fan 14, a bottom frame 16, and a control portion 40.

[0028] The body casing 11 has a top surface portion 11a, a front panel 11b, a back plate 11c and a lower horizontal plate 11d, while housed inside are the indoor heat exchanger 13, the indoor fan 14, the bottom frame 16 and the control portion 40.

[0029] The top surface portion 11a is located to the top of the body casing 11, a suction inlet (not shown in the drawing) being provided in the front portion thereof.

[0030] The front panel 11b constitutes the front surface portion of the indoor unit, having a flat form with no suction inlet. Further, the upper end of the front panel 11b is rotatably supported to the top surface portion 11a, and the front panel 11b is able to operate as a hinge.

[0031] The indoor heat exchanger 13 and the indoor fan 14 are attached to the bottom frame 16. The indoor heat exchanger 13 performs heat exchange by exchange with through-passing air. Further, the indoor heat exchanger 13, in the side view, forms an inverted V-shape with both ends bent downward, the indoor fan 14 being located below. The indoor fan 14 is a cross flow fan, applying air taken in from inside the room to the indoor heat exchanger 13 and causing this to pass through the indoor heat exchanger 13, then blowing out inside the room.

[0032] An outlet 15 is provided in the lower portion of the body casing 11. A wind direction adjusting blade 31 that changes the direction of conditioned air blown out from the outlet 15 is installed to the outlet 15 so as to be able to rotate freely. The wind direction adjusting blade 31, driven by a motor (not shown in the drawing), not only changes the direction of the conditioned air, but also can open and close the outlet 15. The wind direction adjusting blade 31 can take multiple postures of differing angles of inclination.

[0033] Further, a Coanda blade 32 is provided in the vicinity of the outlet 15. The Coanda blade 32, driven by a motor (not shown in the drawing), is able to take postures inclined along the forward-rearward direction, and during operation shutdown is housed in a housing portion 130 provided to the front panel 11b. The Coanda blade 32 can take multiple postures of differing angles of inclination.

[0034] The outlet 15 is linked to the inside of the body casing 11 by an outlet passage 18. The outlet passage 18 is formed following a scroll 17 of the bottom frame 16 from the outlet 15.

[0035] Indoor air is sucked in by the operation of the indoor fan 14 into the indoor fan 14, passing via the suction inlet and the indoor heat exchanger 13, and is blown from the indoor fan 14 out from the outlet 15, after passing via the outlet passage 18.

[0036] The control portion 40 is located to the right side of the indoor heat exchanger 13 and the indoor fan 14, viewing the body casing 11 from the front panel 11b, and controls the rotation speed of the indoor fan 14 and the operation of the wind direction adjusting blade 31 and the Coanda blade 32.

(2) Detailed configuration

(2-1) Front panel 11b

[0037] As shown in FIG. 1, the front panel 11b extends towards the front edge of the lower horizontal plate 11d while drawing a gently arcing curved surface from the front at the top of the body casing 11. A recessed region is toward the inner side of the body casing 11, at the lower portion of the front panel 11b. The depth of the recession is set so as to match the dimensions of the thickness of the Coanda blade 32, forming the housing portion 130 accommodating the Coanda blade 32. The surface of the housing portion 130 also is a gently arcing curved surface.

(2-2) Outlet 15

[0038] As shown in FIG. 1, the outlet 15 is formed in the lower portion of the body casing 11, and is a rectangular opening, the length to the lateral direction (the direction orthogonal to the page of FIG. 1). The lower end of the outlet 15 is in contact with the front edge of the lower horizontal plate 11d, a virtual surface connecting the lower end and the upper end of the outlet 15 inclining forward and upward.

(2-3) Scroll 17

[0039] The scroll 17 is a partition wall curved so as to oppose the indoor fan 14, and is a part of the bottom frame 16. The termination F of the scroll 17 reaches the vicinity of the periphery of the outlet 15. Air passing through the outlet passage 18 advances following the scroll 17, and is delivered in the tangential direction of the termination F of the scroll 17. Accordingly, if the wind direction adjusting blade 31 is not over the outlet 15, the wind direction of conditioned air blown out from the outlet 15 is substantially the direction along the tangential line LO of the termination F of the scroll 17.

(2-4) Perpendicular wind direction adjusting blade 20

[0040] The perpendicular wind direction adjusting blade 20, as shown in FIG. 1 and FIG. 2, has a plurality of blade pieces 201 and a connecting rod 203 connecting the plurality of blade pieces 201. Further, the perpendicular wind direction adjusting blade 20 is arranged, in the outlet passage 18, closer to the indoor fan 14 than the wind direction adjusting blade 31.

[0041] The plurality of blade pieces 201, due to the horizontal reciprocal movement of the connecting rod 203 following the longitudinal direction of the outlet 15, swing left-right centered on a vertical condition in relation to that longitudinal direction. Note that the connecting rod 203 is driven in the horizontal reciprocal movement by a motor (not shown in the drawing).

(2-5) Wind direction adjusting blade 31

[0042] The wind direction adjusting blade 31 has an area of an extent that enables blocking of the outlet 15. In the state in which the wind direction adjusting blade 31 has closed the outlet 15, the outside surface 31a finishes as a convex, gently arcing curved surface on the outside, as if extending along the curved surface of the front panel 11b. Further the inner surface 31b of the wind direction adjusting blade 31 (refer FIG. 2) also forms an arcing curved surface substantially parallel to the outside.

[0043] The wind direction adjusting blade 31 has a rotating shaft 311 at the lower end portion thereof. The rotating shaft 311 links to the rotating shaft of a stepping motor (not shown in the drawing) secured to the body casing 11 in the vicinity of the lower end of the outlet 15.

[0044] By turning of the rotating shaft 311 in the anti-clockwise direction in the front view of FIG. 1, the upper end of the wind direction adjusting blade 31 recedes from the upper end side of the outlet 15, opening the outlet 15, while by turning of the rotating shaft 311 in the clockwise direction in the front view of FIG. 1, the upper end of the wind direction adjusting blade 31 moves closer to the upper end side of the outlet 15, closing the outlet 15.

[0045] In the condition in which the wind direction adjusting blade 31 has opened the outlet 15, conditioned air blown out from the outlet 15 flows substantially along the inner surface 31b of the wind direction adjusting blade 31. That is, the wind direction of the conditioned air blown out substantially following the tangential direction of the termination F of the scroll 17, is changed to be somewhat upwardly directed by the wind direction adjusting blade 31.

(2-6) Coanda blade 32

[0046] The Coanda blade 32 is housed in the housing portion 130 during air conditioning operations shut down or during operation of normal blowout mode described subsequently. The Coanda blade 32 moves away from the housing portion 130 by rotating. A rotating shaft 321

of the Coanda blade 32 is provided in the vicinity of the lower end of the housing portion 130, positioned to the inner side of the body casing 11 (a position above the upper wall of the outlet passage 18), the lower end portion of the Coanda blade 32 and the rotating shaft 321 being connected maintaining a predetermined distance. Thus to the extent that, as the rotating shaft 321 turns, the Coanda blade 32 moves away from the housing portion 130 of the indoor unit front surface portion, the height position of the lower end of the Coanda blade 32 turns so as to lower. Further, the inclination when the Coanda blade 32 turns and opens is more gradual than the inclination of the indoor unit front surface portion.

[0047] In this embodiment, the housing portion 130 is provided outside of the wind blast passage, and when housed, the entirety of the Coanda blade 32 is accommodated to the outside of the wind blast passage. Instead of this configuration, it is also suitable for only part of the Coanda blade 32 to be housed outside the wind blast passage, and for the remainder to be accommodated within the wind blast passage (for example the upper wall portion of the wind blast route).

[0048] Further, as the rotating shaft 321 turns in the anti-clockwise direction in the front view of FIG. 1, the upper end and the lower end of the Coanda blade 32 move away from the housing portion 130, drawing an arc, at which time, the minimum distance between that upper end and the housing portion 130 of the indoor unit front surface portion, above the outlet 15, is greater than the minimum distance between that lower end and the housing portion 130. That is, the Coanda blade 32 is controlled to a posture moving away from the indoor unit front surface portion in accordance with forward movement. As the rotating shaft 321 turns in the clockwise direction in the front view of FIG. 1, the Coanda blade 32 approaches the housing portion 130 and finally is accommodated therein. The postures for the conditions of operation of the Coanda blade 32, are the state of the Coanda blade 32 being accommodated in the housing portion 130, rotated, inclining the posture forward and upward, further rotated, the posture becoming largely horizontal, and further rotated, inclining the posture forward and downward.

[0049] In the state in which the Coanda blade 32 is accommodated in the housing portion 130, the outside surface 32a of the Coanda blade 32 finishes as a convex, gently arcing curved surface on the outside, as if extending the gently arcing curved surface of the front panel 11b. Further, the inner surface 32b of the Coanda blade 32 finishes as an arc curved surface following the surface of the housing portion 130.

[0050] Further, the dimensions in the longitudinal direction of the Coanda blade 32 are set so as to be greater than the dimensions in the longitudinal direction of the wind direction adjusting blade 31. The reason is that all conditioned air having the wind direction adjusted by the wind direction adjusting blade 31 is received at the Coanda blade 32, the purpose being to prevent conditioned air short-circuiting from the side direction of the Coanda

blade 32.

(3) Directional control of conditioned air

[0051] The air conditioner indoor unit according to this embodiment has, as a means for controlling the directionality of conditioned air, a normal blowout mode that causes rotation of only the wind direction adjusting blade 31, adjusting the direction of conditioned air, and a Coanda airflow effect using mode, that causes rotation of the wind direction adjusting blade 31 and the Coanda blade 32, with conditioned air, due to the Coanda effect, becoming Coanda airflow following the outside surface 32a of the Coanda blade 32.

[0052] The wind direction adjusting blade 31 and the Coanda blade 32 change posture for each blowout direction of air in each of the above modes, and these postures will now be described with reference to the drawings. Note that selection of the blowout direction is performed by a user via for example, a remote control or the like. Further, it is possible to control the mode change or blowout direction so as to change automatically.

(3-1) Normal blowout mode

[0053] The normal blowout mode is a mode that causes rotation of the wind direction adjusting blade 31 only, for adjusting the direction of conditioned air, and includes "normal forward blow" and "normal forward-downward blow".

(3-1-1) Normal forward blow

[0054] FIG. 3A is a side view of the wind direction adjusting blade 31 and the Coanda blade 32 during normal forward blow of conditioned air. In FIG. 3A, when the user selects "normal forward blow", the control portion 40 causes rotation of the wind direction adjusting blade 31 until the inner surface 31b of the wind direction adjusting blade 31 reaches a position roughly horizontal. Note that in the case as in this embodiment, in which the inner surface 31b of the wind direction adjusting blade 31 forms an arcing curved, the wind direction adjusting blade 31 is caused to rotate such that the tangential line for the forward end E1 of the inner surface 31b becomes roughly horizontal. Resultantly, the conditioned air is in the forward blow condition.

(3-1-2) Normal forward-downward blow

[0055] FIG. 3B is a side view of the wind direction adjusting blade 31 and the Coanda blade 32 during normal forward-downward blow of conditioned air. In FIG. 3B, when the user wants the blowout direction facing further downward than "normal forward blow", the user selects "normal forward-downward blow".

[0056] Here, the control portion 40 causes rotation of the wind direction adjusting blade 31 until the tangential

line for the forward end E1 of the inner surface 31b of the wind direction adjusting blade 31 becomes more forward falling than horizontal. Resultantly, the conditioned air is in the forward-downward blow condition.

(3-1-3) Automatic wind direction

[0057] FIG. 6A is a side view of a space for installation of the air conditioner indoor unit indicating the wind direction of conditioned air from the upward and downward swing of the wind direction adjusting blade 31. Wind direction adjustment as shown in FIG. 6A, also found in existing products, is what is known as wind direction adjustment through auto louver function, employing means for repeating an operation to apply wind and an operation to not apply wind to a human 400.

(3-2) Coanda effect using mode

[0058] Coanda (effect) is a phenomena in which if there is a wall near a flow of gas or liquid, even if the direction of the flow and the direction of the wall are different, the flow direction comes to follow the wall surface ("Hōsoku no Jiten (Legal Dictionary)", Asakura Publishing Co., Ltd.). The Coanda effect using mode includes "Coanda airflow forward blow" and "Coanda airflow ceiling blow", using the Coanda effect.

[0059] Further, while in respect of the direction of the conditioned air and the direction of Coanda airflow, the method of definition differs according to how the reference position is taken, an example will now be provided. Fig. 4A is a conceptual diagram showing the direction of conditioned air and the direction of the Coanda airflow. In FIG. 4A, generating Coanda effect at the outside surface 32a side of the Coanda blade 32 requires that the inclination of the direction (D1) of conditioned air as changed by the wind direction adjusting blade 31 becomes close to the posture (inclination) of the Coanda blade 32, and if both those blades are too removed the Coanda effect does not arise. Thus, in the Coanda effect using mode it is necessary that the Coanda blade 32 and the wind direction adjusting blade 31 are equal to or at less than a predetermined angle of opening, that both blades (31, 32) are made within that range, such that the above described relationship is formed. Thus, as shown in FIG. 4A, after the wind direction of the conditioned air is changed to D1 by the wind direction adjusting blade 31, the wind direction is further changed by the Coanda effect to D2.

[0060] Further, with the Coanda effect using mode according to this embodiment, it is preferable that the Coanda blade 32 be located forward of (downstream side of blowout) and above the wind direction adjusting blade 31.

[0061] Again, while in respect of the angle of opening of the wind direction adjusting blade 31 and the Coanda blade 32, the method of definition differs according to how the reference position is taken, an example will now be provided. Fig. 4B is a conceptual diagram showing an

example of the opening angles of the wind direction adjusting blade 31 and the Coanda blade 32. In FIG. 4B, when the angle of the horizontal line and the straight line joining the front and rear ends of the inner surface 31b of the wind direction adjusting blade 31 is made the angle of inclination $\theta 1$ of the wind direction adjusting blade 31, and the angle of the horizontal line and the straight line joining the front and rear ends of the outside surface 32a of the Coanda blade 32 is made the angle of inclination $\theta 2$ of the Coanda blade 32, the opening angles of the wind direction adjusting blade 31 and the Coanda blade 32 are $\theta = \theta 2 - \theta 1$. Note that $\theta 1$ and $\theta 2$ are not absolute values, and in the case of being below the horizontal line in the front view of FIG. 4B, are negative values.

[0062] With both "Coanda airflow forward blow" and "Coanda airflow ceiling blow", it is preferable that the wind direction adjusting blade 31 and the Coanda blade 32 take a posture that fulfills the condition in which the interior angle formed by the tangential line of termination F of the scroll 17 and the Coanda blade 32, is greater than the interior angle formed by the tangential line of termination F of the scroll 17 and the wind direction adjusting blade 31.

[0063] Concerning these interior angles, referring to FIG. 5A and FIG. 5B, FIG. 5A comparing, during Coanda airflow forward blow, the interior angle R2 formed by the tangential line L0 of the termination F of the scroll 17 and the Coanda blade 32, and the interior angle R1 formed by the tangential line L0 of the termination F of the scroll 17 and the wind direction adjusting blade 31; and FIG. 5B comparing, during Coanda airflow ceiling blow, the interior angle R2 formed by the tangential line L0 of the termination F of the scroll 17 and the Coanda blade 32, and the interior angle R1 formed by the tangential line L0 of the termination F of the scroll 17 and the wind direction adjusting blade 31.

[0064] Further, as shown in FIG. 5A and FIG. 5B, with the Coanda blade 32 in the Coanda effect using mode, the tip end portion of the Coanda blade 32 being forward and above horizontal, is positioned further outside and above the outlet 15. Resultantly, the Coanda airflow reaches further, there is suppressed generation of strong airflow passing to the upper side of the Coanda blade 32, and upward guidance of Coanda airflow is less inhibited.

[0065] Again, as the height position of the rear end portion of the Coanda blade 32 becomes lower than during operation shutdown, Coanda airflow from the Coanda effect at the upstream side is generated easily.

(3-2-1) Coanda airflow forward blow

[0066] FIG. 3C is a side view of the wind direction adjusting blade 31 and the Coanda blade 32 during Coanda airflow forward blow. In FIG. 3C, when "Coanda airflow forward blow" is selected, the control portion 40 rotates the wind direction adjusting blade 31 until the tangential line L1 for the forward end E1 of the inner surface 31b

of the wind direction adjusting blade 31 becomes more forward falling than horizontal.

[0067] Next, the control portion 40 rotates the Coanda blade 32 until the outside surface 32a of the Coanda blade 32 reaches a position roughly horizontal. Note that in the case as in this embodiment, in which the outside surface 32a of the Coanda blade 32 forms an arced curve, the Coanda blade 32 is caused to rotate such that the tangential line L2 for the forward end E2 of the outside surface 32a becomes roughly horizontal. That is, as shown in FIG. 5A, the interior angle R2 formed by the tangential line L0 and the tangential line L2 is greater than the interior angle R1 formed between the tangential line L0 and the tangential line L1.

[0068] The conditioned air adjusted to forward-downward blow at the wind direction adjusting blade 31, becomes, due to the Coanda effect, flow adhering to the outside surface 32a of the Coanda blade 32, changing to a Coanda airflow following the outside surface 32a.

[0069] Thus, though the direction of the tangential line L1 for the forward end E1 of the wind direction adjusting blade 31 is forward-downward blow, as the direction of the tangential line L2 for the forward end E2 of the Coanda blade 32 is horizontal, due to the Coanda effect, the conditioned air is blown out in the direction L2 for the forward end E2 of the outside surface 32a of the Coanda blade 32, that is to say the horizontal direction.

[0070] In this way, the Coanda blade 32 separates from the indoor unit front surface portion, the inclination becoming gradual, and the conditioned air becomes susceptible to Coanda effect further forward of the front panel 11b. Resultantly, though the conditioned air with wind direction adjusted at the wind direction adjusting blade 31 is forward-downward blow, this becomes, due to the Coanda effect, horizontally blown air. That is, in comparison to the method in which air, immediately after passing through the outlet, approaches the front panel, and is upwardly directed by the Coanda effect of the front panel, pressure loss through ventilation resistance of the wind direction adjusting blade 31 is controlled while changing the wind direction.

(3-2-2) Coanda airflow ceiling blow

[0071] FIG. 3D is a side view of the wind direction adjusting blade 31 and the Coanda blade 32 during Coanda airflow ceiling blow. In FIG. 3D, when "Coanda airflow ceiling blow" is selected, the control portion 40 rotates the wind direction adjusting blade 31 until the tangential line L1 for the forward end E1 of the inner surface 31b of the wind direction adjusting blade 31 is horizontal.

[0072] Then, the control portion 40 rotates the Coanda blade 32 until the tangential line L2 for the forward end E2 of the outside surface 32a is directed forward and upward. That is, as shown in FIG. 5B, the interior angle R2 formed by the tangential line L0 and the tangential line L2 becomes greater than the interior angle R1 formed by the tangential line L0 and the tangential line L1. The

conditioned air adjusted to horizontal blow at the wind direction adjusting blade 31, due to the Coanda effect, flows adhering to the outside surface 32a of the Coanda blade 32, changing to this Coanda airflow following the outside surface 32a.

[0073] Accordingly, though the direction of the tangential line L1 for the forward end E1 of the wind direction adjusting blade 31 is forward blow, as the direction of the tangential line L2 for the forward end E2 of the Coanda blade 32 is forward-upward blow, due to the Coanda effect, the conditioned air is blown out in the direction L2 for the forward end E2 of the outside surface 32a of the Coanda blade 32, that is to say the direction toward the ceiling. As the tip end portion of the Coanda blade 32 projects to the outside of the outlet 15, the Coanda airflow reaches further. Moreover, as the tip end portion of the Coanda blade 32 is positioned above the outlet 15, there is suppressed generation of strong airflow passing to the upper side of the Coanda blade 32, and upward guidance of Coanda airflow is less inhibited.

[0074] In this way, the Coanda blade 32 separates from the indoor unit front surface portion, the inclination becoming gradual, and the conditioned air becomes susceptible to Coanda effect further forward of the front panel 11b. Resultantly, though the conditioned air with wind direction adjusted at the wind direction adjusting blade 31 is forward blow, this becomes, due to the Coanda effect, upwardly directed air.

[0075] Note that the dimensions in the longitudinal direction of the Coanda blade 32 are greater than the dimensions in the longitudinal direction of the wind direction adjusting blade 31. Thus all conditioned air having the wind direction adjusted by the wind direction adjusting blade 31 can be received at the Coanda blade 32, furnishing the effect of preventing conditioned air short-circuiting from the side direction of the Coanda blade 32.

(3-2-3) Unexpected breeze

[0076] FIG. 6B is a side view of the air conditioner indoor unit installation space showing the wind direction of conditioned air when the wind direction adjusting blade 31 is downwardly directed. Further, FIG. 6C is a side view of the air conditioner indoor unit installation space showing the wind direction of the Coanda airflow when the posture of the Coanda blade is the ceiling blow posture.

[0077] In FIG. 6B and FIG. 6C, wind directed to the human 400, as in FIG. 6B, changes to an upwardly directed Coanda airflow, as in FIG. 6C, through usage of the Coanda effect, thereafter, by performing the contrary operation, an unexpected breeze can be created and expelled, as if applied suddenly to the human 400.

[0078] For example, when the wind direction adjusting blade 31 directs conditioned air in the direction in which an occupant is, in the case of having the Coanda blade 32 in an irregular cycle, move so as to span the boundary area between the region in which Coanda effect is generated and the region in which Coanda effect is not gen-

erated, Coanda airflow is repeatedly generated and stopped, producing wind that is applied suddenly to the occupant.

(3-2-4) Fluctuating airflow

[0079] Fluctuating airflow is airflow generated by irregularly fluctuating the wind direction of conditioned air, and differs to automatic wind direction as described in (3-1-3) on the point that wind direction is irregularly fluctuated.

[0080] FIG. 7 is a flowchart showing operations of the wind direction adjusting blade 31 and the Coanda blade 32 during fluctuating airflow control. In FIG. 7, the wind direction adjusting blade 31 swings between an upper limit position and a lower limit position, interspersed by an operation of waiting in an intermediate position. The control portion 40 irregularly changes the time periods in which the wind direction adjusting blade 31 waits in the intermediate position (the intermediate position waiting time), so that by irregularly interchanging the combination of wind approaching the occupant and wind receding from the occupant, the occupant is provided with a variety of wind.

[0081] Moreover, the Coanda blade 32 swings between an upper limit position and a lower limit position. As shown in FIG. 7, fluctuating airflow control includes a first pattern in which, while the Coanda blade 32 swings between the upper limit position and the lower limit position, the wind direction adjusting blade 31 swings between the upper limit position and the intermediate position, and a second pattern in which, while the Coanda blade 32 waits in the upper limit position, the wind direction adjusting blade 31 swings between the intermediate position and the lower limit position.

[0082] In the first pattern, the operation of the Coanda blade 32 swinging from the upper limit position toward the lower limit position synchronizes with the timing of the wind direction adjusting blade 31 swinging from the intermediate position toward the upper limit position. Further, the operation of the Coanda blade 32 swinging from the lower limit position toward the upper limit position synchronizes with the timing of the wind direction adjusting blade 31 swinging from the upper limit position toward the intermediate position.

[0083] When the wind direction adjusting blade 31 is in the intermediate position, the Coanda blade 32 is controlled so as to be in the upper limit position so Coanda airflow is not generated. Accordingly, by changing the intermediate position waiting time of the wind direction adjusting blade 31 irregularly, the times during which Coanda airflow is not generated change irregularly, interspersed irregularly with intervals of wind unexpectedly blowing, enabling the occupant to be provided with a variety of winds.

[0084] Thus, fluctuating airflow is generated by mixing a plurality of wind direction change patterns, however the method of mixing the first pattern and the second pattern as described above is illustrative and not restrictive, and

fluctuating airflow can also be generated by the method of causing the intermediate position waiting time of the wind direction adjusting blade 31 in only the first pattern to change.

[0085] Note that in the intermediate position waiting time of the wind direction adjusting blade 31, as conditioned air is not caused to flow stably, in one direction, in this embodiment, the time of the wind direction adjusting blade 31 being in the intermediate position, and the time of the Coanda blade 32 being in the upper limit position are counted as waiting time.

[0086] Further, the control portion 40 can cause the respective times for the wind direction adjusting blade 31 waiting in the upper limit position and waiting in the lower limit position to change irregularly, and cause the times at which the Coanda blade 32 waits in the lower limit position to change irregularly.

[0087] In this way, as the wind direction adjusting blade 31 and the Coanda blade 32 swing irregularly, the occupant is able to be provided with conditioned air closer to natural wind.

(4) Cyclical airflow control during the cooling operation

[0088] This control implements the upper airflow mode controlling the direction of conditioned air to be horizontal or upwardly directed, in order to avoid giving a drafty feeling through applying cool wind when the cooling operation begins, and after the room temperature has stabilized, the upward and downward wind direction mode is implemented applying conditioned air to give the occupant a cool wind feeling.

(4-1) Cyclical airflow control from the wind direction adjusting blade 31

[0089] FIG. 8 is a flowchart showing cyclical airflow control from the wind direction adjusting blade 31. In FIG. 8 the control portion 40, at step S1, determines whether the current operation is the cooling operation, and if so, proceeds to step S2, while if not, continues step S1.

[0090] The control portion 40, at step S2, determines whether the room temperature T_r is stable, and if room temperature T_r is not stable, proceeds to step S3, while if room temperature T_r is stable, proceeds to step S5. Note that room temperature T_r is detected by a temperature sensor 49 provided to the suction inlet side of the body casing 11. Further, the room temperature T_r is within a target temperature range ($T_s \pm a$) based on set temperatures T_s .

[0091] At step S3, the control portion 40 generates cyclical airflow cycling inside the room while implementing the upper airflow mode. Note that the upper airflow mode is the mode which stops the posture of the wind direction adjusting blade 31 at the upper limit position shown in FIG. 6A, and makes conditioned air to reach throughout the interior of the room by the upward direction airflow.

[0092] At step S4, the control portion 40 again deter-

mines whether the room temperature T_r is stable, and if so proceeds to step S5, while if not, continues step S3.

[0093] At step S5, the control portion 40 implements the upward and downward wind direction mode, applying conditioned air to the occupant. Note that the upward and downward wind direction mode is the upward and downward wind direction shown in FIG. 6A.

[0094] Thus, when room temperature T_r is not stable, the upper airflow mode is implemented to cause airflow to reach into all of the corners in the room, and when room temperature T_r is stable, the conditioned air is able to give a cool feeling applied to the occupant by implementing the upward and downward wind direction mode.

(4-2) Cyclical airflow control from the wind direction adjusting blade 31 and the Coanda blade 32

[0095] FIG. 9 is a flowchart showing cyclical airflow control from the wind direction adjusting blade 31 and the Coanda blade 32. In FIG. 9, step S11, step S12 and step S14 are the same as step S1, step S2 and step S4 in FIG. 8, therefore an explanation of these steps is omitted here, while step S13 and step S14 only will now be described.

[0096] At step S13, "Coanda airflow ceiling blow" is applied as the upper airflow mode of step S3 in FIG. 8. With Coanda airflow ceiling blow conditioned air cycles following each of the surfaces, these being in order, the ceiling surface, the wall surface and the floor surface, such that conditioned air reaches throughout the interior of the room, and temperature distribution readily becomes uniform.

[0097] Further, at step S15, "fluctuating airflow" is applied as the upper wind direction mode of step S5 in FIG. 8. Fluctuating airflow is fluctuating airflow control as described with respect to FIG. 7, in which by irregularly swinging the wind direction adjusting blade 31 and the Coanda blade 32, conditioned air close to natural wind is applied to the occupant, giving a cooling feeling.

(5) Characteristics

(5-1)

[0098] With the air conditioner indoor unit 10, when the room temperature T_r is not within the target temperature range ($T_s \pm a$) based on the set temperatures T_s , the upper airflow mode is implemented in order to cause airflow to reach into all of the corners within the room. Then, when the room temperature T_r has become within the target temperature range as the temperature of the conditioned air has risen, by implementing the upward and downward wind direction mode, the wind can be applied to the occupant, giving a cooling feeling.

(5-2)

[0099] By applying "fluctuating airflow" as the upward

and downward wind direction mode, the flow of conditioned air is caused to swing upward and downward by the wind direction adjusting blade, and as the pattern of conditioned air gradually approaching and gradually receding from the occupant changes each time, the occupant can be given a more comfortable feeling of coolness than when a fixed wind is applied.

(5-3)

[0100] By applying "Coanda airflow ceiling blow" as the upper airflow mode, the flow of conditioned air becomes, due to the Coanda effect, upwardly directed Coanda airflow, and is able to reach further. That is, cyclical airflow that circulates is generated that circulates in the room. Thus, even in the case in which there is a substantial distance in both the height from the outlet to the ceiling and the distance from the outlet to the opposing wall, conditioned air can be caused to reach uniformly through the space to be air-conditioned.

(5-4)

[0101] Because in fluctuating airflow, time slots for generating Coanda airflow and time slots for not generating Coanda airflow are mixed, when conditioned air is being applied to the occupant the conditioned air stops being applied to the occupant simultaneous with Coanda airflow starting, while the conditioned air is applied to the occupant simultaneous with the Coanda effect stopping, enabling the occupant to feel wind close to "unexpectedly blowing, natural wind".

INDUSTRIAL APPLICABILITY

[0102] The present invention is capable of providing conditioned air closer to natural wind to an occupant as described above, and can be applied to not only a wall-mounted type air conditioner indoor unit, but also an air purifier.

REFERENCE SIGNS LIST

[0103]

- 10 Air conditioner indoor unit
- 15 Outlet
- 31 Wind direction adjusting blade
- 32 Coanda blade
- 40 Control portion

PATENT LITERATURE

Patent document 1

[0104] Japanese Laid-open Patent Application No. 2004-108652

Claims

1. An air conditioner indoor unit capable of changing the direction of conditioned air blown out from an outlet port (15) of said air conditioning unit to a pre-determined direction, provided with:

a wind direction adjusting blade (31), for changing the blowout angle of the conditioned air in relation to a horizontal plane; and
a control portion (40), through which wind direction automatic control for automatically changing the direction of the conditioned air via the wind direction adjustment blade (31) can be selectively set,

wherein the wind direction automatic control includes at least

an upper airflow mode for controlling the direction of the conditioned air to be horizontal or upward, and

an upward and downward wind direction mode for applying conditioned air to a person while causing the wind direction of the conditioned air to change upwardly and downwardly, and the control portion (40), when the wind direction automatic control is selected for the cooling operation,

is for implementing the upper airflow mode in the state in which the room temperature is not in a stable region, and

is for implementing the upward and downward wind direction mode in the state in which the room temperature is in the stable region,

wherein the stable region is within a target temperature range based on temperatures as set, **characterized in that**

the air conditioner indoor unit is further provided with a Coanda blade (32) provided in the vicinity of the outlet port (15), for forming the conditioned air into a Coanda airflow caused to follow the lower face of the blade itself, guided in a predetermined direction, wherein,

in the upper airflow mode,

the Coanda blade (32) is configured to form the conditioned air into an upwardly directed Coanda airflow, and

in the upward and downward wind direction mode, said air conditioner indoor unit is configured to generate fluctuating airflow by mixing a plurality of patterns of wind direction change and while generating fluctuating airflow the air conditioner indoor unit is further configured to mix timeslots for generating the Coanda airflow and timeslots for not generating the Coanda airflow.

2. The air conditioner indoor unit according to claim 1, further provided with a temperature sensor installed in the suction passage through which air from inside

the room is sucked in, wherein

when the temperature detected by the temperature sensor is within the target temperature range, the control portion (40) is configured to determine that the room temperature is in the stable region.

3. The air conditioner indoor unit according to claim 1, wherein
in the upper airflow mode, the air conditioner indoor unit is configured to generate a cyclical airflow so that the conditioned air cycles within the room.

Patentansprüche

1. Klimaanlageinnenraumeinheit, die fähig ist, die Richtung aufbereiteter Luft, die aus einer Auslassöffnung (15) der Klimaanlageinheit geblasen wird, in eine vorbestimmte Richtung zu ändern, versehen mit:

einem Windrichtungseinstellflügel (31) zum Ändern des Ausblaswinkels der aufbereiteten Luft in Bezug auf eine horizontale Ebene und

einem Steuerabschnitt (40), durch den eine automatische Windrichtungssteuerung zum automatischen Ändern der Richtung der aufbereiteten Luft über den Windrichtungseinstellflügel (31) selektiv eingestellt werden kann,

wobei die automatische Windrichtungssteuerung mindestens beinhaltet

einen oberen Luftstrommodus zum Steuern der Richtung der aufbereiteten Luft, so dass sie horizontal oder aufwärts ist, und

einen Aufwärts- und Abwärts-Windrichtungsmodus zum Aufbringen aufbereiteter Luft auf eine Person, während veranlasst wird, dass sich die Windrichtung der aufbereiteten Luft aufwärts und abwärts ändert, und

wobei der Steuerabschnitt (40), wenn die automatische Windrichtungssteuerung für den Kühlbetrieb ausgewählt ist,

zum Implementieren des oberen Luftstrommodus in dem Zustand, in dem die Raumtemperatur nicht in einem beständigen Bereich liegt, bestimmt ist, und

zum Implementieren des Aufwärts- und Abwärts-Windrichtungsmodus in dem Zustand, in dem die Raumtemperatur in einem beständigen Bereich liegt, bestimmt ist,

wobei der beständige Bereich innerhalb eines Zieltemperaturbereichs liegt, der auf Temperaturen, wie sie eingestellt sind, basiert,

dadurch gekennzeichnet, dass

die Klimaanlageinnenraumeinheit weiter versehen ist mit einem Coanda-Flügel (32), der in der Nähe der Auslassöffnung (15) vorgesehen ist, zum Formen der aufbereiteten Luft in einen

- Coanda-Luftstrom, der veranlasst wird, der unteren Fläche des Flügels selbst, in eine vorbestimmte Richtung geführt, zu folgen, wobei, in dem oberen Luftstrommodus, der Coanda-Flügel (32) konfiguriert ist, um die aufbereitete Luft in einen aufwärts gerichteten Coanda-Luftstrom zu formen, und in dem Aufwärts- und Abwärts-Windrichtungsmodus, die Klimaanlageinnenraumeinheit konfiguriert ist, um einen fluktuierenden Luftstrom durch Mischen einer Vielzahl von Mustern einer Windrichtungsänderung zu erzeugen, und während des Erzeugens eines fluktuierenden Luftstroms die Klimaanlageinnenraumeinheit weiter konfiguriert ist, um Zeitschlitze zum Erzeugen des Coanda-Luftstroms und Zeitschlitze zum Nicht-Erzeugen des Coanda-Luftstroms zu mischen.
2. Klimaanlageinnenraumeinheit nach Anspruch 1, die weiter mit einem Temperatursensor versehen ist, der in dem Ansaugdurchgang, durch den Luft von innerhalb des Raums angesaugt wird, installiert ist, wobei wenn die Temperatur, die von dem Temperatursensor erfasst wird, innerhalb des Zieltemperaturbereichs liegt, der Steuerabschnitt (40) konfiguriert ist, um zu bestimmen, dass die Raumtemperatur in dem beständigen Bereich liegt.
3. Klimaanlageinnenraumeinheit nach Anspruch 1, wobei in dem oberen Luftstrommodus, die Klimaanlageinnenraumeinheit konfiguriert ist, um einen zyklischen Luftstrom derart zu erzeugen, dass die aufbereitete Luft innerhalb des Raums zyklisch umläuft.

Revendications

1. Section intérieure de climatiseur capable de modifier la direction d'air conditionné soufflé depuis un orifice de sortie (15) de ladite section de climatisation vers une direction prédéterminée, pourvue de :
- une pale de réglage de direction du vent (31), pour modifier l'angle de soufflerie de l'air conditionné par rapport à un plan horizontal ; et une partie de commande (40), à travers laquelle une commande automatique de direction du vent pour modifier automatiquement la direction de l'air conditionné par l'intermédiaire de la pale de réglage de direction du vent (31) peut être sélectivement définie, dans laquelle la commande automatique de direction du vent inclut au moins un mode d'écoulement d'air supérieur pour commander la direction de l'air conditionné

comme étant horizontale ou vers le haut, et un mode de direction du vent vers le haut et vers le bas pour appliquer de l'air conditionné sur une personne tout en amenant la direction du vent de l'air conditionné à se modifier vers le haut et vers le bas, et la partie de commande (40), lorsque la commande automatique de direction du vent est sélectionnée pour l'opération de refroidissement, est destinée à mettre en œuvre le mode d'écoulement d'air supérieur dans l'état dans lequel la température ambiante n'est pas dans une région stable, et est destinée à mettre en œuvre le mode de direction du vent vers le haut et vers le bas dans l'état dans lequel la température ambiante est dans la région stable, dans lequel la région stable se trouve dans une plage de température cible basée sur des températures telles que définies,

caractérisée en ce que

la section intérieure de climatiseur est en outre pourvue d'une aube Coanda (32) fournie à proximité de l'orifice de sortie (15), pour former l'air conditionné dans un écoulement d'air Coanda amené à suivre la face inférieure de l'aube elle-même, guidé dans une direction prédéterminée, dans laquelle, dans le mode d'écoulement d'air supérieur, l'aube Coanda (32) est configurée pour former l'air conditionné dans un écoulement d'air Coanda dirigé vers le haut, et dans le mode de direction du vent vers le haut et vers le bas, ladite section intérieure de climatiseur est configurée pour générer un écoulement d'air fluctuant en mélangeant une pluralité de motifs de changement de direction du vent et, tout en générant un écoulement d'air fluctuant, la section intérieure de climatiseur est en outre configurée pour mélanger des créneaux temporels pour générer l'écoulement d'air Coanda et des créneaux temporels pour ne pas générer l'écoulement d'air Coanda.

2. Section intérieure de climatiseur selon la revendication 1, en outre pourvue d'un capteur de température installé dans le passage d'aspiration à travers lequel de l'air depuis l'intérieur de la pièce est aspiré, dans laquelle lorsque la température détectée par le capteur de température se trouve dans la plage de température cible, la partie de commande (40) est configurée pour déterminer que la température ambiante est dans la région stable.
3. Section intérieure de climatiseur selon la revendication 1, dans laquelle dans le mode d'écoulement d'air supérieur, la sec-

tion intérieure de climatiseur est configurée pour générer un écoulement d'air cyclique de sorte que l'air conditionné fluctue dans la pièce.

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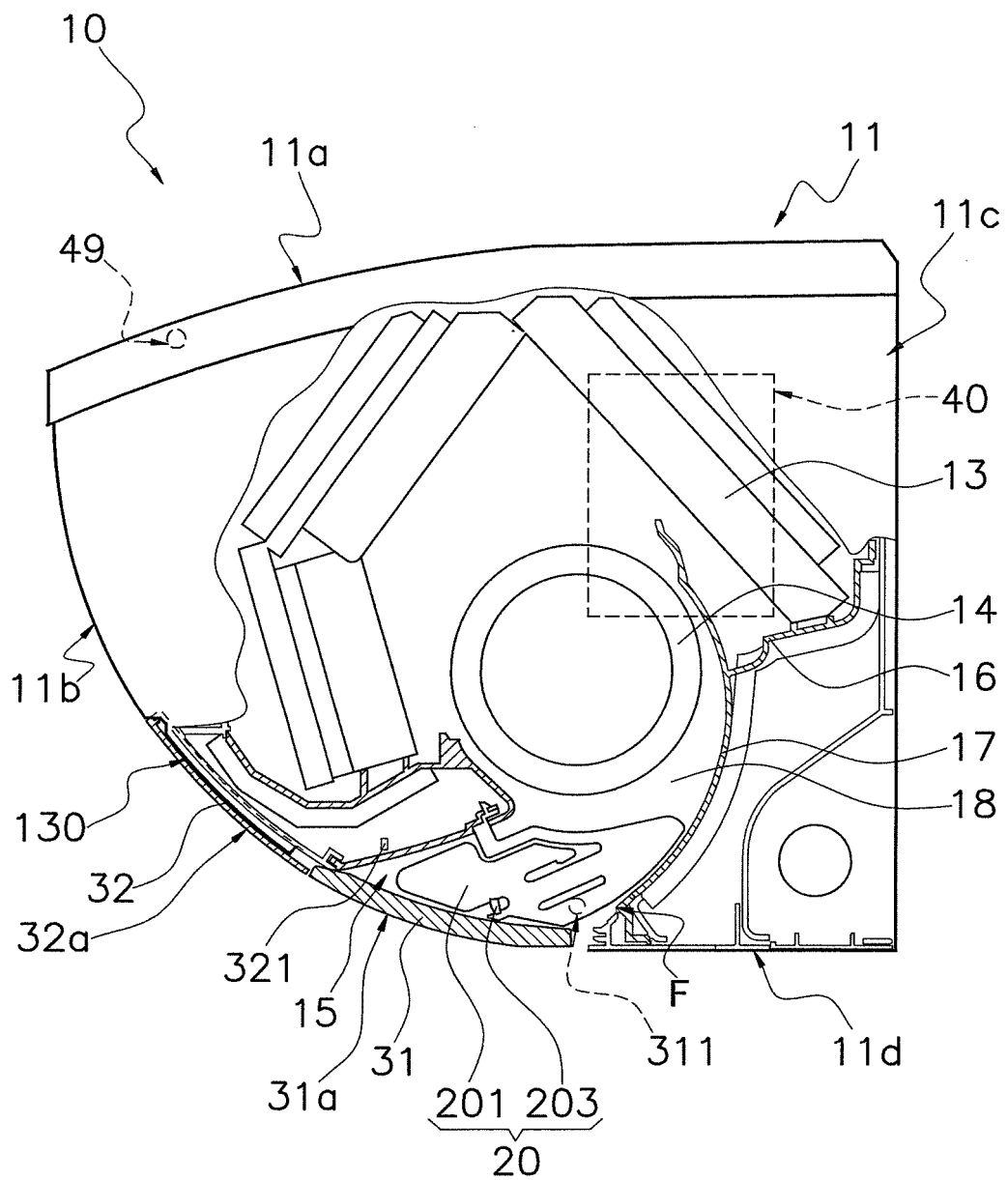


FIG. 1

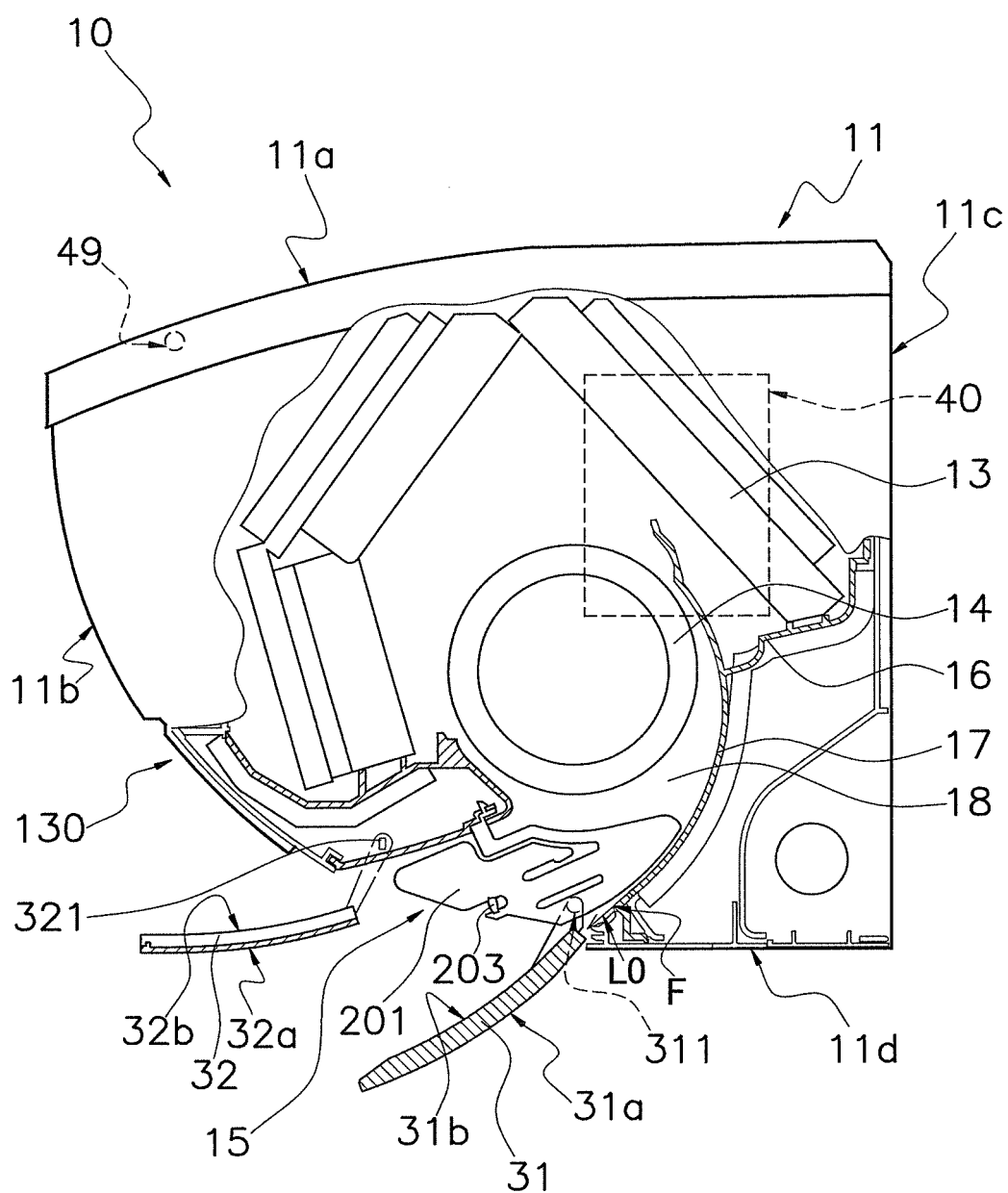


FIG. 2

FIG. 3A

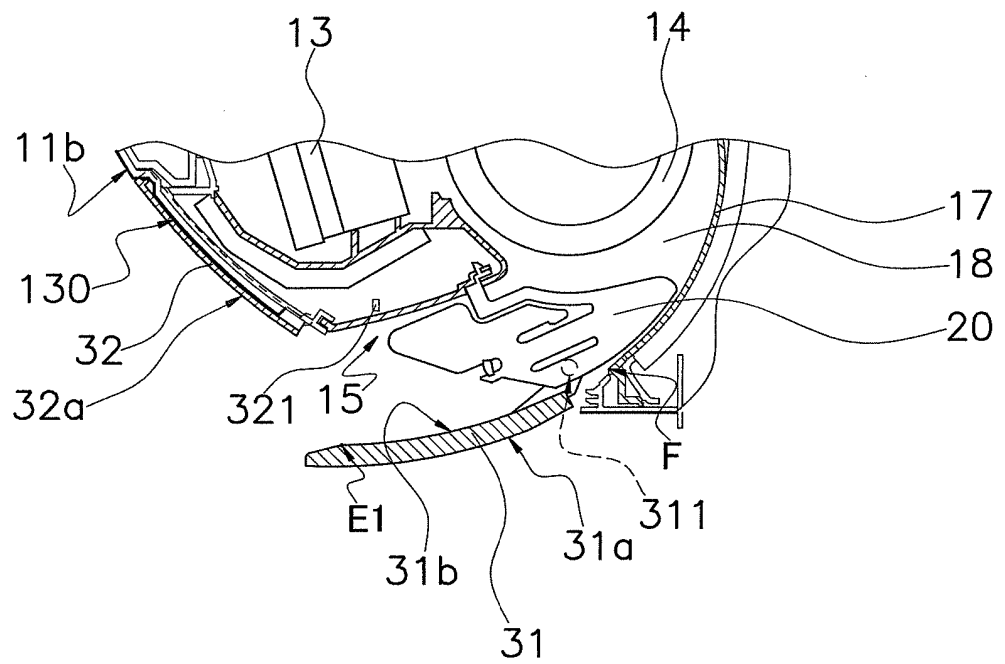


FIG. 3B

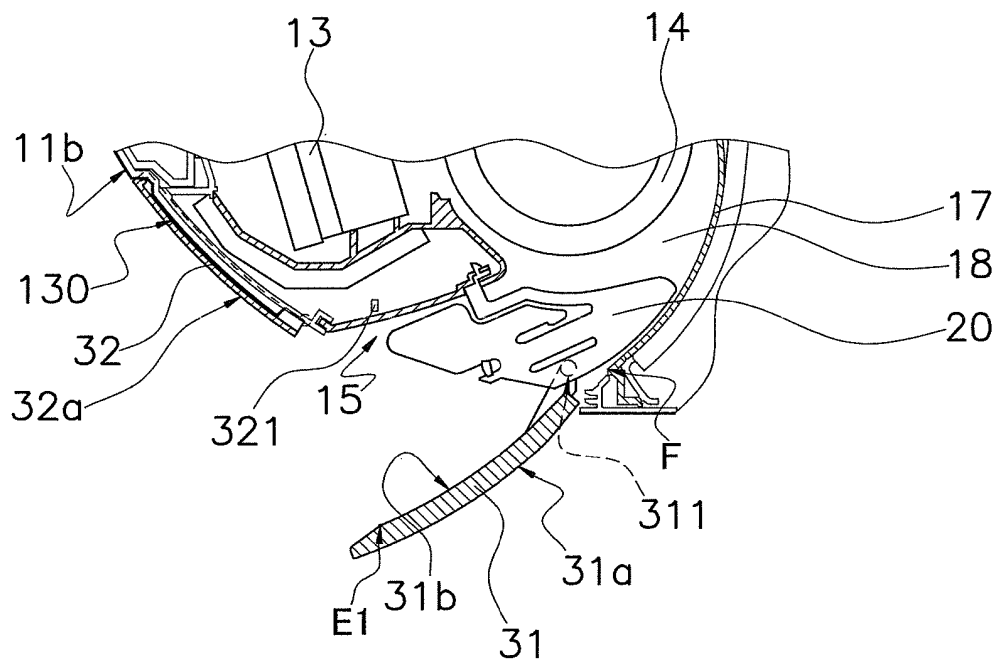


FIG. 3C

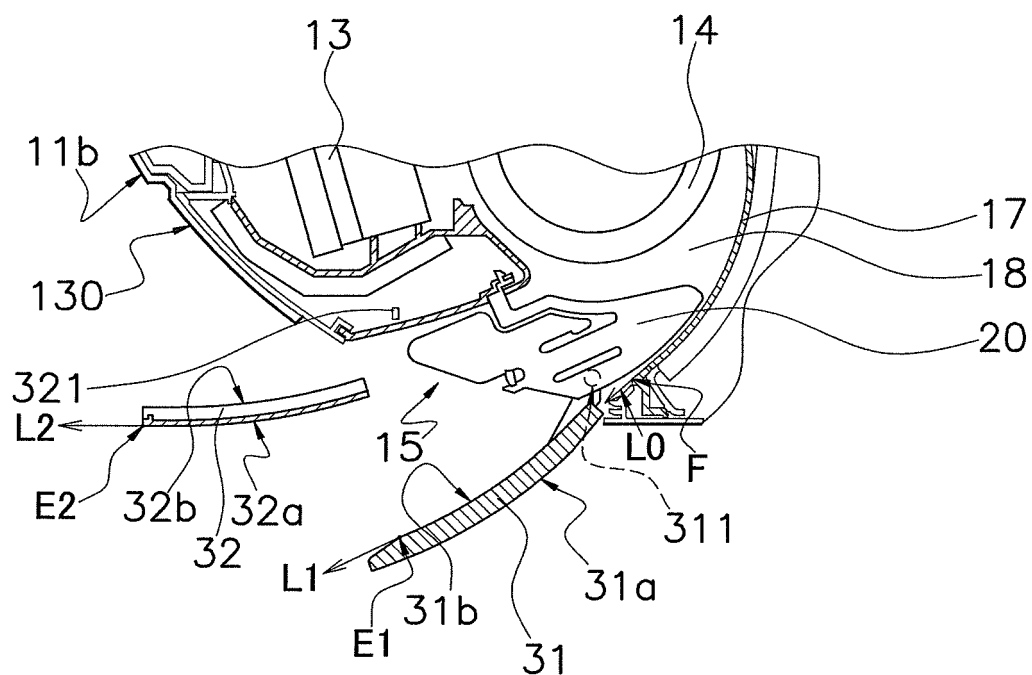


FIG. 3D

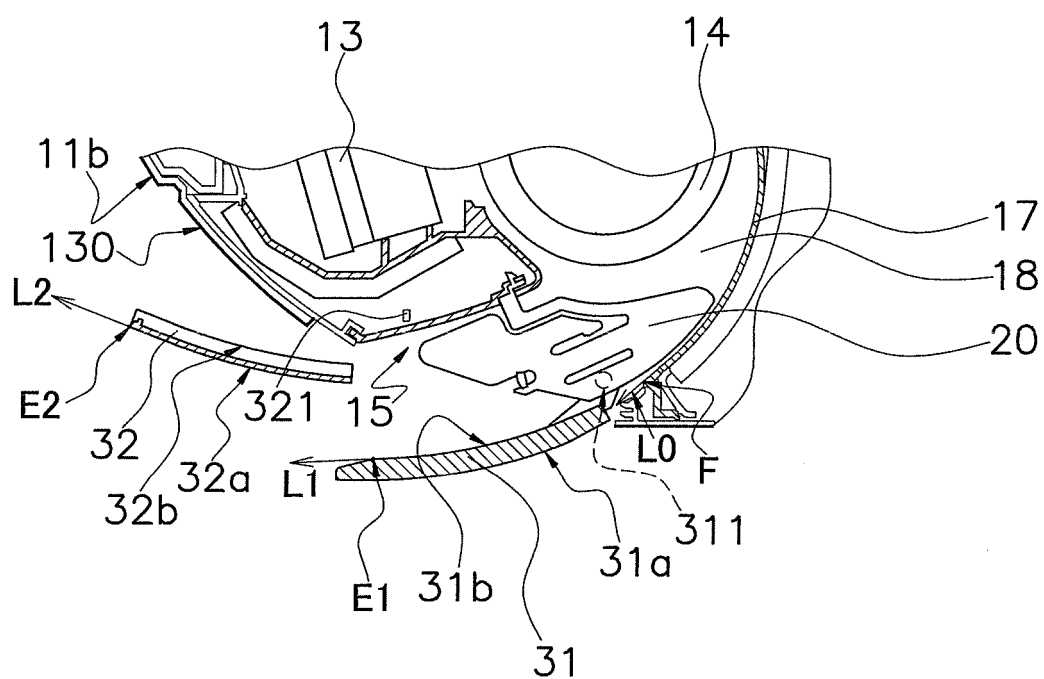


FIG. 4A

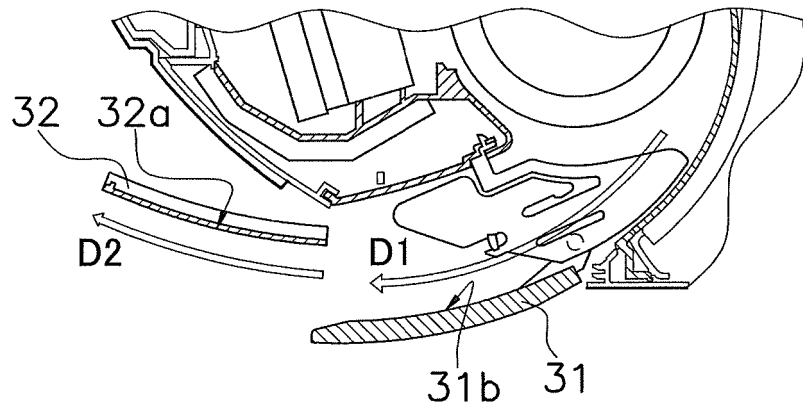


FIG. 4B

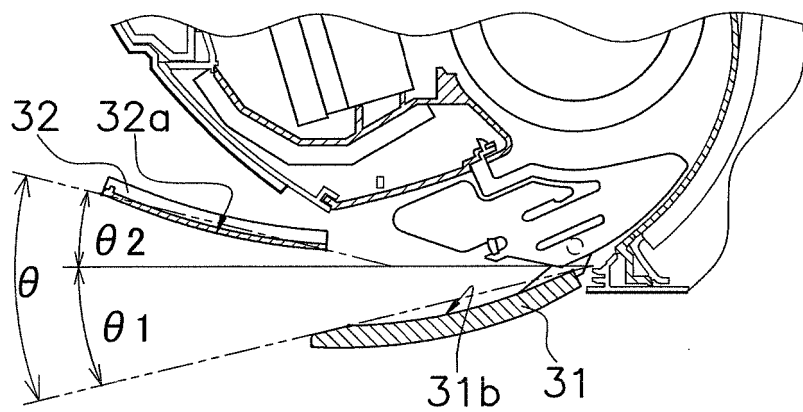


FIG. 5A

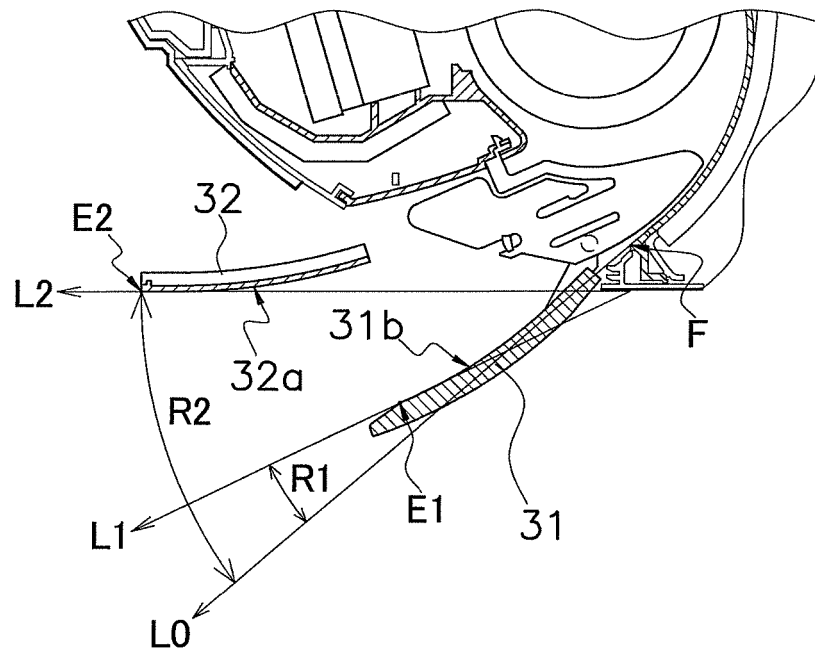


FIG. 5B

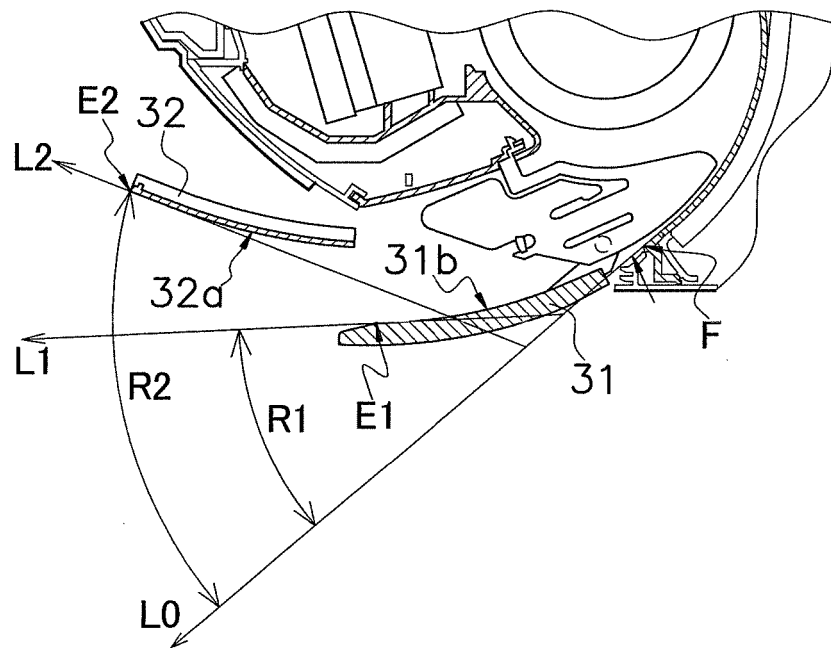


FIG. 6A

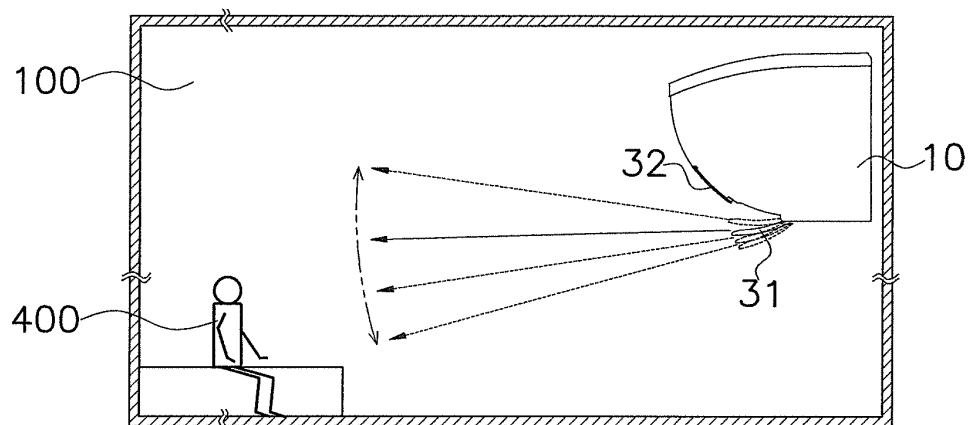


FIG. 6B

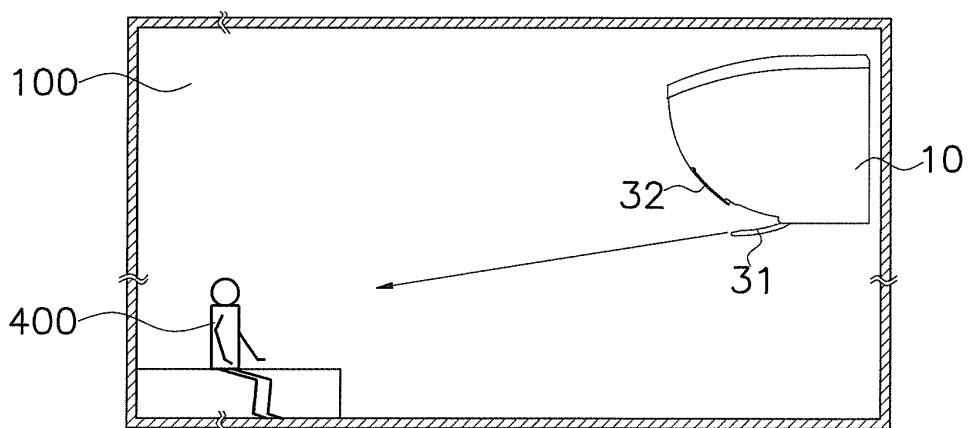
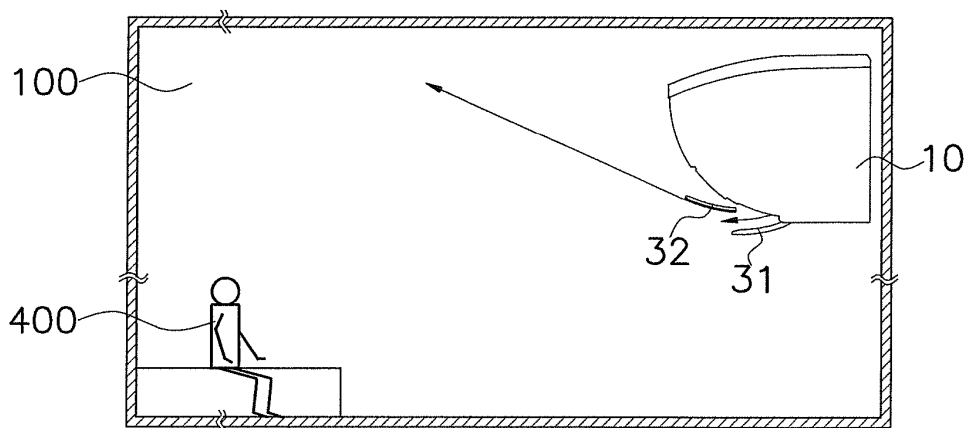


FIG. 6C



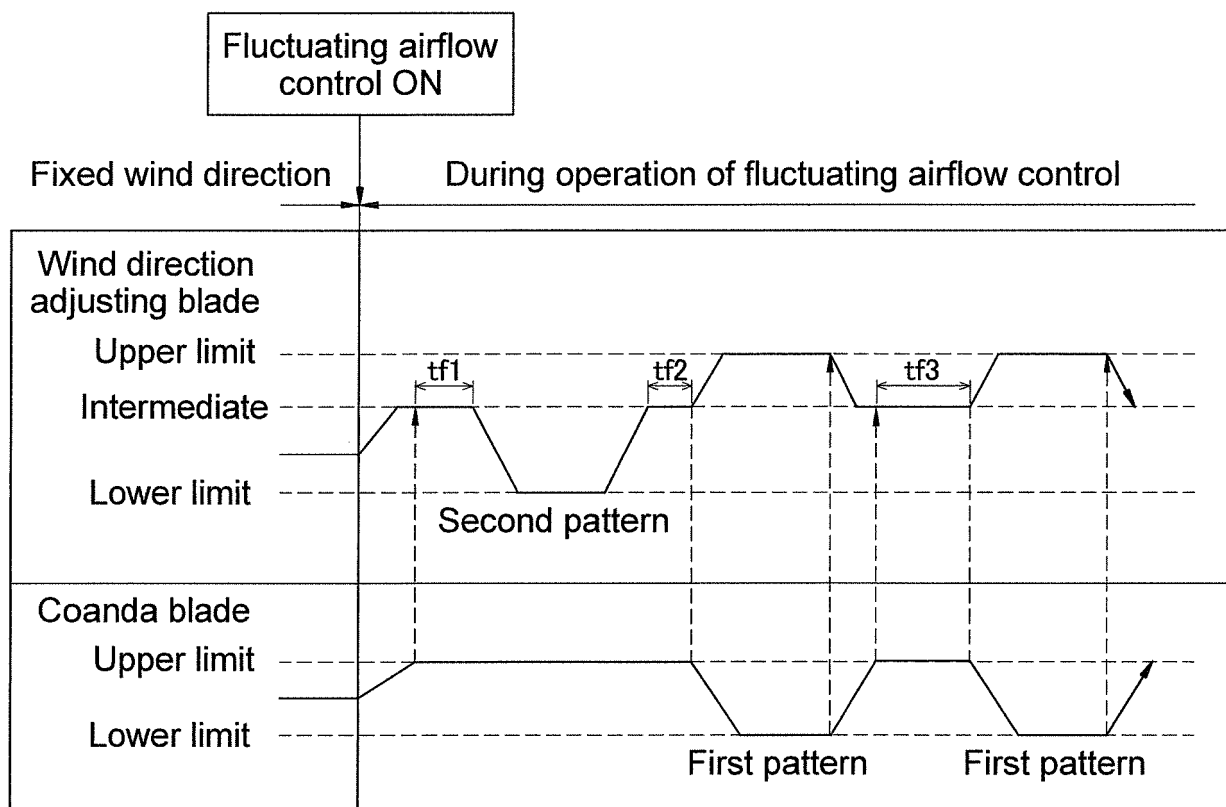


FIG. 7

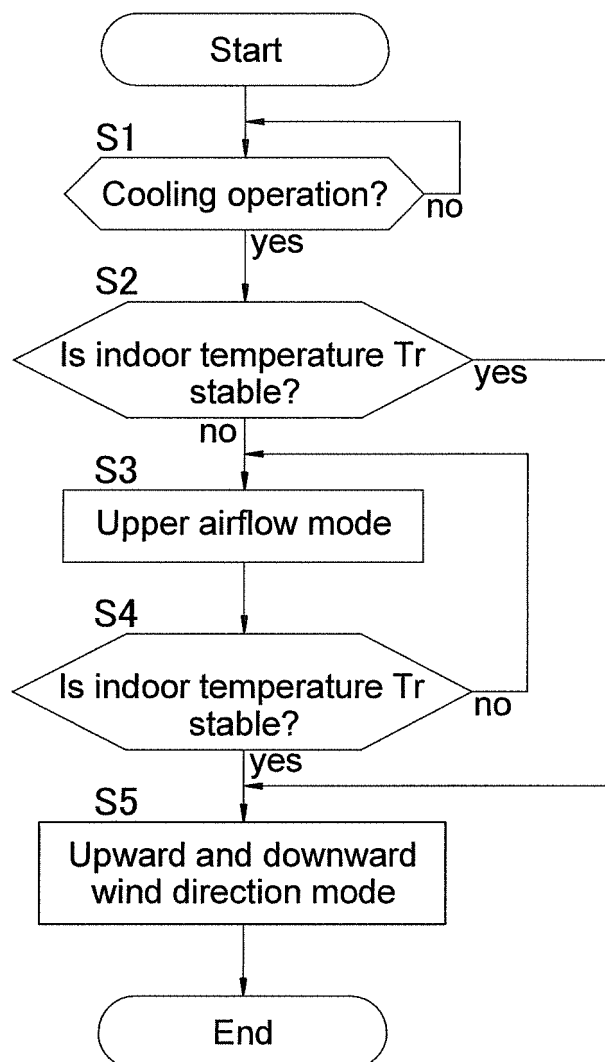


FIG. 8

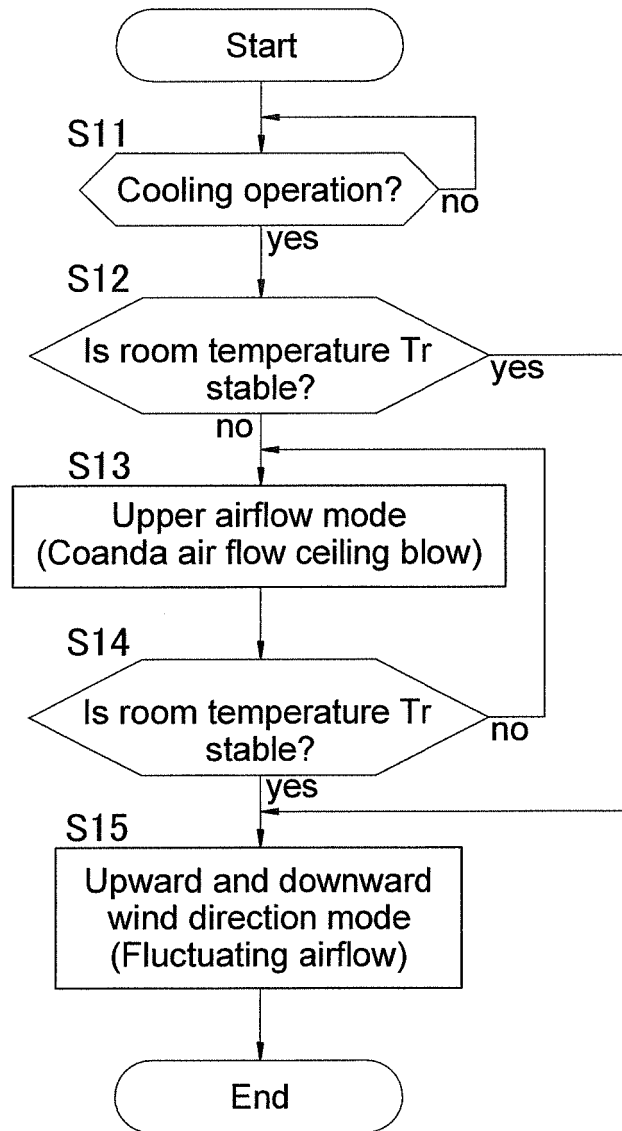


FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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