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- **YOKOMIZO, Tsuyoshi**  
Sakai-shi  
Osaka 591-8511 (JP)
- **MICHITSUJI, Yoshiharu**  
Sakai-shi  
Osaka 591-8511 (JP)
- **NOUCHI, Yoshiteru**  
Sakai-shi  
Osaka 591-8511 (JP)

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(71) Applicant: **Daikin Industries, Ltd.**  
**Osaka-shi, Osaka 530-8323 (JP)**

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

(72) Inventors:  
• **YUMOTO, Yoshiaki**  
Sakai-shi  
Osaka 591-8511 (JP)

(54) **CEILING-MOUNTED INDOOR UNIT FOR AIR CONDITIONING DEVICE**

(57) To improve the far reach of blown air and to improve the agitation of air in an air-conditioned room. A ceiling-mounted indoor unit (4) is comprised of a casing (51), at least four horizontal blades (71a to 71d), and an indoor control unit (67). An air outlet (56) is formed in the casing (51) along a peripheral edge portion of a decorative panel (52). The at least four horizontal blades (71a to 71d) are rotatably disposed in the air outlet (56), and their airflow-direction angles in an up-and-down direction

are capable of being changed independently. The indoor control unit (67) controls the horizontal blades in such a way that first horizontal blades, which are at least two of the horizontal blades (71a to 71d) adjacent to each other among the at least four horizontal blades (71a to 71d), synchronously swing while taking the same posture and a combination of the first horizontal blades shifts in order along the peripheral edge portion of the decorative panel (52).

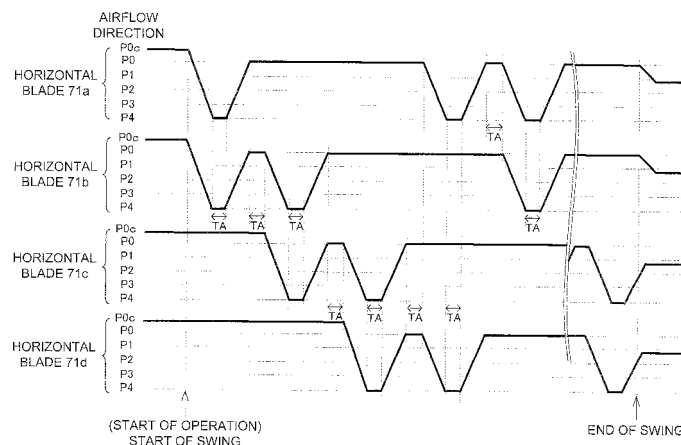


FIG. 11

**Description****TECHNICAL FIELD**

5 **[0001]** The present invention relates to a ceiling-mounted indoor unit for an air conditioning apparatus and particularly a ceiling-mounted indoor unit for an air conditioning apparatus where at least four horizontal blades whose airflow-direction angles in an up-and-down direction are capable of being changed independently are disposed in an air outlet.

**BACKGROUND ART**

10 **[0002]** Conventionally, as an indoor unit for an air conditioning apparatus, that is a type of indoor unit that is mounted in a ceiling in an air-conditioned room. Examples of this kind of indoor unit include the indoor unit disclosed in patent document 1 (Japanese Patent Unexamined publication No.2009-103417). In the indoor unit for an air conditioning apparatus pertaining to patent document 1, one air inlet and four air outlets positioned so as to surround the air inlet are disposed, and rotatable horizontal blades are disposed in the air outlets. This indoor unit has a so-called dual mode where two horizontal blades in air outlets opposing each other and two horizontal blades in the other air outlets opposing each other swing in mutually opposite directions.

**SUMMARY OF INVENTION**

20 <Technical Problem>

25 **[0003]** However, in the dual mode, horizontal blades adjacent to each other rotate in mutually opposite directions. That is, arbitrary horizontal blades rotate in the up direction but the horizontal blades positioned adjacent to those horizontal blades rotate in the down direction. For that reason, in the dual mode, it is difficult to send the air blown out from the air outlets to places away from the indoor unit and, moreover, it is difficult to say that this effectively agitates the air in the air-conditioned room.

30 **[0004]** Therefore, it is a problem of the present invention to improve the far reach of blown air and to improve the agitation of air in an air-conditioned room.

<Solution to Problem>

35 **[0005]** A ceiling-mounted indoor unit for an air conditioning apparatus pertaining to a first aspect of the present invention is a ceiling-mounted indoor unit for an air conditioning apparatus disposed in a ceiling of an air-conditioned room and is comprised of a casing, at least four horizontal blades, and a control unit. An air outlet is formed in an undersurface of the casing along a peripheral edge portion of the undersurface. The at least four horizontal blades are rotatably disposed in the air outlet, and their airflow-direction angles in an up-and-down direction are capable of being changed independently. The control unit controls the horizontal blades in such a way that at least two of the horizontal blades (hereinafter called "first horizontal blades") adjacent to each other among the horizontal blades synchronously swing while taking the same posture. Moreover, the control unit controls the horizontal blades in such a way that a combination of the first horizontal blades shifts in order along the peripheral edge portion of the undersurface.

40 **[0006]** According to this ceiling-mounted indoor unit, the at least two horizontal blades adjacent to each other-that is, the first horizontal blades-synchronously swing while taking the same posture. For that reason, in this ceiling-mounted indoor unit, the air blown out into the air-conditioned room from the air outlet in the indoor unit can be sent even farther and a higher agitating effect can be obtained compared to a case where adjacent horizontal blades perform individually different swings. Moreover, the combination of the first horizontal blades shifts in order along the peripheral edge portion of the undersurface. For this reason, a higher agitating effect can be obtained compared to a case where the combination of the first horizontal blades that synchronously swing is fixed.

45 **[0007]** A ceiling-mounted indoor unit for an air conditioning apparatus pertaining to a second aspect of the present invention is the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the first aspect, wherein the control unit shifts the combination of the horizontal blades sequentially one blade at a time.

**[0008]** According to this ceiling-mounted indoor unit, the combination of the first horizontal blades shifts sequentially one blade at a time. For that reason, the air in the air-conditioned room becomes more easily agitated.

50 **[0009]** A ceiling-mounted indoor unit for an air conditioning apparatus pertaining to a third aspect of the present invention is the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the first aspect or the second aspect, wherein the control unit shifts the combination of the first horizontal blades every time the first horizontal blades reciprocally rotate a predetermined number of times in the up-and-down direction with respect to the air outlet.

55 **[0010]** According to this ceiling-mounted indoor unit, the timing when the combination of the first horizontal blades

shifts becomes matched to the action of the reciprocal rotation of the first horizontal blades. For that reason, by setting the number of times that the first horizontal blades reciprocally rotate, the far reach of the blown air can be given priority or the agitation of the air in the air-conditioned room can be given priority.

**[0011]** A ceiling-mounted indoor unit for an air conditioning apparatus pertaining to a fourth aspect of the present invention is the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the first aspect or the second aspect, wherein the control unit shifts the combination of the first horizontal blades every time the first horizontal blades swing for a first predetermined amount of time.

**[0012]** According to this ceiling-mounted indoor unit, the combination of the first horizontal blades is shifted after the first horizontal blades swing for the first predetermined amount of time. For this reason, by setting the first predetermined amount of time, the far reach of the blown air can be given priority or the agitation of the air in the air-conditioned room can be given priority.

**[0013]** A ceiling-mounted indoor unit for an air conditioning apparatus pertaining to a fifth aspect of the present invention is the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to any of the first aspect to the fourth aspect, wherein the control unit puts second horizontal blades into a state where the second horizontal blades are fixed at a predetermined angle while the first horizontal blades synchronously swing while taking the same posture. The second horizontal blades are the remaining blades among the at least four horizontal blades excluding the first horizontal blades.

**[0014]** According to this ceiling-mounted indoor unit, the remaining blades other than the first horizontal blades—that is, the second horizontal blades—are fixed at the predetermined angle while the first horizontal blades are swinging. For that reason, the air in the air-conditioned room becomes agitated by the first horizontal blades that are swinging, and the air in the air-conditioned room becomes sent far, for example, by the second horizontal blades.

**[0015]** A ceiling-mounted indoor unit for an air conditioning apparatus pertaining to a sixth aspect of the present invention is the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to any of the first aspect to the fifth aspect, wherein the first horizontal blades reciprocally rotate in the up-and-down direction with respect to the air outlet. Additionally, the control unit temporarily stops the actions of the first horizontal blades when the rotational directions of the first horizontal blades change.

**[0016]** In this ceiling-mounted indoor unit, so-called rest periods in which the actions of the first horizontal blades temporarily stop when the rotational directions of the first horizontal blades change are disposed. Because of this, as the air in the air-conditioned room is being agitated, the air blown out from the air outlet is reliably blown out in a horizontal direction or a vertical direction, for example.

**[0017]** A ceiling-mounted indoor unit for an air conditioning apparatus pertaining to a seventh aspect of the present invention is the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to any of the first aspect to the sixth aspect, wherein during a second predetermined amount of time after the start of operation, the control unit controls the horizontal blades in such a way that the first horizontal blades synchronously swing while taking the same posture and the combination of the first horizontal blades shifts in order along the peripheral edge portion of the undersurface. Additionally, after the elapse of the second predetermined amount of time after the start of operation, the control unit tilts the first horizontal blades at a predetermined angle.

**[0018]** In this ceiling-mounted indoor unit, when the second predetermined amount of time elapses after the start of operation, the action of the first horizontal blades synchronously swinging and the action of the combination of the first horizontal blades sequentially shifting end. Additionally, the first horizontal blades tilt at the predetermined angle. Because of this, air with the desired temperature can be supplied to the air-conditioned room whose air has been sufficiently agitated, so discomfort that a user feels because of a draft can be suppressed and the air-conditioned room can be made comfortable.

**[0019]** A ceiling-mounted indoor unit for an air conditioning apparatus pertaining to an eighth aspect of the present invention is the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to any of the first aspect to the seventh aspect, wherein the undersurface of the casing has a substantially four-sided shape as seen in a plan view. Four of the horizontal blades are disposed in correspondence to each side of the undersurface. Additionally, the air outlet has corner-portion air outlets that are divided by the horizontal blades and correspond to each corner portion of the undersurface.

**[0020]** In this ceiling-mounted indoor unit, the first horizontal blades adjacent to each other across an arbitrary corner-portion air outlet synchronously swing while taking the same posture. Moreover, the combination of the first horizontal blades shifts sequentially. For that reason, the air blown out from the corner-portion air outlet is, together with the air blown out from the sections of the air outlet opened and closed by the first horizontal blades adjacent to each other across this corner portion, reliably sent far by the first horizontal blades while incorporating some of the air in the air-conditioned room. Consequently, the air in the air-conditioned room can be agitated by even more of the air that is blown out, and even more of the conditioned air can be sent far, compared to the case of causing the individual horizontal blades to swing separately without synchronizing them.

**[0021]** A ceiling-mounted indoor unit for an air conditioning apparatus pertaining to a ninth aspect of the present

invention is the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the eighth aspect, wherein the first horizontal blades are configured by two of the horizontal blades adjacent to each other.

[0022] Because of this, the air in the air-conditioned room can be effectively agitated and even more of the conditioned air can be sent far.

[0023] A ceiling-mounted indoor unit for an air conditioning apparatus pertaining to a tenth aspect of the present invention is the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the eighth aspect, wherein the first horizontal blades are configured by three of the horizontal blades adjacent to each other.

[0024] Because of this, the air in the air-conditioned room can be effectively agitated and even more of the conditioned air can be sent far.

#### <Advantageous Effects of Invention>

[0025] As stated in the above description, according to the present invention, the following effects are obtained.

[0026] According to the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the first aspect of the present invention, the air blown out into the air-conditioned room from the air outlet in the indoor unit can be sent even farther and a higher agitating effect can be obtained.

[0027] According to the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the second aspect of the present invention, the air in the air-conditioned room becomes more easily agitated.

[0028] According to the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the third aspect of the present invention, by setting the number of times that the first horizontal blades reciprocally rotate, the far reach of the blown air can be given priority or the agitation of the air in the air-conditioned room can be given priority.

[0029] According to the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the fourth aspect of the present invention, by setting the first predetermined amount of time, the far reach of the blown air can be given priority or the agitation of the air in the air-conditioned room can be given priority.

[0030] According to the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the fifth aspect of the present invention, the air in the air-conditioned room becomes agitated by the first horizontal blades that are swinging, and the air in the air-conditioned room becomes sent far, for example, by the second horizontal blades.

[0031] According to the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the sixth aspect of the present invention, as the air in the air-conditioned room is being agitated, the air blown out from the air outlet is reliably blown out in a horizontal direction or a vertical direction, for example.

[0032] According to the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the seventh aspect of the present invention, discomfort that a user feels because of a draft can be suppressed and the air-conditioned room can be made comfortable.

[0033] According to the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the eighth aspect of the present invention, the air in the air-conditioned room can be agitated by even more of the air that is blown out, and even more of the conditioned air can be sent far.

[0034] According to the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the ninth aspect of the present invention, the air in the air-conditioned room can be effectively agitated and even more of the conditioned air can be sent far.

[0035] According to the ceiling-mounted indoor unit for the air conditioning apparatus pertaining to the tenth aspect of the present invention, the air in the air-conditioned room can be effectively agitated and even more of the conditioned air can be sent far.

#### BRIEF DESCRIPTION OF DRAWINGS

[0036]

FIG. 1 is a schematic configuration diagram of an air conditioning apparatus in which a ceiling-mounted indoor unit pertaining to an embodiment of the present invention is employed.

FIG. 2 is an external perspective view of the ceiling-mounted indoor unit pertaining to the embodiment of the present invention.

FIG. 3 is a schematic side sectional view of the ceiling-mounted indoor unit pertaining to the embodiment of the present invention and is a sectional view taken along I-O-I in FIG. 4.

FIG. 4 is a schematic plan view showing a state where a top plate of the ceiling-mounted indoor unit pertaining to the embodiment of the present invention has been removed.

FIG. 5 is a bottom view of a decorative panel of the ceiling-mounted indoor unit pertaining to the embodiment of the present invention, that is, a plan view where the decorative panel is seen from within an air-conditioned room.

FIG. 6 is a schematic diagram showing flows of conditioned air blown out from an air outlet in the ceiling-mounted

indoor unit pertaining to the embodiment of the present invention and a detection range of a presence sensor.

FIG. 7 is a schematic diagram showing the configuration of the presence sensor disposed in the ceiling-mounted indoor unit pertaining to the embodiment of the present invention.

FIG. 8 is a schematic diagram showing the detection range of the presence sensor as seen in a side view of the ceiling-mounted indoor unit pertaining to the embodiment of the present invention.

FIG. 9 is a block diagram schematically showing an indoor control unit pertaining to the embodiment of the present invention and various devices in the ceiling-mounted indoor unit that are connected to the control unit.

FIG. 10 is a view showing a change range of airflow directions of horizontal blades of the ceiling-mounted indoor unit pertaining to the embodiment of the present invention.

FIG. 11 is a timing chart for describing actions of the horizontal blades of the ceiling-mounted indoor unit pertaining to the embodiment of the present invention.

FIG. 12 is a diagram showing a combination of first horizontal blades shifting in order.

FIG. 13 shows examples of screens displayed on a display of a remote controller when setting various modes.

FIG. 14 is a flowchart showing an overall flow of actions of the air conditioning apparatus in which the ceiling-mounted indoor unit pertaining to the embodiment of the present invention is employed.

FIG. 15 is a flowchart showing an overall flow of actions of the air conditioning apparatus in which the ceiling-mounted indoor unit pertaining to the embodiment of the present invention is employed.

FIG. 16 is a diagram showing the combination of the first horizontal blades pertaining to another embodiment (A) shifting in order.

FIG. 17 is a timing chart for describing the actions of the horizontal blades pertaining to another embodiment (D).

FIG. 18 is a diagram showing the combination of the first horizontal blades pertaining to another embodiment (D) shifting in order.

## DESCRIPTION OF EMBODIMENT

**[0037]** An embodiment of a ceiling-mounted indoor unit pertaining to the present invention will be described on the basis of the drawings.

<Configurations>

-Overall-

**[0038]** FIG. 1 is a schematic configuration diagram of an air conditioning apparatus 1 in which a ceiling-mounted indoor unit 4 pertaining to the embodiment of the present invention is employed. The air conditioning apparatus 1 is a split type air conditioning apparatus, mainly has an outdoor unit 2, the ceiling-mounted indoor unit 4, and a liquid refrigerant connection tube 5 and a gas refrigerant connection tube 6 that interconnect the outdoor unit 2 and the ceiling-mounted indoor unit 4, and configures a vapor compression refrigerant circuit 10. The air conditioning apparatus 1 is capable of performing a cooling operation and a heating operation.

-Outdoor Unit-

**[0039]** The outdoor unit 2 is installed outdoors or the like and mainly has a compressor 21, a four-way switching valve 22, an outdoor heat exchanger 23, an expansion valve 24, a liquid-side stop valve 25, and a gas-side stop valve 26.

**[0040]** The compressor 21 is a mechanism for sucking in low-pressure gas refrigerant, compressing the low-pressure gas refrigerant into high-pressure gas refrigerant, and thereafter discharging the high-pressure gas refrigerant. Here, a closed compressor, where a rotary or scroll positive-displacement compression element (not shown) housed inside a casing (not shown) is driven by a compressor motor 21, a similarly housed inside the casing, is employed as the compressor 21. The rotational speed (that is, the operating frequency) of the compressor motor 21 can be varied by an inverter device (not shown), whereby it becomes possible to control the capacity of the compressor 21.

**[0041]** The four-way switching valve 22 is a valve for switching the direction of the flow of the refrigerant when switching between the cooling operation and the heating operation. During the cooling operation, the four-way switching valve 22 is capable of interconnecting the discharge side of the compressor 21 and the gas side of the outdoor heat exchanger 23 and also interconnecting the gas-side stop valve 26 and the suction side of the compressor 21 (see the solid lines of the four-way switching valve 22 in FIG. 1). Further, during the heating operation, the four-way switching valve 22 is capable of interconnecting the discharge side of the compressor 21 and the gas-side stop valve 26 and also interconnecting the gas side of the outdoor heat exchanger 23 and the suction side of the compressor 21 (see the dashed lines of the four-way switching valve 22 in FIG. 1).

**[0042]** The outdoor heat exchanger 23 is a heat exchanger that functions as a radiator for the refrigerant during the

cooling operation and functions as an evaporator for the refrigerant during the heating operation. The liquid side of the outdoor heat exchanger 23 is connected to the expansion valve 24, and the gas side of the outdoor heat exchanger 23 is connected to the four-way switching valve 22.

[0043] The expansion valve 24 is a motor-driven expansion valve which, during the cooling operation, is capable of reducing the pressure of the high-pressure liquid refrigerant that has given off heat in the outdoor heat exchanger 23 before sending the refrigerant to an indoor heat exchanger 42 (described later) and which, during the heating operation, is capable of reducing the pressure of the high-pressure liquid refrigerant that has given off heat in the indoor heat exchanger 42 before sending the refrigerant to the outdoor heat exchanger 23.

[0044] The liquid-side stop valve 25 and the gas-side stop valve 26 are valves disposed in openings that connect to external devices and pipes (specifically, the liquid refrigerant connection tube 5 and the gas refrigerant connection tube 6). The liquid-side stop valve 25 is connected to the expansion valve 24. The gas-side stop valve 26 is connected to the four-way switching valve 22.

[0045] Also disposed in the outdoor unit 2 is an outdoor fan 27 for sucking outdoor air into the unit 2, supplying the outdoor air to the outdoor heat exchanger 23, and thereafter exhausting the air to the outside of the unit 2. That is, the outdoor heat exchanger 23 is a heat exchanger that uses the outdoor air as a cooling source or a heating source to cause the refrigerant to give off heat or evaporate. Here, a propeller fan driven by an outdoor fan motor 27a is employed as the outdoor fan 27. The rotational speed (that is, the operating frequency) of the outdoor fan motor 27a can be varied by an inverter device (not shown), whereby it becomes possible to control the air volume of the outdoor fan 27.

[0046] Although they are not shown, also disposed in the outdoor unit 2 are sensors that detect the suction pressure and the discharge pressure, a sensor that detects the temperature of the refrigerant on the liquid side of the outdoor heat exchanger 23, and a sensor that detects the outside air temperature.

[0047] Moreover, the outdoor unit 2 has an outdoor control unit 39 that controls the actions of the devices configuring the outdoor unit 2. The outdoor control unit 39 is configured by a microcomputer comprising a CPU and a memory and can exchange control signals and so forth with an indoor control unit 67 (described later) of the ceiling-mounted indoor unit 4.

#### -Liquid Refrigerant Connection Tube-

[0048] The liquid refrigerant connection tube 5 is a refrigerant tube connected to the liquid-side stop valve 25. The liquid refrigerant connection tube 5 is a refrigerant tube which, during the cooling operation, is capable of carrying the refrigerant out from the outlet of the outdoor heat exchanger 23 functioning as a radiator for the refrigerant to the outside of the outdoor unit 2. Further, the liquid refrigerant connection tube 5 is also a refrigerant tube which, during the heating operation, is capable of carrying the refrigerant in from the outside of the outdoor unit 2 to the inlet of the outdoor heat exchanger 23 functioning as an evaporator for the refrigerant.

#### -Gas Refrigerant Connection Tube-

[0049] The gas refrigerant connection tube 6 is a refrigerant tube connected to the gas-side stop valve 26. The gas refrigerant connection tube 6 is a refrigerant tube which, during the cooling operation, is capable of carrying the refrigerant in from the outside of the outdoor unit 2 to the suction side of the compressor 21. Further, the gas refrigerant connection tube 6 is also a refrigerant tube which, during the heating operation, is capable of carrying the refrigerant out from the discharge side of the compressor 21 to the outside of the outdoor unit 2.

#### -Ceiling-mounted Indoor Unit-

[0050] For the ceiling-mounted indoor unit 4, here, a form of ceiling-mounted air conditioning unit called a ceiling-embedded type is employed. As shown in FIG. 2 to FIG. 5 and FIG. 9, the ceiling-mounted indoor unit 4 has a casing 51 that stores various configurational devices inside, four horizontal blades 71 a, 71 b, 71 c, and 71 d, various sensors 61, 62, and 63, the indoor control unit 67 (corresponding to a control unit), and a remote control-use receiving unit 69.

#### -Casing-

[0051] The casing 51 is configured from a casing body 51a and a decorative panel 52 that is placed on the underside of the casing body 51a and corresponds to an undersurface of the casing 51. As shown in FIG. 3, the casing body 51a is inserted and placed in an opening formed in a ceiling U of an air-conditioned room. Additionally, the decorative panel 52 is placed in such a way as to be fitted into the opening in the ceiling U. Here, FIG. 2 is an external perspective view of the ceiling-mounted indoor unit 4. FIG. 3 is a schematic side sectional view of the ceiling-mounted indoor unit 4 and is a sectional view taken along I-O-I in FIG. 4. FIG. 4 is a schematic plan view showing a state where a top plate 53 of

the ceiling-mounted indoor unit 4 has been removed. FIG. 5 is a plan view showing the decorative panel 52 of the ceiling-mounted indoor unit 4 as seen from within the air-conditioned room. FIG. 9 is a block diagram schematically showing the indoor unit control unit 67 and various devices in the ceiling-mounted indoor unit 4 that are connected to the control unit 67.

**[0052]** The casing body 51a is a box-like body that has a substantially eight-sided shape where long sides and short sides are alternately formed as seen in a plan view, and the undersurface of the casing body 51a is open. The casing body 51a has the top plate 53, which has a substantially eight-sided shape where long sides and short sides are alternately and consecutively formed, and a side plate 54, which extends downward from the peripheral edge portion of the top plate 53. The side plate 54 is configured from side plates 54a, 54b, 54c, and 54d, which correspond to the long sides of the top plate 53, and side plates 54e, 54f, 54g, and 54h, which correspond to the short sides of the top plate 53. The side plate 54h configures a section penetrated by indoor refrigerant tubes 43 and 44 for interconnecting the indoor heat exchanger 42 and the refrigerant connection tubes 5 and 6 (see FIG. 4).

**[0053]** Additionally, as shown in FIG. 3, an indoor fan 41 and the indoor heat exchanger 42 are mainly placed inside the casing body 51a.

**[0054]** The indoor fan 41 is a centrifugal blower that sucks the air in the air-conditioned room via an air inlet 55 into the casing body 51a and, after the air has exchanged heat in the indoor heat exchanger 42, blows out the air via an air outlet 56 from the casing body 51a. The indoor fan 41 has an indoor fan motor 41a, which is disposed in the center of the top plate 53 of the casing body 51a, and an impeller 41b, which is coupled to and driven to rotate by the indoor fan motor 41a. The impeller 41b is an impeller with turbo blades and can suck the air into the impeller 41b from below and blow out the air toward the outer peripheral side of the impeller 41b as seen in a plan view. The rotational speed (that is, the operating frequency) of the indoor fan motor 41 a can be varied by an inverter device (not shown), whereby it becomes possible to control the air volume of the indoor fan 41.

**[0055]** The indoor heat exchanger 42 is a heat exchanger that functions as an evaporator for the refrigerant during the cooling operation and functions as a radiator for the refrigerant during the heating operation. The indoor heat exchanger 42 is connected to the refrigerant connection tubes 5 and 6 (see FIG. 1) via the indoor refrigerant tubes 43 and 44 and is configured by a fin-and-tube heat exchanger that is bent and placed in such a way as to surround the periphery of the indoor fan 41 as seen in a plan view. The indoor heat exchanger 42 can perform heat exchange between the refrigerant and the air in the air-conditioned room that is sucked into the casing body 51a; during the cooling operation, the indoor heat exchanger 42 can cool the air in the air-conditioned room, and during the heating operation, the heat exchanger 42 can heat the air in the air-conditioned room.

**[0056]** A drain pan 45 is installed on the underside of the indoor heat exchanger 42 and in the lower portion of the casing body 51a. The drain pan 45 is for receiving drain water produced as a result of moisture in the air being condensed by the indoor heat exchanger 42. Further, a bellmouth 41c for guiding the air sucked in from the air inlet 55 to the impeller 41b of the indoor fan 41 is placed in a suction port 45j in the drain pan 45.

**[0057]** The decorative panel 52 is a plate-like body that has a substantially four-sided shape as seen in a plan view, and the decorative panel 52 is mainly configured from a panel body 52a that is fixed to the lower end portion of the casing body 51 a. The air outlet 56 and the air inlet 55 are formed in the panel body 52a. The air outlet 56 is an opening for blowing out the air into the air-conditioned room and is positioned along the peripheral edge portion of the panel body 52a as seen in a plan view. The air inlet 55 is an opening for sucking in the air in the air-conditioned room and is positioned in the substantial center of the panel body 52a as seen in a plan view—that is, in such a way as to be surrounded by the air outlet 56. More specifically, the air inlet 55 is an opening that has a substantially four-sided shape, and a suction grille 57 and an intake filter 58 that is for removing dirt and dust in the air sucked in from the air inlet 55 are disposed in the air inlet 55. Additionally, the air outlet 56 is an opening with a substantially four-sided ring shape. Because of this, the conditioned air is blown out not only in directions corresponding to each side of the four-sided shape of the panel body 52a (see the directions of arrows X1, X2, X3, and X4 in FIG. 5) but also in directions corresponding to each corner portion of the four-sided shape of the panel body 52a (see the directions of arrows Y1, Y2, Y3, and Y4 in FIG. 5).

-Horizontal Blades-

**[0058]** The four horizontal blades 71a to 71d are positioned in correspondence to each side of the four-sided shape of the panel body 52a and are rotatably disposed in the air outlet 56. The horizontal blades 71a to 71d are capable of changing the airflow-direction angles, in the up-and-down direction, of the conditioned air blown out into the air-conditioned room. More specifically, the horizontal blades 71a to 71d are plate-like members extending long and narrow along each side of the four-sided shape of the air outlet 56; both lengthwise direction end portions of each of the horizontal blades 71a to 71d are supported on the decorative panel 52, in such a way that the horizontal blades 71a to 71d are rotatable about shafts in their lengthwise directions, by pairs of blade support portions 72 and 73 that are placed in such a way as to block parts of the air outlet 56. Additionally, the horizontal blades 71a to 71d are driven by blade drive motors 74a, 74b, 74c, and 74d. Because of this, the airflow-direction angles, in the up-and-down direction, of the horizontal blades

71a to 71d are capable of being changed independently, and the horizontal blades 71a to 71d can reciprocally rotate in the up-and-down direction with respect to the air outlet 56. The blade drive motors 74a to 74d here are disposed in the blade support portions 72 and 73.

[0059] The air outlet 56 is divided by the blade support portions 72 and 73 into side-portion air outlets 56a, 56b, 56c, and 56d, which correspond to each side of the four-sided shape of the panel body 52a, and corner-portion air outlets 56e, 56f, 56g, and 56h, which correspond to each corner portion of the four-sided shape of the panel body 52a. Here, the area where air conditioning is performed mainly by the conditioned air blown out mainly from the side-portion air outlet 56a (see arrows X1, Y1, and Y2 in FIG. 5) is an "air conditioning target area A" (see FIG. 6). Further, the area where air conditioning is performed mainly by the conditioned air blown out from the side-portion air outlet 56b (see arrows X2, Y2, and Y3 in FIG. 5) is an "air conditioning target area B." Further, the area where air conditioning is performed mainly by the conditioned air blown out from the side-portion air outlet 56c (see arrows X3, Y3, and Y4 in FIG. 5) is an "air conditioning target area C." Moreover, the area where air conditioning is performed mainly by the conditioned air blown out from the side-portion air outlet 56d (see arrows X4, Y4, and Y1 in FIG. 5) is an "air conditioning target area D."

-Various Sensors-

[0060] Examples of the sensors disposed in the ceiling-mounted indoor unit 4 pertaining to the present embodiment include an intake air temperature sensor 61, a presence sensor 62, and a floor temperature sensor 63.

[0061] The intake air temperature sensor 61 is a temperature sensor that detects an intake air temperature  $T_r$  that is the temperature of the air in the air-conditioned room sucked into the casing body 51a through the air inlet 55. Here, as shown in FIG. 3, the intake air temperature sensor 61 is disposed in the air inlet 55.

[0062] The presence sensor 62 is an infrared sensor that detects the distribution of persons in the air-conditioned room (here, whether or not persons are present in the air conditioning target areas A to D pertaining to FIG. 6). One presence sensor 62 is placed in a position where it can be placed on the lower portion of the decorative panel 52; here, this is in a corner portion of the decorative panel 52 (see FIGS. 2 and 5). More specifically, the presence sensor 62 is disposed in such a way as to project downward from the surface of the decorative panel 52 in a position on the outer peripheral side of the corner-portion air outlet 56f, and the presence sensor 62 has a substantially circular shape as seen in a plan view of the decorative panel 52. The presence sensor 62 is a type of sensor that detects whether or not persons are present in the air-conditioned room by fluctuations in infrared radiant energy radiated from objects; as shown in FIG. 7, an open portion 62a for receiving infrared light is formed in an infrared light-receiving element (not shown). Here, the open portion 62a may be covered by a transparent member capable of allowing the infrared light to be received by the infrared light-receiving element. Additionally, the open portion 62a is capable of rotating 360° as seen in a plan view of the decorative panel 52, so that whether or not persons are present in each of the air conditioning target areas A to D can be detected. Further, as shown in FIG. 6, the detection range of the presence sensor 62 as seen in a plan view is a range where detection angles  $\alpha$ ,  $\beta$ ,  $\gamma$ , and  $\delta$  are about 90° in any of the cases of detecting whether or not persons are present in the air conditioning target areas A to D. Further, as shown in FIG. 8, the detection range of the presence sensor 62 as seen in a side view is a range where detection angles  $\varepsilon$  are about 135° in any of the cases of detecting whether or not persons are present in the air conditioning target areas A to D.

[0063] The presence sensor 62 is not limited to the structure described above and may, for example, also be a sensor where the infrared light-receiving element rotates instead of the open portion 62a rotating or a sensor having four infrared light-receiving elements that face the directions of each of the air conditioning target areas A to D.

[0064] The floor temperature sensor 63 is an infrared sensor that detects a temperature  $T_f$  of the floor in the air-conditioned room. The floor temperature sensor 63 is placed in a position where it can be placed on the lower portion of the decorative panel 52; here, this is in a corner portion of the decorative panel 52. More specifically, the floor temperature sensor 63 is disposed in such a way as to face downward from the surface of the decorative panel 52 in a position on the outer peripheral side of the corner-portion air outlet 56f. The floor temperature sensor 63 detects the temperature  $T_f$  of the floor in the air-conditioned room by infrared radiant energy radiated from objects.

-Indoor Control Unit-

[0065] The indoor control unit 67 is a microcomputer comprising a CPU and a memory and controls the actions of the devices configuring the ceiling-mounted indoor unit 4. Specifically, as shown in FIG. 9, the indoor control unit 67 is electrically connected to the various sensors 61 to 63 in the indoor unit 4, the indoor fan motor 41 a, the blade drive motors 74a to 74d, an outdoor unit-use communication unit 68, and the remote control-use receiving unit 69. The outdoor unit-use communication unit 68 is for exchanging control signals and so forth with the outdoor control unit 39 of the outdoor unit 2 and is electrically connected via a wire 9 to the outdoor control unit 39 (see FIG. 1).

[0066] The indoor control unit 67 performs drive control of the indoor motor 41 a and performs drive control of the blade drive motors 74a to 74d on the basis of the detection results of the various sensors 61 to 63, various instructions

that have been given via a remote controller 99 (see FIG. 1) by a user in the air-conditioned room, and control signals that have been sent from the outdoor control unit 39. For example, in a case where an instruction to start the heating operation or the cooling operation has been given via the remote controller 99 by a user, the indoor control unit 67 starts driving the motors 41 a and 74a to 74d. In this case, the outdoor unit-use communication unit 68 sends to the outdoor control unit 39 a control signal indicating that the outdoor control unit 39 is to start driving the outdoor unit 2 and indicating the operation for which the start instruction has been given. Further, in a case where an instruction to stop the operation has been given via the remote controller 99, the indoor control unit 67 stops driving the motors 41a and 74a to 74d. In this case, the outdoor unit-use communication unit 68 sends to the outdoor control unit 39 a control signal indicating that the outdoor control unit 39 is to stop driving the outdoor unit 2.

#### -Control of Airflow-direction Angles of Horizontal Blades-

**[0067]** Here, control of the airflow-direction angles of the horizontal blades 71a to 71d by the indoor control unit 67 will be described. While the air conditioning apparatus 1 is performing the heating operation or the cooling operation, the indoor control unit 67 can set the horizontal blades 71a to 71d to a fixed state or a swing state, on the basis of a request from the remote controller 99 and the detection values of the various sensors 61 to 63. The fixed state is a state where the airflow-direction angles of the horizontal blades 71 a to 71d are fixed at a desired airflow-direction angle by the driving of the horizontal blade motors 74a to 74d. As shown in FIG. 10, the airflow-direction angles of the horizontal blades 71a to 71d are changeable in plural stages between an airflow direction P0 (a horizontal airflow direction), which is an airflow-direction angle at which the conditioned air is blown out in an approximately horizontal direction, and an airflow direction P4, which is an airflow-direction angle at which the conditioned air is blown out in a most down direction. Here, the airflow-direction angles of the horizontal blades 71a to 71d are changeable in five stages: the airflow direction P0, an airflow direction P1 that faces more downward than the airflow direction P0, an airflow direction P2 that faces more downward than the airflow direction P1, an airflow direction P3 that faces more downward than the airflow direction P2, and the airflow direction P4 that faces most downward. The swing state is a state where the horizontal blades 71a to 71d are reciprocally rotated by driving the blade drive motors 74a to 74d and repeatedly changing up and down the airflow-direction angles of the horizontal blades 71a to 71d in a change range of the airflow directions (here, between the airflow direction P0 and the airflow direction P4). The indoor control unit 67 is capable of controlling the airflow-direction angles described above with respect to the individual horizontal blades 71a to 71d.

**[0068]** In a state where the ceiling-mounted indoor unit 4 is not operating, the horizontal blades 71a to 71d take a state where they close the air outlet 56 (specifically, the side-portion air outlets 56a to 56d). Below, for the sake of conveyance of description, the airflow-direction angle in a case where the horizontal blades 71a to 71b are in the closed state will be expressed as an "airflow direction P0c" (see FIG. 11). Additionally, in a state where the ceiling-mounted indoor unit 4 is operating, the horizontal blades 71a to 71d are capable of taking any of the airflow directions P0c to P4 in the fixed state or the swing state.

#### -Control for Synchronously Swinging Adjacent Horizontal Blades

**[0069]** However, when the ceiling-mounted indoor unit 4 starts operation, an imbalance arises in the temperature distribution in the air-conditioned room. For that reason, when the ceiling-mounted indoor unit 4 starts operation, it is good to effectively agitate the air in the air-conditioned room, before performing the heating operation or the cooling operation, by sending conditioned air at actually desired airflow-direction angles.

**[0070]** Therefore, as shown in FIG. 11, the indoor control unit 67 pertaining to the present embodiment performs rotation control of the horizontal blades 71a to 71d by performing drive control of the blade drive motors 74a to 74d in such a way that two of the horizontal blades adjacent to each other (hereinafter called "first horizontal blades") among the four horizontal blades 71a to 71d synchronously swing while taking the same posture for a predetermined amount of time (corresponding to a second predetermined amount of time) after an instruction for the ceiling-mounted indoor unit 4 to start operation has been given. Moreover, in the rotation control, the indoor control unit 67 puts the remaining horizontal blades (e.g., the horizontal blades 71c and 71d; hereinafter called "second horizontal blades") among the four horizontal blades 71a to 71d excluding the first horizontal blades (e.g., the horizontal blades 71a and 71b) in a state where the second horizontal blades are fixed at a predetermined angle (e.g., the airflow direction P0).

**[0071]** Moreover, the indoor control unit 67 also performs combination shift control of the first horizontal blades in such a way that a combination of the first horizontal blades shifts in order along the peripheral edge portion of the decorative panel 52 during a predetermined amount of time after an instruction for the ceiling-mounted indoor unit 4 to start operation has been given. In particular, the indoor control unit 67 pertaining to the present embodiment shifts the combination of the first horizontal blades every time the first horizontal blades reciprocally rotate a predetermined number of times in the up-and-down direction with respect to the air outlet 56.

**[0072]** Actions that the horizontal blades 71a to 71d take under the rotation control and the combination shift control

will be specifically described below using FIG. 11 and FIG. 12. FIG. 11 and FIG. 12 show, as an example, a case where the combination of the first horizontal blades shifts every time the first horizontal blades reciprocally rotate one time—that is, swing one time—in the up-and-down direction. In FIG. 12, the horizontal blades that are blacked out represent the first horizontal blades, and the horizontal blades that are not blacked out represent the second horizontal blades. Before

starting operation, the horizontal blades 71a to 71d are in a posture (the airflow direction P0c) where they close the air outlet 56. **[0073]** When operation starts, first, the horizontal blade 71 a and the horizontal blade 71 b adjacent to each other across the corner-portion air outlet 56f in the decorative panel 52 correspond to the first horizontal blades, and those blades 71a and 71b start swinging at the same timing and while taking the same posture. Specifically, the horizontal blades 71a and 71b both rotate at the same rotational speed in a direction in which they rotate from the airflow direction P0c to the airflow direction P4—that is, in the down direction. Consequently, the airflow-direction angles of the horizontal blades 71a and 71b go from the airflow direction P0 to the airflow direction P1, the airflow direction P2, and the airflow direction P3 at the same timing and before long reach the airflow direction P4 at substantially the same time. After the horizontal blades 71 a and 71b have reached the airflow direction P4, the rotational direction of the horizontal blades 71a and 71b changes from the down direction to the up direction, and the airflow-direction angles of the horizontal blades 71a and 71b before long reach the airflow direction P0 at substantially the same time. During this time, the horizontal blades 71c and 71d adjacent to each other across the corner-portion air outlet 56h are fixed in the posture (the airflow direction P0c) where they close the air outlet 56. That is, while the horizontal blades 71a and 71b are the first horizontal blades, the horizontal blades 71c and 71d correspond to the second horizontal blades.

**[0074]** When the horizontal blades 71a and 71b reciprocally rotate one time in the up-and-down direction, the combination of the first horizontal blades changes from the combination of the horizontal blades 71a and 71b to the combination of the horizontal blades 71b and 71c. Meanwhile, the combination of the second horizontal blades changes from the combination of the horizontal blades 71c and 71d to the combination of the horizontal blades 71a and 71d. The horizontal blades 71b and 71c that have become the new first horizontal blades swing just one time in the up-and-down direction at the same timing and while taking the same posture like the horizontal blades 71a and 71b that were the first horizontal blades immediately before. During this time, the horizontal blades 71a and 71d that are the second horizontal blades are fixed in states of the airflow-direction angles corresponding to the airflow directions P0 and P0c, respectively.

**[0075]** After the horizontal blades 71b and 71c have reciprocally rotated one time in the up-and-down direction, the combination of the first horizontal blades changes from the combination of the horizontal blades 71b and 71c to the combination of the horizontal blades 71c and 71d. Meanwhile, the combination of the second horizontal blades changes from the combination of the horizontal blades 71a and 71d to the combination of the horizontal blades 71a and 71b. The horizontal blades 71c and 71d that have become the new first horizontal blades swing just one time in the up-and-down direction at the same timing and while taking the same posture, and the horizontal blades 71a and 71b that have become the second horizontal blades are fixed in states of the airflow-direction angles corresponding to the airflow direction P0.

**[0076]** These actions are repeated, whereby two of the horizontal blades adjacent to each other across the corner-portion air outlets 56e to 56h among the four horizontal blades 71a to 71 d become the first horizontal blades, and every time the first horizontal blades swing one time the combination of the first horizontal blades changes one after another from the horizontal blades 71a and 71b to the horizontal blades 71b and 71c, then from the horizontal blades 71b and 71c to the horizontal blades 71c and 71d, and then from the horizontal blades 71c and 71d to the horizontal blades 71d and 71a. That is, in the present embodiment, the combination of the first horizontal blades shifts sequentially one blade at a time clockwise as seen in a bottom view of the decorative panel 52 (see FIGS. 5 and 12). Consequently, the combination of the first horizontal blades shifts sequentially in such a way as to become a combination of the horizontal blade positioned on the left side of the two horizontal blades that had been the first horizontal blades until then and the horizontal blade positioned further to the left of and adjacent to that horizontal blade and which had been a second horizontal blade until then. Additionally, the remaining two horizontal blades 71a to 71d at those times (the two horizontal blades adjacent to each other across the other corner-portion air outlets 56e to 56h) become the second horizontal blades, and the combination of the second horizontal blades also sequentially changes in accompaniment with the shift in the combination of the first horizontal blades. That is, focusing on the individual horizontal blades 71a to 71d, after each of the horizontal blades 71a to 71d has consecutively swung two times, their postures are fixed for two swings of the other blades. The timings when the horizontal blades 71a to 71d start swinging again from their fixed postures do not coincide among the horizontal blades 71a to 71d but differ for each of the horizontal blades 71a to 71d. Because of this, compared to the case of causing the individual horizontal blades 71a to 71d to swing separately without synchronizing them, the air blown out from the air outlet 56 is reliably sent far by the first horizontal blades while mixing with some of the air in the air-conditioned room. Moreover, because the combination of the first horizontal blades shifts in order, the air is not sent in just one direction but rather the air becomes sent in various directions. For this reason, compared to a case where only one horizontal blade swings and that blade shifts in order, for example, the air is powerfully guided in various directions and the agitation of the air in the air-conditioned room also intensifies.

**[0077]** Moreover, as shown in FIG. 11, the indoor control unit 67 performs control that temporarily stops the actions

of the first horizontal blades when the rotational directions (in the up-and-down direction) of the first horizontal blades (e.g., the horizontal blades 71a and 71b) change. For example, in FIG. 11, in a case where the rotational directions of the horizontal blades 71a and 71b swinging as the first horizontal blades are the down direction and the airflow-direction angles thereof have both reached the airflow direction P4, the horizontal blades 71a and 71b are both fixed during a rest period TA in the state of the airflow direction P4. In this case, the air blown out from the side-portion air outlets 56a and 56b and the corner-portion air outlet 56f becomes blown out in a substantially vertical direction by the horizontal blades 71a and 71b during the rest period TA. Further, for example, in a case where the rotational directions of the horizontal blades 71c and 71d swinging as the first horizontal blades are the up direction and the airflow-direction angles thereof have both reached the airflow direction P0, the horizontal blades 71a and 71b are fixed during the rest period TA in the state of the airflow direction P0. In this case, the air blown out from the side-portion air outlets 56c and 56d and the corner-portion air outlet 56h becomes blown out in a substantially horizontal direction by the horizontal blades 71c and 71d during the rest period TA. In this way, the actions of the first horizontal blades are temporarily stopped when the rotational directions of the first horizontal blades change, so the air blown out from the air outlet 56 can be reliably sent in a vertical direction or a horizontal direction.

**[0078]** The rest period TA is decided to be a predetermined value beforehand by working it out on paper, simulation, or experiment on the basis of the volume of air blown out from the air outlet 56 to the air-conditioned room and the set temperature in the air-conditioned room. In this case, the duration of the rest period TA is a maximum of 5 seconds and is decided to be 3 seconds, for example.

**[0079]** Further, after the elapse of the predetermined amount of time after the start of operation, the indoor control unit 67 ends the rotation control and the combination shift control and tilts the horizontal blades 71 a to 71 d at a predetermined angle. Because of this, the first horizontal blades that were synchronously swinging during the predetermined amount of time after the start of operation stop their swinging actions, the second horizontal blades that were fixed at the predetermined angle are unfixed, and the airflow-direction angles of the horizontal blades 71a to 71d become any of the airflow directions P0 to P4. For example, after the elapse of the predetermined amount of time after the start of operation, the airflow-direction angles of the horizontal blades 71a to 71d can take any of the airflow directions P0 to P4 depending on the type of operation, the set temperature, and the air volume that has been set via the remote controller 99. Further, in a case where swinging actions have been set via the remote controller 99, the horizontal blades 71a to 71d can take any of the airflow directions P0 to P4 by performing swinging actions where they individually and independently rotate in the up-and-down direction.

**[0080]** Here, the predetermined amount of time in which the rotation control and the combination shift control are performed can be 5 minutes, for example, and may also be decided beforehand by working it out on paper, simulation, or experiment. Further, the predetermined amount of time may also be appropriately decided by the indoor control unit 67 in accordance with conditions in the air-conditioned room at those times (specifically, the temperature Tf of the floor, whether or not there are persons in the air-conditioned room, and the intake air temperature Tr).

#### -Air Volume Control-

**[0081]** Further, the indoor control unit 67 performs control of the air volume of the indoor fan 41. The air volume of the indoor fan 41 can, as a result of the indoor control unit 67 changing the rotational speed of the indoor fan motor 41a, be changed in four stages between a high air volume H where the rotational speed of the indoor fan motor 41a is the highest, a medium air volume M where the rotational speed of the indoor fan motor 41a is lower than the rotational speed for the air volume H, a low air volume L where the rotational speed of the indoor fan motor 41 a is even lower than the rotational speed for the air volume M, and a minimum air volume LL where the rotational speed of the indoor fan motor 41a is even lower than the rotational speed for the air volume L. Here, the air volume H, the air volume M, and the air volume L can be set on the basis of a request from the remote controller 99 and the detection values of the various sensors 61 to 63. However, the air volume LL cannot be set by a request from the remote controller 99 but is set in a controlled manner in the case of a predetermined control state.

#### -Remote Control-use Receiving Unit-

**[0082]** The remote control-use receiving unit 69 is for receiving various requests from the remote controller 99 and is configured by an infrared light-receiving element, for example. Specifically, the remote control-use receiving unit 69 can receive instructions to start the cooling operation or the heating operation that have been given by a user via the remote controller 99 and can receive settings relating to the set temperature in the air-conditioned room, the air volume, and the airflow direction and instructions to switch operation on and off with a timer.

**[0083]** In particular, the remote control-use receiving unit 69 pertaining to the present embodiment can receive various settings relating to the airflow direction that have been given via the remote controller 99 from a user and, for example, the setting of a "cycle swinging" mode where the rotation control and the combination shift control described above are

performed. Here, FIG. 13 shows, as an example, screens D 1 and D2 that are displayed on a display 99a of the remote controller 99 in a case where various settings received by the remote control-use receiving unit 69 are given by a user. The screen D1 is a main menu screen, and when "set the airflow direction" is selected from the main menu, a mode selection screen D2 is displayed. From the screen D2, either an "independent swinging" mode where the horizontal blades 71a to 71d rotate individually and independently or the "cycle swinging" mode where the rotation control and the combination shift control are performed can be selected as the content of the actions of the horizontal blades during the predetermined amount of time after the start of operation.

<Actions>

#### (1) Overall Flow of Actions of Ceiling-mounted Indoor Unit

**[0084]** FIGS. 14 and 15 are flowcharts showing an overall flow of actions of the air conditioning apparatus 1 in which the ceiling-mounted indoor unit 4 pertaining to the present embodiment is employed.

**[0085]** Step S1: In a case where an operation such as the heating operation or the cooling operation of the air conditioning apparatus 1 has been instructed to start by a user via the remote controller 99 (YES in S1), the outdoor unit 2 and the ceiling-mounted indoor unit 4 start the operation.

**[0086]** Steps S2 and S3: In a case where the "cycle swinging" mode has been set via the remote controller 99 before the instruction to start the operation is given (YES in S2), the indoor control unit 67 performs the rotation control of the horizontal blades 71a to 71d and the combination shift control of the first horizontal blades pertaining to FIGS. 11 and 12 (S3). That is, the indoor control unit 67 performs the rotation control in such a way that the first horizontal blades synchronously swing while taking the same posture and performs the rotation control that fixes the second horizontal blades at the predetermined angle. Moreover, the indoor control unit 67 shifts the combination of the first horizontal blades one blade at a time clockwise as seen in a bottom view of the decorative panel 52 every time the first horizontal blades swing one time.

**[0087]** Step S4: In a case where the "independent swinging" mode has been set in step S2 (NO in S2), the indoor control unit 67 individually rotates, rather than synchronously rotates, the horizontal blades 71a to 71d (S4).

**[0088]** Steps S5 and S6: In a case where the predetermined amount of time has elapsed after the instruction to start the operation pertaining to step S1 was given (YES in S5), the indoor control unit 67 ends the control of the horizontal blades 71a to 71d pertaining to steps S3 and S4 (S6).

**[0089]** Steps S7 and S8: In a case where the content of the operation that was instructed in step S 1 is the "heating operation" (YES in S7), the indoor control unit 67 performs control of the airflow-direction angles of the horizontal blades 71 a to 71d and air volume control on the basis of the airflow direction and the air volume that have been requested via the remote controller 99 in such a way that the air-conditioned room is heated in accordance with the desired settings (S8).

**[0090]** Steps S9 and S10: In a case where the content of the operation that was instructed in step S1 is the "cooling operation" (YES in S9), the indoor control unit 67 performs control of the airflow-direction angles of the horizontal blades 71a to 71d and air volume control on the basis of the airflow direction and the air volume that have been requested via the remote controller 99 in such a way that the air-conditioned room is cooled in accordance with the desired settings (S 10).

**[0091]** Step S 11: The operation in steps S8 and S10 is performed continuously until the operation of the air conditioning apparatus 1 is instructed to end via the remote controller 99 (NO in S11). When the operation of the air conditioning apparatus 1 is instructed to end (YES in S11), the outdoor unit 2 and the ceiling-mounted indoor unit 4 end the operation.

#### (2) Heating Operation

**[0092]** Actions in the case where the air conditioning apparatus 1 performs the heating operation (step S8) will be described below.

**[0093]** The heating operation is an operation where the air conditioning apparatus 1 heats the air in the air-conditioned room and supplies the heated air as conditioned air to the air-conditioned room by causing the refrigerant in the refrigerant circuit 10 to circulate in such a way that the outdoor heat exchanger 23 functions as an evaporator for the refrigerant and the indoor heat exchanger 42 functions as a radiator for the refrigerant.

**[0094]** In the heating operation, the four-way switching valve 22 is switched in such a way that the outdoor heat exchanger 23 functions as an evaporator for the refrigerant and the indoor heat exchanger 42 functions as a radiator for the refrigerant (that is, the state indicated by the dashed lines of the four-way switching valve 22 in FIG. 1).

**[0095]** In this state of the refrigerant circuit 10, the low-pressure refrigerant in the refrigeration cycle is sucked into the compressor 21, is compressed to a high pressure in the refrigeration cycle, and is thereafter discharged. The high-pressure refrigerant that has been discharged from the compressor 21 is sent through the four-way switching valve 22, the gas-side stop valve 26, and the gas refrigerant connection tube 6 to the indoor heat exchanger 42. The high-pressure refrigerant that has been sent to the indoor heat exchanger 42 exchanges heat in the indoor heat exchanger 42 with the

air in the air-conditioned room supplied by the indoor fan 41 and gives off heat. Because of this, the air in the air-conditioned room is heated, becomes conditioned air, and is blown out into the air-conditioned room from the air outlet 56 (specifically, the side-portion air outlets 56a to 56d and the corner-portion air outlets 56e to 56h). The high-pressure refrigerant that has given off heat in the indoor heat exchanger 42 is sent through the liquid refrigerant connection tube 5 and the liquid-side stop valve 25 to the expansion valve 24 where its pressure is reduced to a low pressure in the refrigeration cycle. The low-pressure refrigerant whose pressure has been reduced in the expansion valve 42 is sent to the outdoor heat exchanger 23. The low-pressure refrigerant that has been sent to the outdoor heat exchanger 23 exchanges heat in the outdoor heat exchanger 23 with the outdoor air supplied by the outdoor fan 27 and evaporates. The low-pressure refrigerant that has evaporated in the outdoor heat exchanger 23 is again sucked into the compressor 21 through the four-way switching valve 22.

**[0096]** In the heating operation, the intake air temperature  $T_r$  is controlled so as to become a target air temperature  $T_{rs}$  that has been requested from the remote controller 99 or the like. That is, in the heating operation, in a case where the intake air temperature  $T_r$  is lower than the target air temperature  $T_{rs}$ , the indoor control unit 67 performs the operation control (hereinafter this state will be called a "heating thermostat ON state"). Additionally, in a case where the intake air temperature  $T_r$  has reached the target air temperature  $T_{rs}$ , the indoor control unit 67 performs control that stops the compressor 21 to ensure that the refrigerant in the refrigerant circuit 10 is not circulated and changes the air volume of the indoor fan 41 to the air volume LL (hereinafter this state will be called a "heating thermostat OFF state").

**[0097]** Further, in a case where the control based on the requested airflow direction and the requested air volume is performed, the indoor control unit 67 can control the airflow-direction angles of the horizontal blades 71a to 71d and the air volume of the indoor fan 41 while setting them to a variety of airflow directions and air volumes on the basis of the detection results of the various sensors 61 to 63 so that the comfort level of the user in the air-conditioned room can be raised.

**[0098]** For example, in a case where the presence sensor 62 has detected the presence of a person in the air conditioning target areas A to D, the indoor control unit 67 can set, on the basis of the detection value, the airflow-direction angle of the horizontal blade in the side-portion air outlet corresponding to the air conditioning target area in which the presence of the person has been detected to the airflow direction P0. On the other hand, in the air conditioning target areas in which no presence of a person is detected among the air conditioning target areas A to D, the indoor control unit 67 can set the airflow-direction angles of the horizontal blades in the side-portion air outlets corresponding to the air conditioning target areas in which no presence of a person is detected to the airflow directions P1 to P3 that face more downward than the airflow direction P0. Because of this, discomfort caused by a draft on a user present in the air conditioning target areas A to D can be suppressed and the comfort level of the user can be improved.

**[0099]** Further, in a case where the temperature  $T_f$  of the floor in the air-conditioned room detected by the floor temperature sensor 63 is lower than a target floor temperature  $T_{fs}$ , the indoor control unit 67 can set the airflow-direction angles of the horizontal blades 71a to 71d to downward-facing airflow directions (e.g., the airflow directions P3 and P4). On the other hand, in a case where the temperature  $T_f$  of the floor in the air-conditioned room has reached the target floor temperature  $T_{fs}$ , the indoor control unit 67 can set the airflow-direction angles of the horizontal blades 71a to 71d to airflow directions (e.g., the airflow directions P0 and P1) that face more upward than the airflow directions P3 and P4. Because of this, in a case where the vicinity of the floor in the air-conditioned room is not sufficiently heated, heated air can be caused to reach the floor and the comfort level of the user in the air-conditioned room can be improved.

**[0100]** In addition, the indoor control unit 67 may also change the airflow-direction angles of the horizontal blades 71a to 71d and the airflows on the basis of an average temperature of the intake air temperature  $T_r$  detected by the intake air temperature sensor 61 and the temperature  $T_f$  of the floor in the air-conditioned room and also a combination of the average temperature and the detection result of the presence sensor 62.

### (3) Cooling Operation

**[0101]** Actions in the case where the air conditioning apparatus 1 performs the cooling operation (step S 10) will be described below.

**[0102]** The cooling operation is an operation where the air conditioning apparatus 1 cools the air in the air-conditioned room and supplies the cooled air as conditioned air to the air-conditioned room by causing the refrigerant in the refrigerant circuit 10 to circulate in such a way that the outdoor heat exchanger 23 functions as a radiator for the refrigerant and the indoor heat exchanger 42 functions as an evaporator for the refrigerant.

**[0103]** In the cooling operation, the four-way switching valve 22 is switched in such a way that the outdoor heat exchanger 23 functions as a radiator for the refrigerant and the indoor heat exchanger 42 functions as an evaporator for the refrigerant (that is, the state indicated by the solid lines of the four-way switching valve 22 in FIG. 1).

**[0104]** In this state of the refrigerant circuit 10, the low-pressure refrigerant in the refrigeration cycle is sucked into the compressor 21, is compressed to a high pressure in the refrigeration cycle, and is thereafter discharged. The high-pressure refrigerant that has been discharged from the compressor 21 is sent through the four-way switching valve 22

to the outdoor heat exchanger 23. The high-pressure refrigerant that has been sent to the outdoor heat exchanger 23 exchanges heat in the outdoor heat exchanger 23 with the outdoor air supplied by the outdoor fan 27 and gives off heat. The high-pressure refrigerant that has given off heat in the outdoor heat exchanger 23 is sent to the expansion valve 24 where its pressure is reduced to a low pressure in the refrigeration cycle. The low-pressure refrigerant whose pressure has been reduced in the expansion valve 24 is sent through the liquid-side stop valve 25 and the liquid refrigerant connection tube 5 to the indoor heat exchanger 42. The low-pressure refrigerant that has been sent to the indoor heat exchanger 42 exchanges heat in the indoor heat exchanger 42 with the air in the air-conditioned room supplied by the indoor fan 41 and evaporates. Because of this, the air in the air-conditioned room is cooled, becomes conditioned air, and is blown out into the air-conditioned room from the air outlet 56 (specifically, the side-portion air outlets 56a to 56d and the corner-portion air outlets 56e to 56h). The low-pressure refrigerant that has evaporated in the indoor heat exchanger 42 is again sucked into the compressor 21 through the gas refrigerant connection tube 6, the gas-side stop valve 26, and the four-way switching valve 22.

**[0105]** In the cooling operation, the intake air temperature  $T_r$  is controlled so as to become the target air temperature  $T_{rs}$  that has been requested from the remote controller 99 or the like. That is, in the cooling operation, in a case where the intake air temperature  $T_r$  is higher than the target air temperature  $T_{rs}$ , the indoor control unit 67 performs the operation control (hereinafter this state will be called a "cooling thermostat ON state"). Additionally, in a case where the intake air temperature  $T_r$  has reached the target air temperature  $T_{rs}$ , the indoor control unit 67 performs control that stops the compressor 21 to ensure that the refrigerant in the refrigerant circuit 10 is not circulated and changes the air volume of the indoor fan 41 to the air volume LL (hereinafter this state will be called a "cooling thermostat OFF state").

**[0106]** Further, in a case where the control based on the requested airflow direction and the requested air volume is performed, the indoor control unit 67 can control the airflow-direction angles of the horizontal blades 71a to 71d and the air volume of the indoor fan 41 while setting them to a variety of airflow directions and air volumes on the basis of the detection results of the various sensors 61 to 63 so that the comfort level of the user in the air-conditioned room can be raised.

**[0107]** For example, in a case where the presence sensor 62 has detected the presence of a person in the air conditioning target areas A to D, the indoor control unit 67 can set, on the basis of the detection value, the airflow-direction angle of the horizontal blade in the side-portion air outlet corresponding to the air conditioning target area in which the presence of the person has been detected to the airflow direction P0. On the other hand, in the air conditioning target areas in which no presence of a person is detected among the air conditioning target areas A to D, the indoor control unit 67 can set the airflow-direction angles of the horizontal blades in the side-portion air outlets corresponding to the air conditioning target areas in which no presence of a person is detected to the airflow directions P1 to P3 that face more downward than the airflow direction P0. Because of this, discomfort caused by a draft on a user present in the air conditioning target areas A to D can be suppressed and the comfort level of the user can be improved.

<Characteristics>

**[0108]** The ceiling-mounted indoor unit 4 pertaining to the present embodiment has the following characteristics.

(1)

In a conventional indoor unit, the indoor unit agitates the air in the air-conditioned room by causing adjacent horizontal blades to swing mutually oppositely. However, in this indoor unit, the airflows sent into the air-conditioned room from the adjacent horizontal blades end up weakening each other and the airflow velocity ends up dropping. Consequently, the force with which the air in the air-conditioned room is agitated ends up becoming weaker, and it ends up becoming difficult to send the air blown out from the air outlet to places away from the indoor unit. Further, even if the indoor unit causes just one horizontal blade to swing and shifts the swinging horizontal blade in order, the volume of air guided from the one horizontal blade into the air-conditioned room is small, and the air in the room cannot be sufficiently agitated.

In contrast, in the ceiling-mounted indoor unit 4 pertaining to the present embodiment, the first horizontal blades that are two of the horizontal blades 71a to 71d adjacent to each other synchronously swing while taking the same posture. Because of this, the air blown out from the air outlet 56 is sent into the air-conditioned room in such a way as to be surrounded by the first horizontal blades, and the air in the air-conditioned room becomes agitated. Consequently, in the ceiling-mounted indoor unit 4 pertaining to the present embodiment, a higher agitating effect can be obtained compared to a case where adjacent horizontal blades perform individually different swings, and the air blown out into the air-conditioned room from the air outlet 56 in the ceiling-mounted indoor unit 4 can be sent farther. In particular, in the present embodiment, the combination of the first horizontal blades is shifted in order along the peripheral edge portion of the decorative panel 52. For that reason, a higher agitating effect can be obtained compared to a case where the combination of the first horizontal blades that synchronously swing is fixed.

(2)

Further, in the ceiling-mounted indoor unit 4 pertaining to the present embodiment, the combination of the first horizontal blades shifts sequentially one blade at a time. For that reason, the air in the air-conditioned room becomes more easily agitated.

(3)

Further, in the ceiling-mounted indoor unit 4 pertaining to the present embodiment, the combination of the first horizontal blades is shifted every time the first horizontal blades reciprocally rotate a predetermined number of times in the up-and-down direction with respect to the air outlet 56. That is, the timing when the combination of the first horizontal blades shifts becomes matched to the action of the reciprocal rotation of the first horizontal blades. For that reason, by setting the number of times that the first horizontal blades reciprocally rotate, the far reach of the blown air can be given priority or the agitation of the air in the air-conditioned room can be given priority.

(4)

Further, in the ceiling-mounted indoor unit 4 pertaining to the present embodiment, the second horizontal blades that are the remaining blades excluding the first horizontal blades are fixed at the predetermined angle while the first horizontal blades synchronously swing while taking the same posture. For that reason, the air in the air-conditioned room becomes agitated by the first horizontal blades that are swinging, and the air in the air-conditioned room becomes sent far, for example, by the second horizontal blades.

(5)

Moreover, in the ceiling-mounted indoor unit 4 pertaining to the present embodiment, as shown in FIG. 11, the so-called rest periods TA in which the actions of the first horizontal blades temporarily stop when the rotational directions of the first horizontal blades change are disposed. This is because when the rotational directions end up immediately changing from the down direction to the up direction during the heating operation, for example, it becomes difficult for the vicinity of the floor in the air-conditioned room to become heated. Because of this, as the air in the air-conditioned room is being agitated, the air blown out from the air outlet 56 is reliably blown out in a horizontal direction or a vertical direction, for example. Consequently, when the rotational directions change from the down direction to the up direction during the heating operation, for example, the heated air from the air outlet 56 becomes blown out in the down direction, so the vicinity of the floor can be heated while remedying the imbalance in the temperature in the air-conditioned room.

Further, when the rotational directions change from the up direction to the down direction during the cooling operation, for example, the cool air from the air outlet 56 becomes blown out in the up direction, so discomfort that a user feels because of a so-called cold draft can be suppressed.

(6)

Further, in the ceiling-mounted indoor unit 4 pertaining to the present embodiment, until the predetermined amount of time elapses after the start of operation, the action of the first horizontal blades synchronously swinging while taking the same posture and the action of the combination of the first horizontal blades shifting in order along the peripheral edge portion of the undersurface are performed. However, after the predetermined amount of time elapses, these actions end and the horizontal blades 71a to 71d tilt at the predetermined angle. Because of this, air with the desired temperature can be supplied to the air-conditioned room whose air has been sufficiently agitated, so discomfort that a user feels because of a draft can be suppressed and the air-conditioned room can be made comfortable.

(7)

Further, in the ceiling-mounted indoor unit 4 pertaining to the present embodiment, the first horizontal blades adjacent to each other across an arbitrary corner-portion air outlet 56e to 56h synchronously swing while taking the same posture. Moreover, the combination of the first horizontal blades shifts sequentially. For that reason, the air blown out from the corner-portion air outlets 56e to 56h is, together with the air blown out from the side-portion air outlets 56a to 56d opened and closed by the first horizontal blades, reliably sent far by the first horizontal blades while incorporating some of the air in the air-conditioned room. Consequently, the air in the air-conditioned room can be agitated by even more of the air that is blown out, and even more of the conditioned air can be sent far, compared to the case of causing the individual horizontal blades to swing separately without synchronizing them.

(8)

In particular, in the present embodiment, the first horizontal blades are configured by two of the horizontal blades 71a to 71d adjacent to each other. Because of this, the air in the air-conditioned room can be effectively agitated and even more of the conditioned air can be sent far.

#### <Other Embodiments>

**[0109]** An embodiment of the present invention has been described above on the basis of the drawings, but the specific configurations thereof are not limited to this embodiment and are changeable without departing from the gist of the invention.

(A)

In the above embodiment, a case was described where the combination of the first horizontal blades shifts every time the first horizontal blades swing one time. However, the indoor control unit 67 may also shift the combination of the first horizontal blades after the first horizontal blades swing two or more times rather than one time.

Further, as shown in FIG. 16, the indoor control unit 67 may also shift the combination of the first horizontal blades every time the first horizontal blades swing for a predetermined amount of time (corresponding to a first predetermined amount of time). Here, as an example, FIG. 16 shows a case where the combination of the first horizontal blades changes every minute. In FIG. 16, like in FIG. 12, the horizontal blades that are blacked out represent the first horizontal blades, and the horizontal blades that are not blacked out represent the second horizontal blades.

The number of times that the first horizontal blades swing and the amount of time in which the first horizontal blades swing, which serve as the timing when the combination of the first horizontal blades shift, may be decided beforehand by working it out on paper, simulation, or experiment or may be appropriately decided by the indoor control unit 67 in accordance with conditions in the air-conditioned room at those times (specifically, the temperature  $T_f$  of the floor, whether or not there are persons in the air-conditioned room, and the intake air temperature  $T_r$ ). By appropriately setting the amount of time in which the first horizontal blades swing, the far reach of the blown air can be given priority or the agitation of the air in the air-conditioned room can be given priority.

(B)

In the above embodiment, a case was described where the combination of the first horizontal blades shifts sequentially clockwise as seen in a bottom view of the decorative panel 52. However, the combination of the first horizontal blades may also shift sequentially counter-clockwise as seen in a bottom view of the decorative panel 52. Whether the combination of the first horizontal blades shifts clockwise or counter-clockwise may be decided beforehand by working it out on paper, simulation, or experiment or may be appropriately decided by the indoor control unit 67 in accordance with conditions in the air-conditioned room at those times (specifically, the temperature  $T_f$  of the floor, whether or not there are persons in the air-conditioned room, and the intake air temperature  $T_r$ ).

(C)

In the above embodiment, a case was described where, as shown in FIG. 11, the second horizontal blades are fixed in the airflow direction "P0." However, the angle at which the second horizontal blades are fixed is not limited to the airflow direction "P0" and may be any angle. For example, the second horizontal blades may be fixed at an angle corresponding to the downward-facing airflow direction "P4" in the case of the heating operation and fixed at an angle corresponding to the upward-facing airflow direction "P1" in the case of the cooling operation.

Further, the second horizontal blades may also swing to a small extent between the airflow direction P0 and the airflow direction P1, for example, rather than being fixed at a predetermined angle while the first horizontal blades swing between the airflow direction P0 and the airflow direction P4. In this case, the swing of the second horizontal blades is sufficiently small compared to the swing of the first horizontal blades.

(D)

In the above embodiment, a case was described where the first horizontal blades are configured by two blades. However, the number of blades configuring the first horizontal blades may also be more than two, such as three, for example. In this regard, however, in a case where N represents the number of the horizontal blades disposed in the ceiling-mounted indoor unit, the upper limit of the number of blades configuring the first horizontal blades should be equal to or less than N-1. That is, it is necessary that a number M of the blades configuring the first horizontal blades satisfy the condition of " $2 \leq M \leq N-1$ ."

FIGS. 17 and 18 show a case where the first horizontal blades are configured by three of the horizontal blades adjacent to each other. Specifically, as shown in FIGS. 17 and 18, examples of combinations of the first horizontal blades include the combination of the horizontal blades 71 a, 71 b, and 71 c, the combination of the horizontal blades 71 b, 71 c, and 71 d, the combination of the horizontal blades 71 c, 71 d, and 71 a, and the combination of the horizontal blades 71 d, 71 a, and 71 b. Additionally, in a case where the combination of the first horizontal blades is the horizontal blades 71 a to 71 c, for example, the horizontal blade 71 d other than the horizontal blades 71 a to 71 c becomes the second horizontal blade. In this case, the horizontal blades 71 a to 71 c that are the first horizontal blades synchronously swing while taking the same posture, and the horizontal blade 71 d that is the second horizontal blade is fixed at a predetermined angle (e.g., the airflow direction P0). Additionally, after the first horizontal blades swing one time, the combination of the first horizontal blades is shifted in order along the peripheral edge portion of the decorative panel 52. Specifically, in FIGS. 17 and 18, the combination of the first horizontal blades shifts one blade at a time clockwise as seen in a bottom view of the decorative panel 52. That is, focusing on the individual horizontal blades 71 a to 71 d, after each the horizontal blades 71 a to 71 d has consecutively swung three times, they take postures in which they are fixed at a predetermined angle for one swing of the other blades. The timings when the horizontal blades 71 a to 71 d start swinging again from their fixed postures do not coincide among the horizontal blades 71 a to 71 d but differ for each of the horizontal blades 71 a to 71 d. Because of this, the air in the air-conditioned room can be effectively agitated and even more of the conditioned air can be sent far.

Further, in FIGS. 17 and 18, a case was described where the combination of the first horizontal blades shifts one blade at a time as shown in the shift from the combination of the horizontal blades 71a, 71b, and 71c to the combination of the horizontal blades 71b, 71c, and 71d. However, in a case where the first horizontal blades are configured by three of the horizontal blades, the combination is not limited to a case where it shifts one blade at a time and may also shift two blades at a time. Examples of cases where the combination of the first horizontal blades shifts two blades at a time include a shift from the combination of the horizontal blades 71a, 71b, and 71c to the combination of the horizontal blades 71c, 71d, and 71a.

(E)

In the above embodiment, a case was described where, as shown in FIG. 11, all of the horizontal blades 71a to 71d tilt at the predetermined angle after the cycle swinging mode is performed and the predetermined amount of time elapses after the start of operation. However, the horizontal blades that switch over to the action of tilting at the predetermined angle after the elapse of the predetermined amount of time may also be just the horizontal blades that were the first horizontal blades immediately before the elapse of the predetermined amount of time. For example, the horizontal blades that were the second horizontal blades immediately before the elapse of the predetermined amount of time may also, even after the elapse of the predetermined amount of time, continue to take the posture that they had taken in which they were fixed without swinging.

(F)

In the above embodiment, a case was described where there were four horizontal blades—that is, a case where the conditioned air is blown out in four directions. However, the number of the horizontal blades is not limited to this and may also be more than four. That is, the ceiling-mounted indoor unit 4 pertaining to the present invention can also be applied to a case where it blows out the conditioned air in more than four directions.

(G)

In the above embodiment, a type of the ceiling-mounted indoor unit 4 where the air outlet 56 and the four horizontal blades 71a to 71d are disposed in the decorative panel 52 corresponding to the undersurface of the casing 51 was described. However, the ceiling-mounted indoor unit pertaining to the present invention can also be employed in a type of indoor unit where air outlets are disposed in each side surface of the casing.

(H)

In the above embodiment, a case was described where the rest periods TA are decided to be a predetermined value beforehand. However, the rest periods TA may also be appropriately changed in accordance with the detection results of the various sensors 61 to 63 at those times.

For example, let it be assumed that during the heating operation a person in the air conditioning target areas A to D was not detected by the presence sensor 62. In this case, in a case where the temperature Tf of the floor is low and the temperature difference between the intake air temperature Tr detected by the intake air temperature sensor 61 and the temperature Tf of the floor detected by the floor temperature sensor 63 is equal to or greater than a first temperature difference, the indoor control unit 67 may set the rest periods TA to a long duration (e.g., 5 seconds). Conversely, in a case where the temperature Tf of the floor is high and the temperature difference is equal to or less than a second temperature difference and is lower than the first temperature difference, the indoor control unit 67 may set the rest periods TA to a short duration (e.g., 1 second).

Further, the duration of the rest periods may differ depending on whether the content of the operation that has been instructed to start is heating or cooling or may differ in accordance with the airflow direction of the air blown out from the air outlet 56. For example, during the heating operation, the rest periods may be set to a short duration in a case where the airflow-direction angles of the horizontal blades 71a to 71d are the airflow direction P0 and set to a long duration in a case where the airflow-direction angles of the horizontal blades 71a to 71d are the airflow direction P4. Because of this, when the rotational directions change, the air that has been heated by heat exchange is not blown out much in an approximately horizontal direction but becomes blown out for a relatively long time in an approximately vertical direction. Consequently, the temperature Tf of the floor can be raised while agitating the air in the air-conditioned room. Further, during the cooling operation, the rest periods may be set to a long duration in a case where the airflow-direction angles of the horizontal blades 71a to 71d are the airflow direction P0 and set to a short duration in a case where the airflow-direction angles of the horizontal blades 71a to 71d are the airflow direction P4. Because of this, even as the air in the air-conditioned room is being agitated, when the rotational directions change, the air that has been cooled by heat exchange is not blown out much in an approximately vertical direction but becomes blown out for a relatively long time in an approximately horizontal direction. Consequently, the discomfort that a user feels because of a cold draft can be suppressed.

(I)

In the above embodiment, the action of the first horizontal blades synchronously swinging while taking the same posture and the action of the combination of the first horizontal blades shifting sequentially were described as being performed until the predetermined amount of time elapses after the start of operation. However, these actions are not limited being performed during the predetermined amount of time after the start of operation (i.e., immediately

after the air conditioning apparatus starts up) and may also be performed during normal operation where the air conditioning apparatus regulates, by heating and cooling, the room to the temperature requested by a user.

## INDUSTRIAL APPLICABILITY

**[0110]** The present invention is widely applicable to ceiling-mounted indoor units for air conditioning apparatus where plural horizontal blades whose airflow-direction angles in an up-and-down direction are capable of being changed independently are disposed in an air outlet.

## REFERENCE SIGNS LIST

### [0111]

|                    |                                                   |
|--------------------|---------------------------------------------------|
| 1                  | Air Conditioning Apparatus                        |
| 4                  | Ceiling-mounted Indoor Unit                       |
| 39                 | Outdoor Control Unit                              |
| 41                 | Indoor Fan                                        |
| 51                 | Casing                                            |
| 56                 | Air Outlet                                        |
| 56a, 56b, 56c, 56d | Side-portion Air Outlets                          |
| 56e, 56f, 56g, 56h | Comer-portion Air Outlets                         |
| 61                 | Intake Air Temperature Sensor                     |
| 62                 | Presence Sensor                                   |
| 63                 | Floor Temperature Sensor                          |
| 71a, 71b, 71c, 71d | Horizontal Blades                                 |
| 67                 | Indoor Control Unit                               |
| 69                 | Remote Control-use Receiving Unit                 |
| 99                 | Remote Controller                                 |
| 99a                | Display                                           |
| D1, D2             | Screens Displayed on Display of Remote Controller |

## CITATION LIST

<Patent Literature>

**[0112]** Patent Citation 1: Japanese Patent Unexamined publication No.2009-103417

## Claims

1. A ceiling-mounted indoor unit (4) for an air conditioning apparatus disposed in a ceiling of an air-conditioned room, the ceiling-mounted indoor unit comprising:

a casing (51) in which an air outlet (56) is formed along a peripheral edge portion of an undersurface of the casing; at least four horizontal blades (71a to 71d) that are rotatably disposed in the air outlet (56) and whose airflow-direction angles in an up-and-down direction are capable of being changed independently; and  
 5 a control unit (67) that controls the horizontal blades (71a to 71d) in such a way that first horizontal blades, which are at least two of the horizontal blades adjacent to each other among the horizontal blades, synchronously swing while taking the same posture and a combination of the first horizontal blades shifts in order along the peripheral edge portion.

2. The ceiling-mounted indoor unit (4) for the air conditioning apparatus according to claim 1, wherein the control unit (67) shifts the combination of the first horizontal blades sequentially one blade at a time.
3. The ceiling-mounted indoor unit (4) for the air conditioning apparatus according to claim 1 or 2, wherein the control unit (67) shifts the combination of the first horizontal blades every time the first horizontal blades reciprocally rotate a predetermined number of times in the up-and-down direction with respect to the air outlet.
4. The ceiling-mounted indoor unit (4) for the air conditioning apparatus according to claim 1 or 2, wherein the control unit (67) shifts the combination of the first horizontal blades every time the first horizontal blades swing for a first predetermined amount of time.
5. The ceiling-mounted indoor unit (4) for the air conditioning apparatus according to any one of claims 1 to 4, wherein the control unit (67) puts second horizontal blades, which are the remaining blades among the at least four horizontal blades excluding the first horizontal blades, into a state where the second horizontal blades are fixed at a predetermined angle while the first horizontal blades synchronously swing while taking the same posture.
6. The ceiling-mounted indoor unit (4) for the air conditioning apparatus according to any one of claims 1 to 5, wherein the first horizontal blades (71a to 71d) reciprocally rotate in the up-and-down direction with respect to the air outlet, and the control unit (67) temporarily stops the actions of the first horizontal blades when the rotational directions of the first horizontal blades change.
7. The ceiling-mounted indoor unit (4) for the air conditioning apparatus according to any one of claims 1 to 6, wherein during a second predetermined amount of time after the start of operation, the control unit (67) controls the horizontal blades in such a way that the first horizontal blades synchronously swing while taking the same posture and the combination of the first horizontal blades shifts in order along the peripheral edge portion, and after the elapse of the second predetermined amount of time after the start of operation, the control unit (67) tilts the first horizontal blades at a predetermined angle.
8. The ceiling-mounted indoor unit (4) for the air conditioning apparatus according to any one of claims 1 to 7, wherein the undersurface of the casing (51) has a substantially four-sided shape as seen in a plan view, four of the horizontal blades (71a to 71d) are disposed in correspondence to each side of the undersurface, and the air outlet (56) has corner-portion air outlets that are divided by the horizontal blades (71a to 71d) and correspond to each corner portion of the undersurface.
9. The ceiling-mounted indoor unit (4) for the air conditioning apparatus according to claim 8, wherein the first horizontal blades are configured by two of the horizontal blades adjacent to each other.
10. The ceiling-mounted indoor unit (4) for the air conditioning apparatus according to claim 8, wherein the first horizontal blades are configured by three of the horizontal blades adjacent to each other.

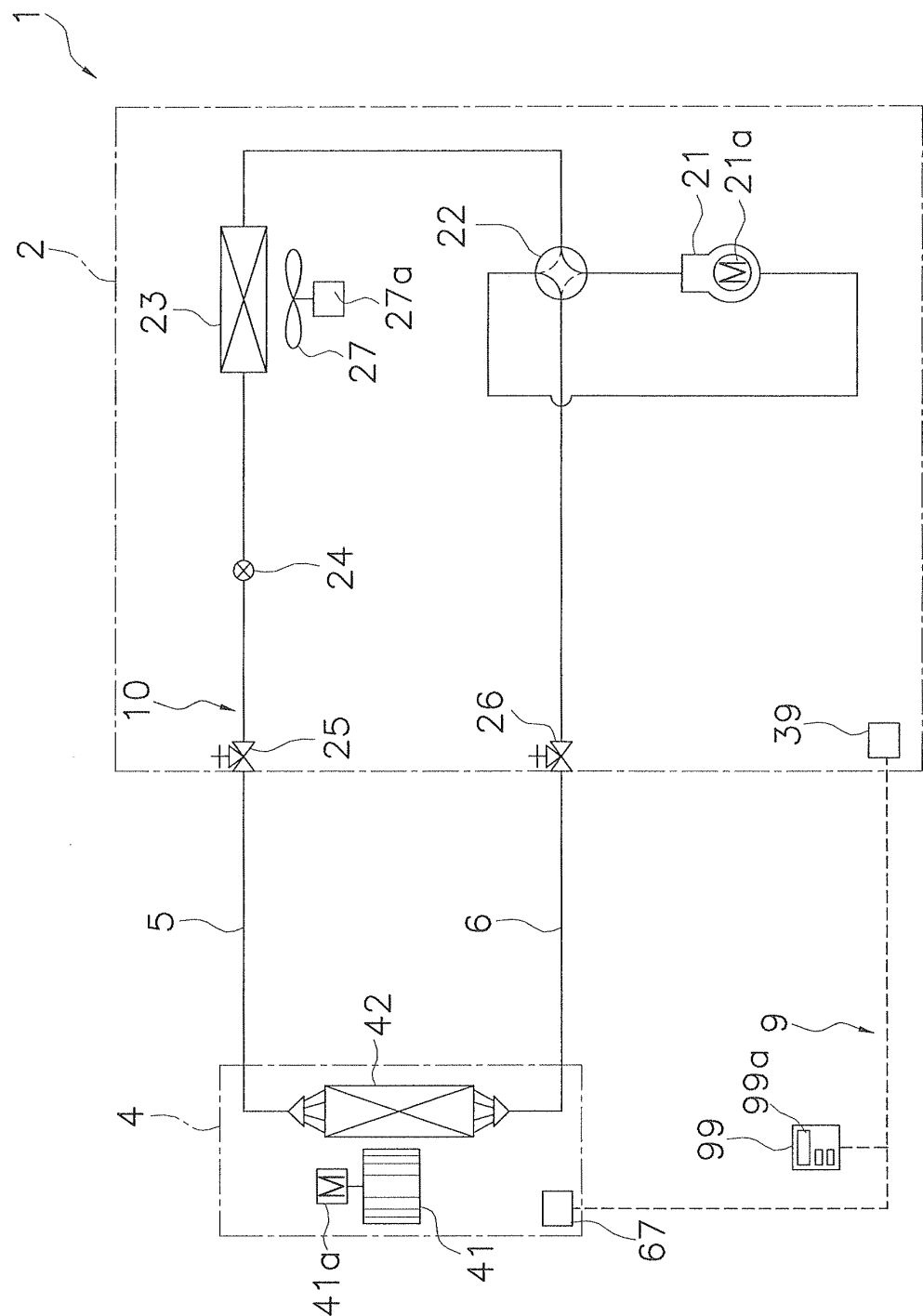


FIG. 1

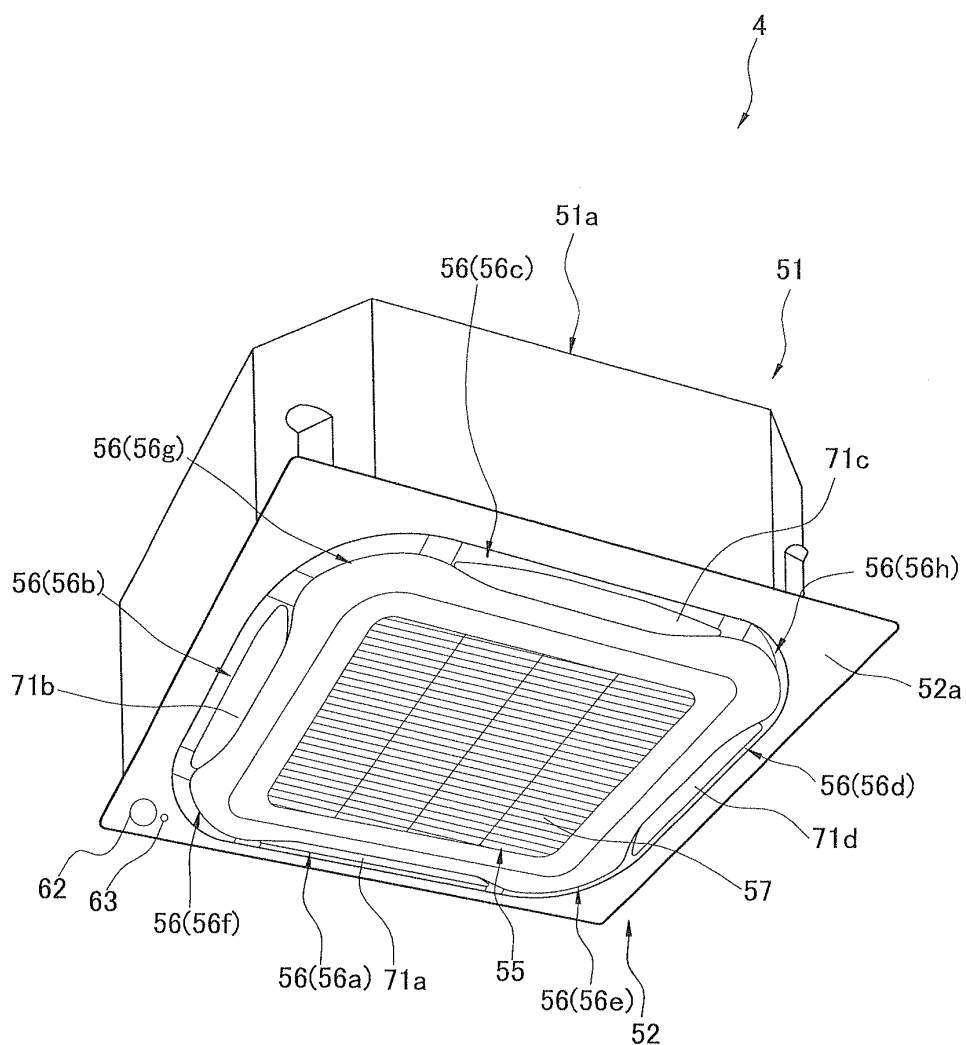


FIG. 2

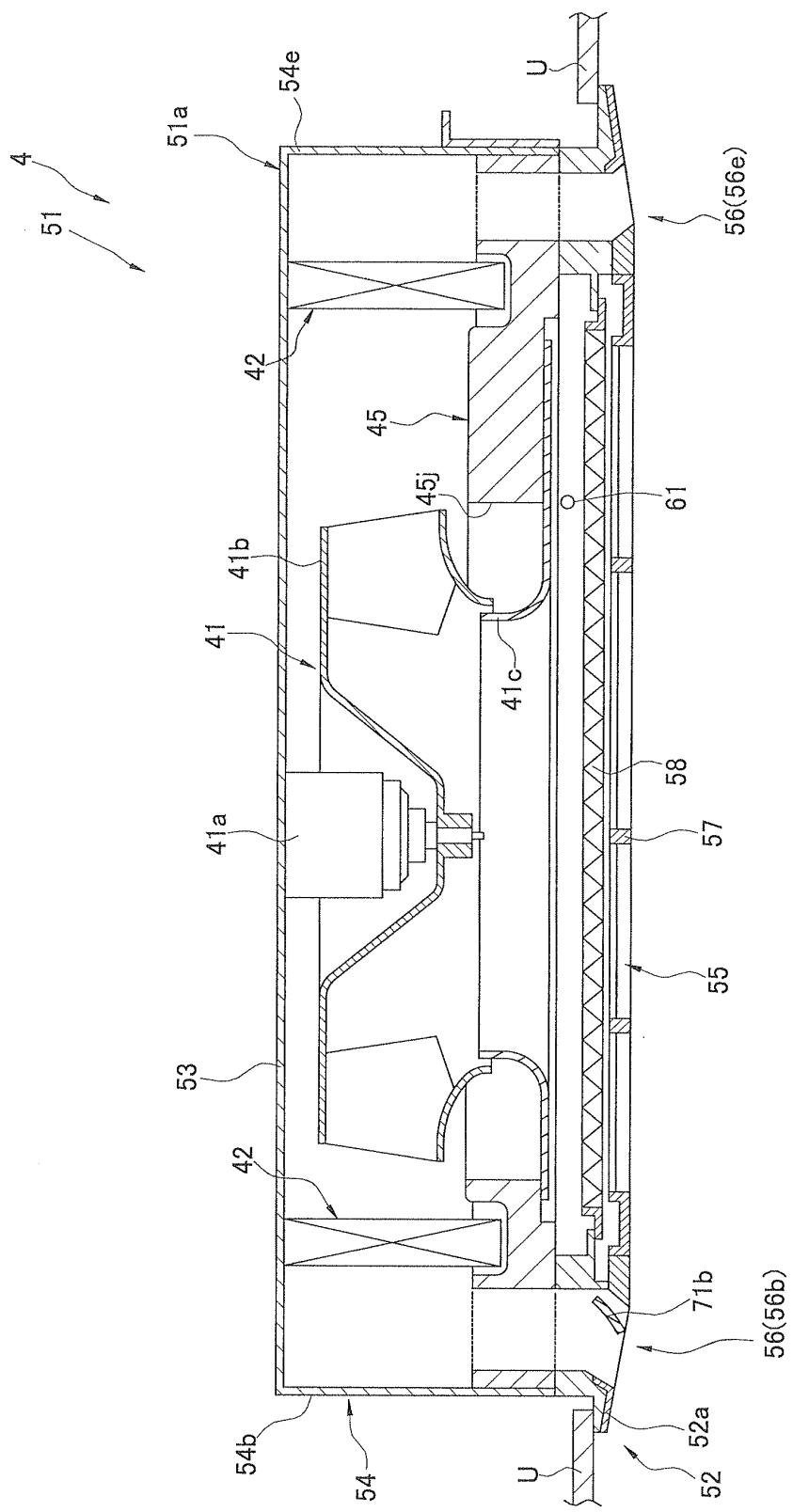


FIG. 3

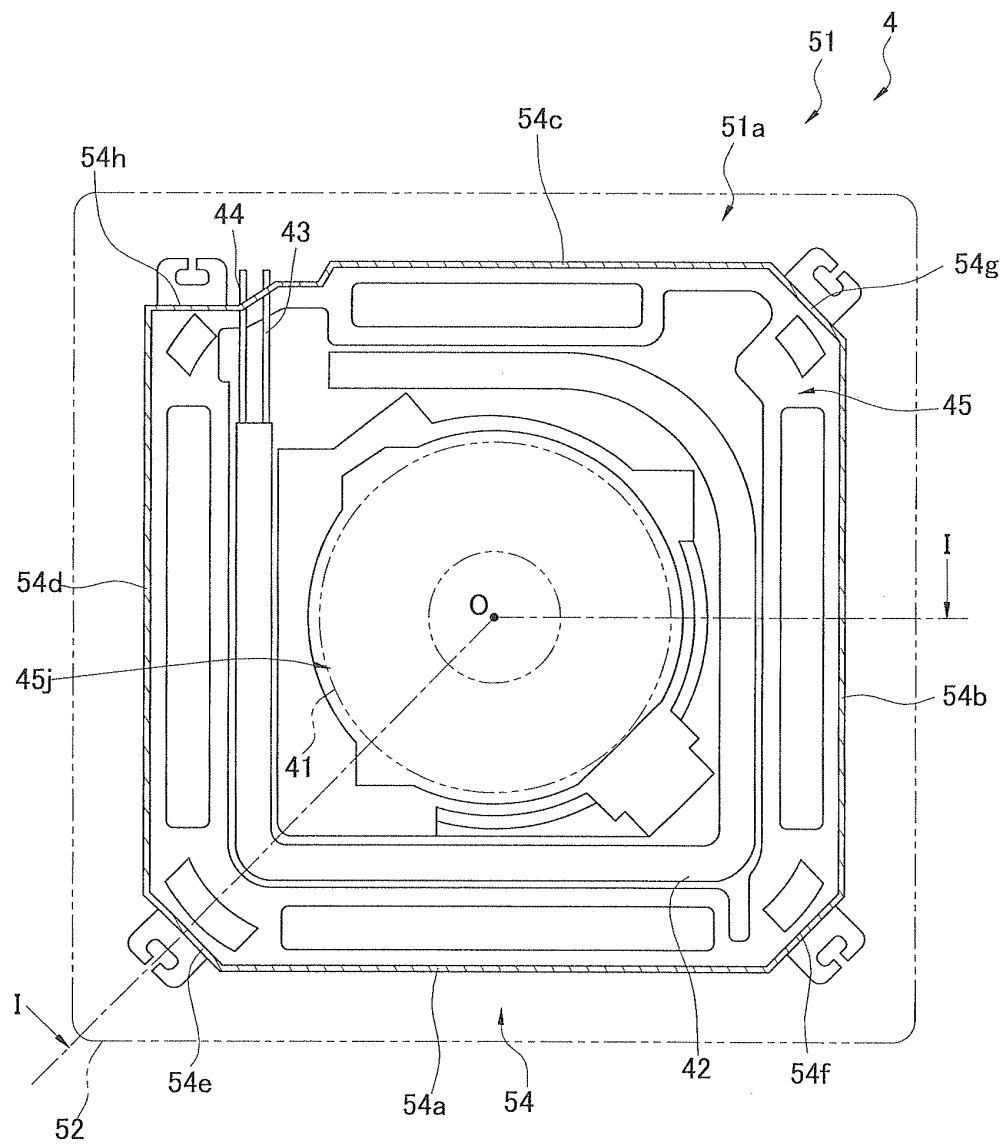


FIG. 4

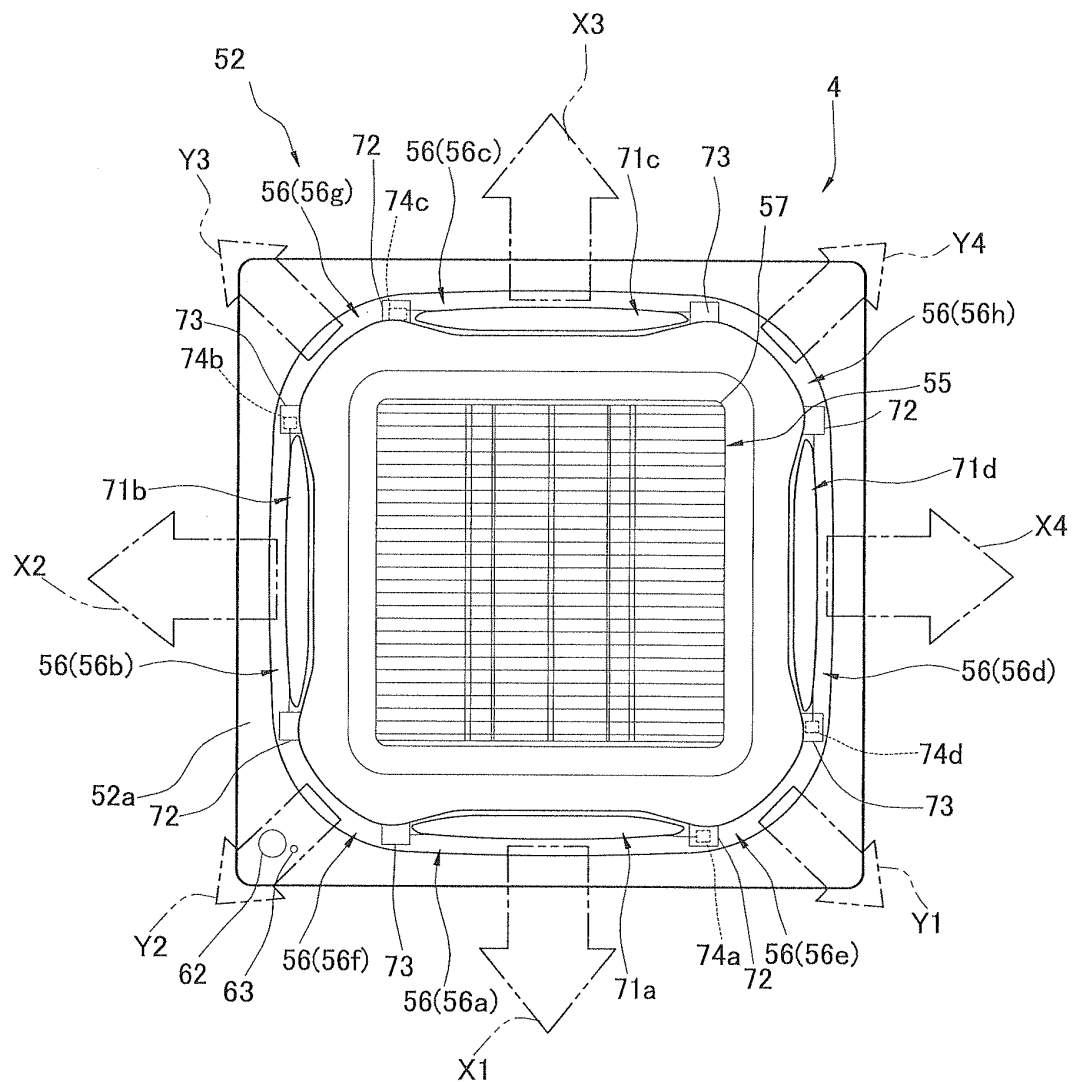


FIG. 5

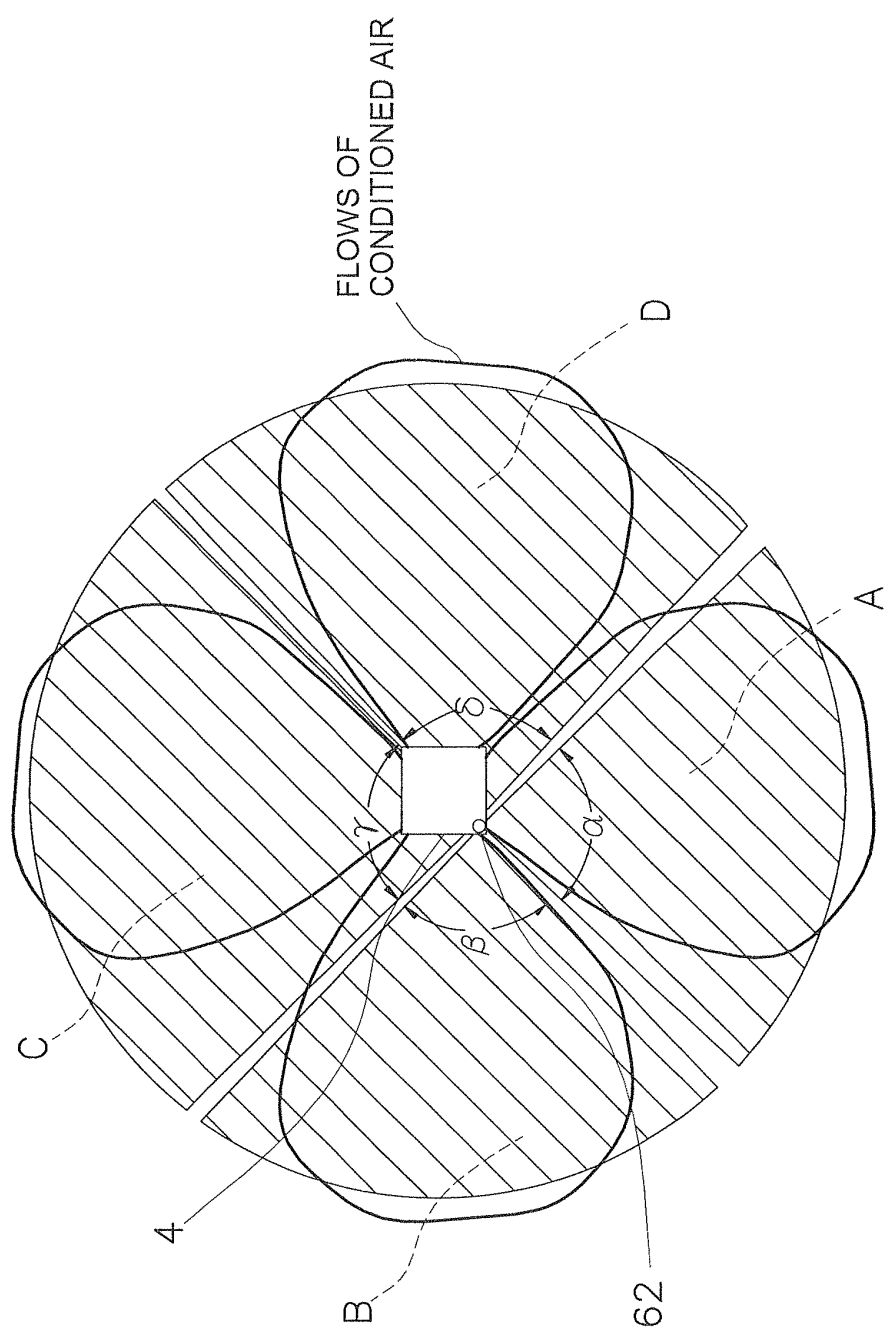


FIG. 6

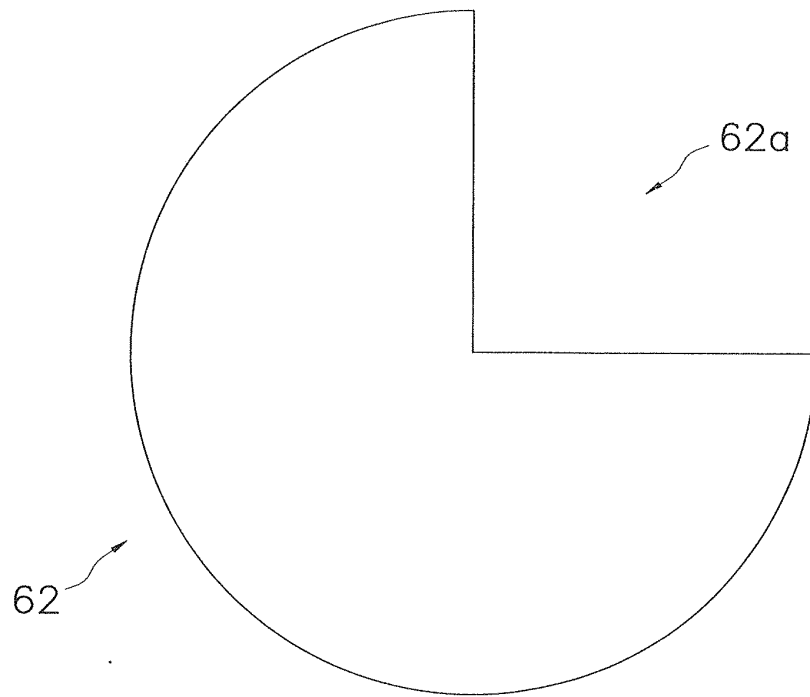


FIG. 7

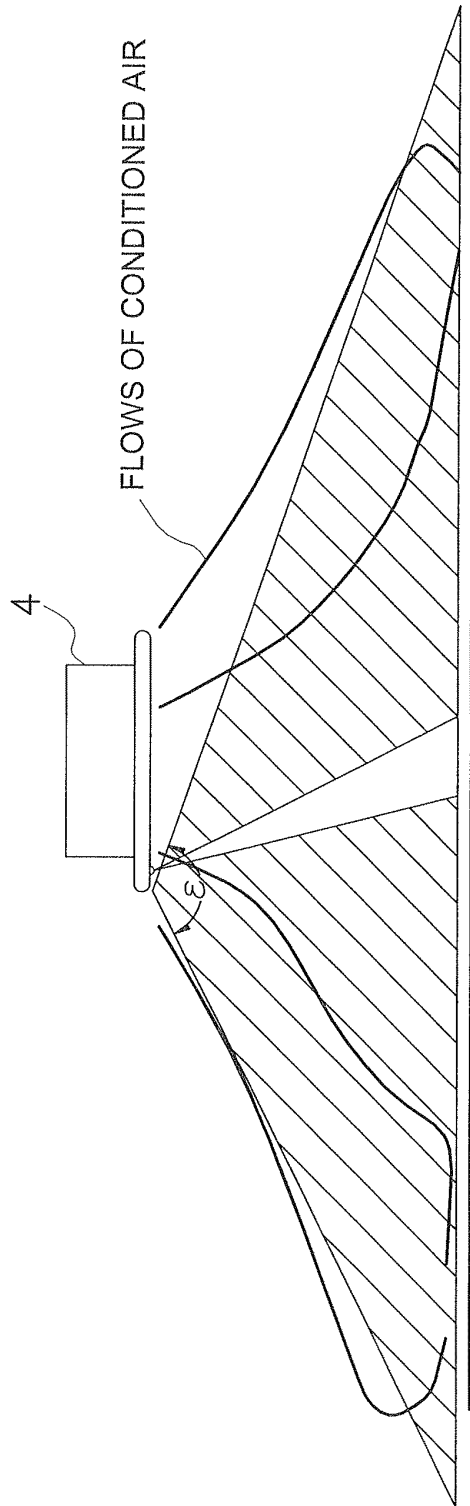


FIG. 8

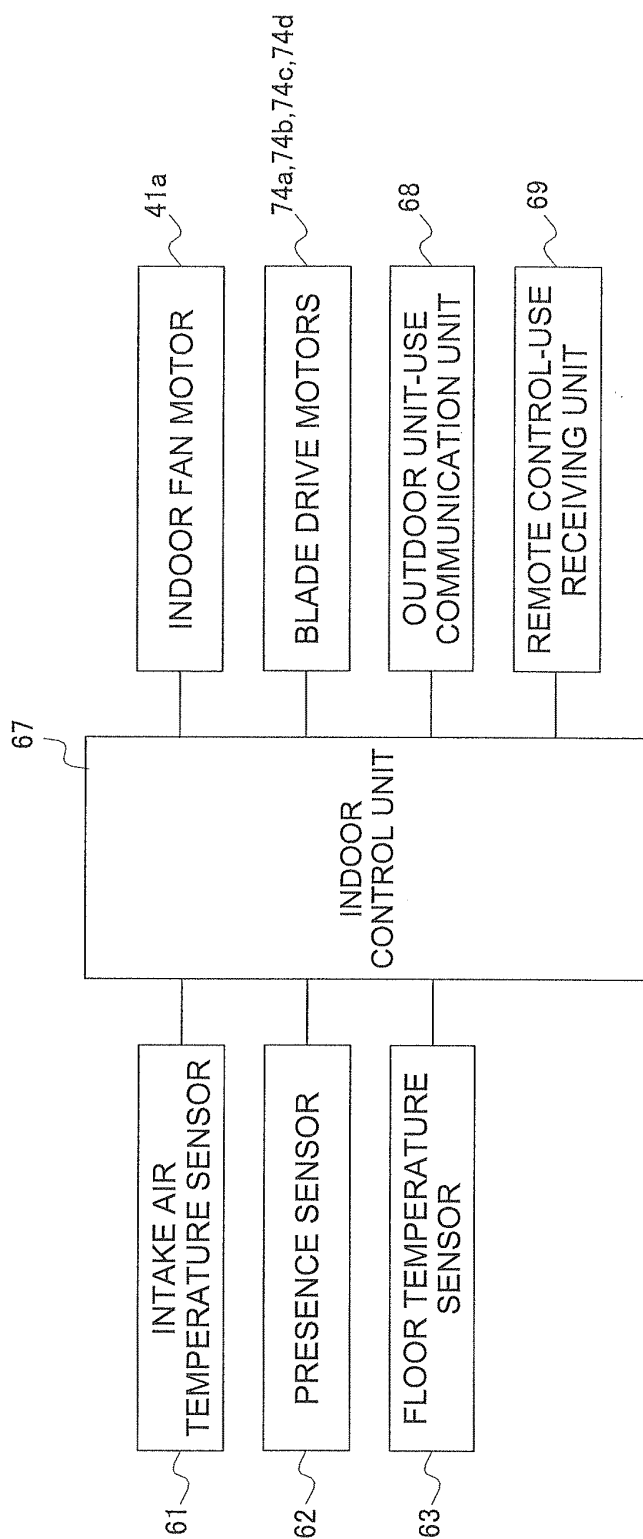


FIG. 9

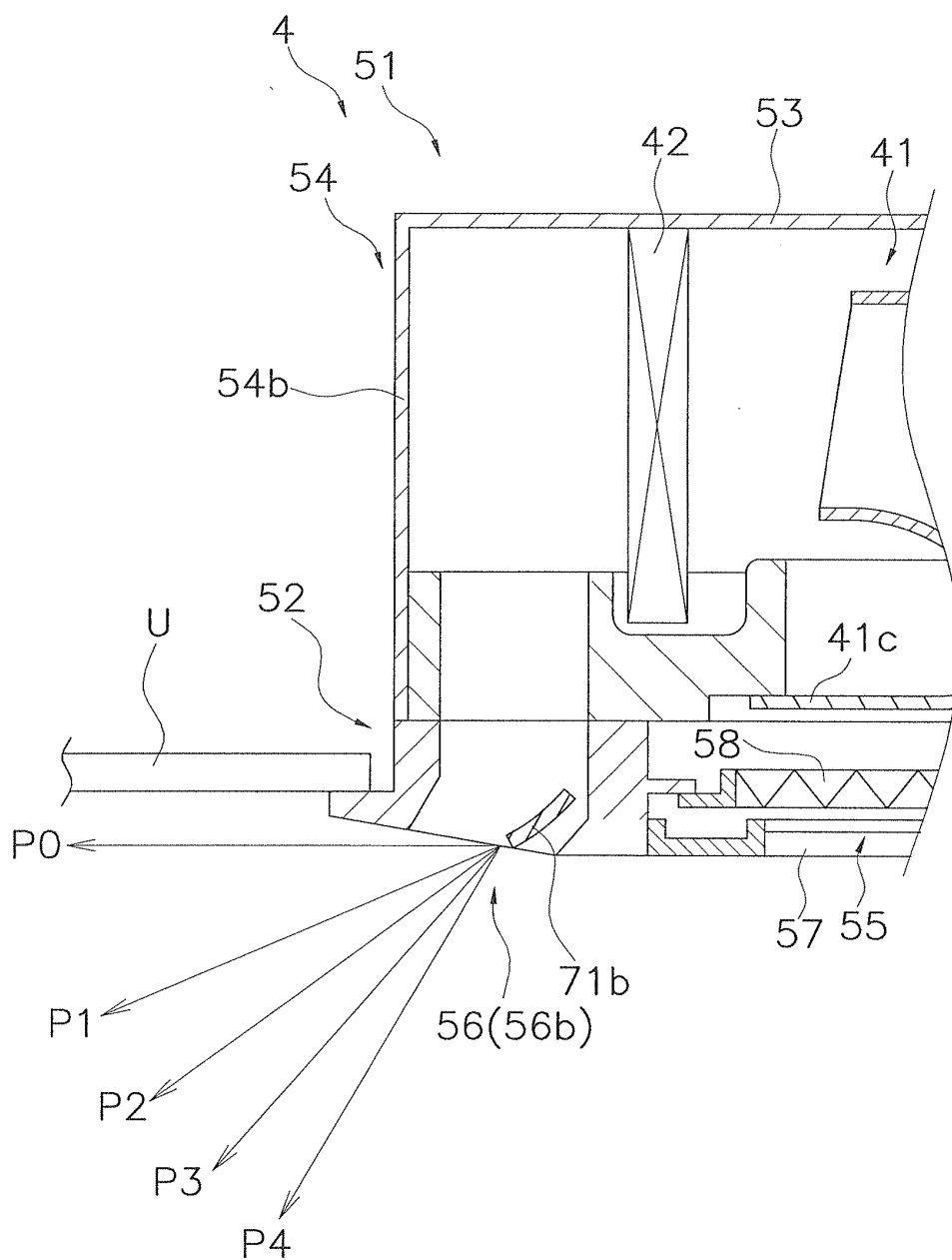


FIG. 10

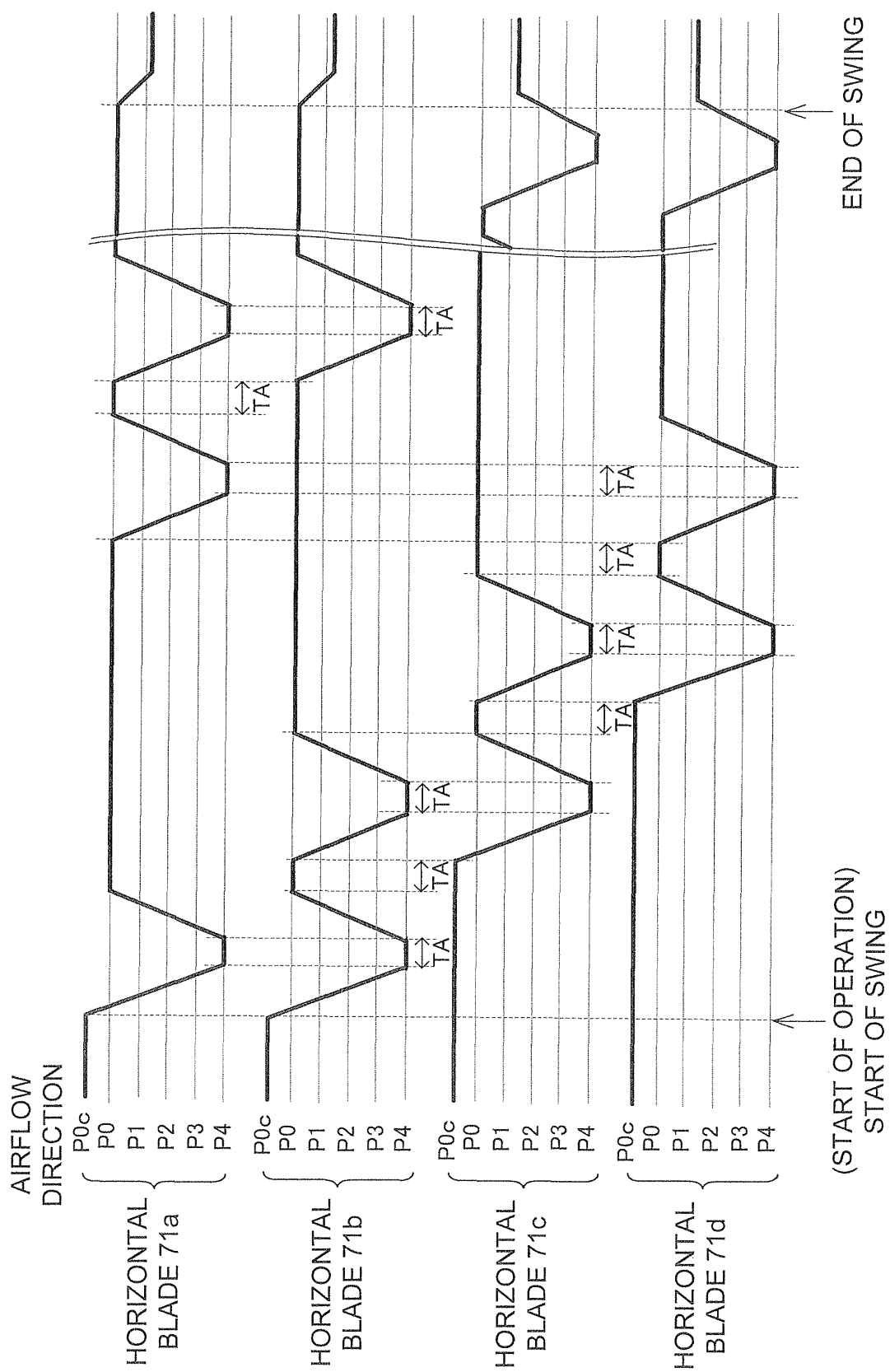


FIG. 11

<COMBINATION OF FIRST HORIZONTAL BLADES>

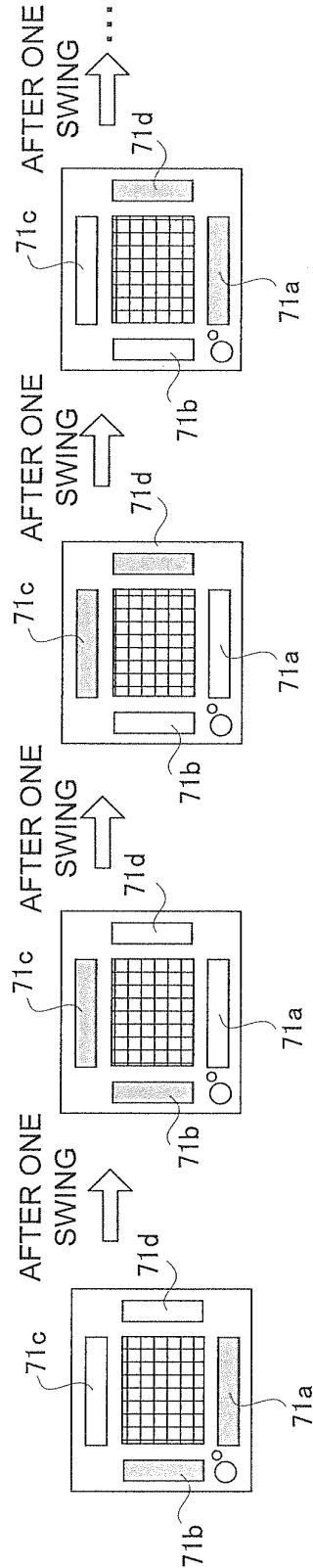


FIG. 12

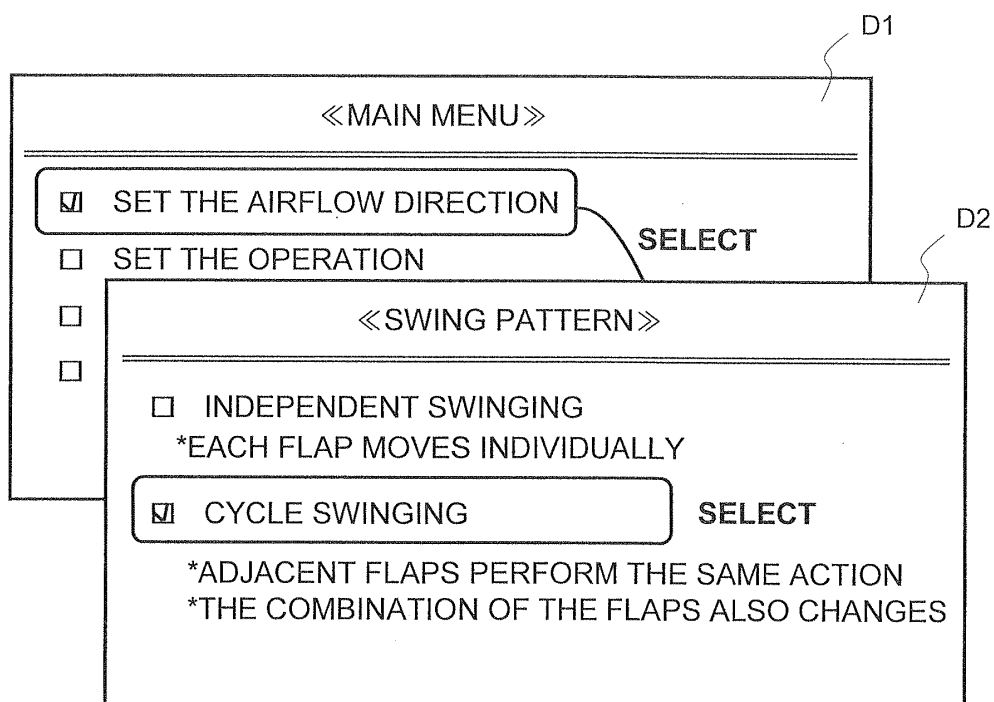


FIG. 13

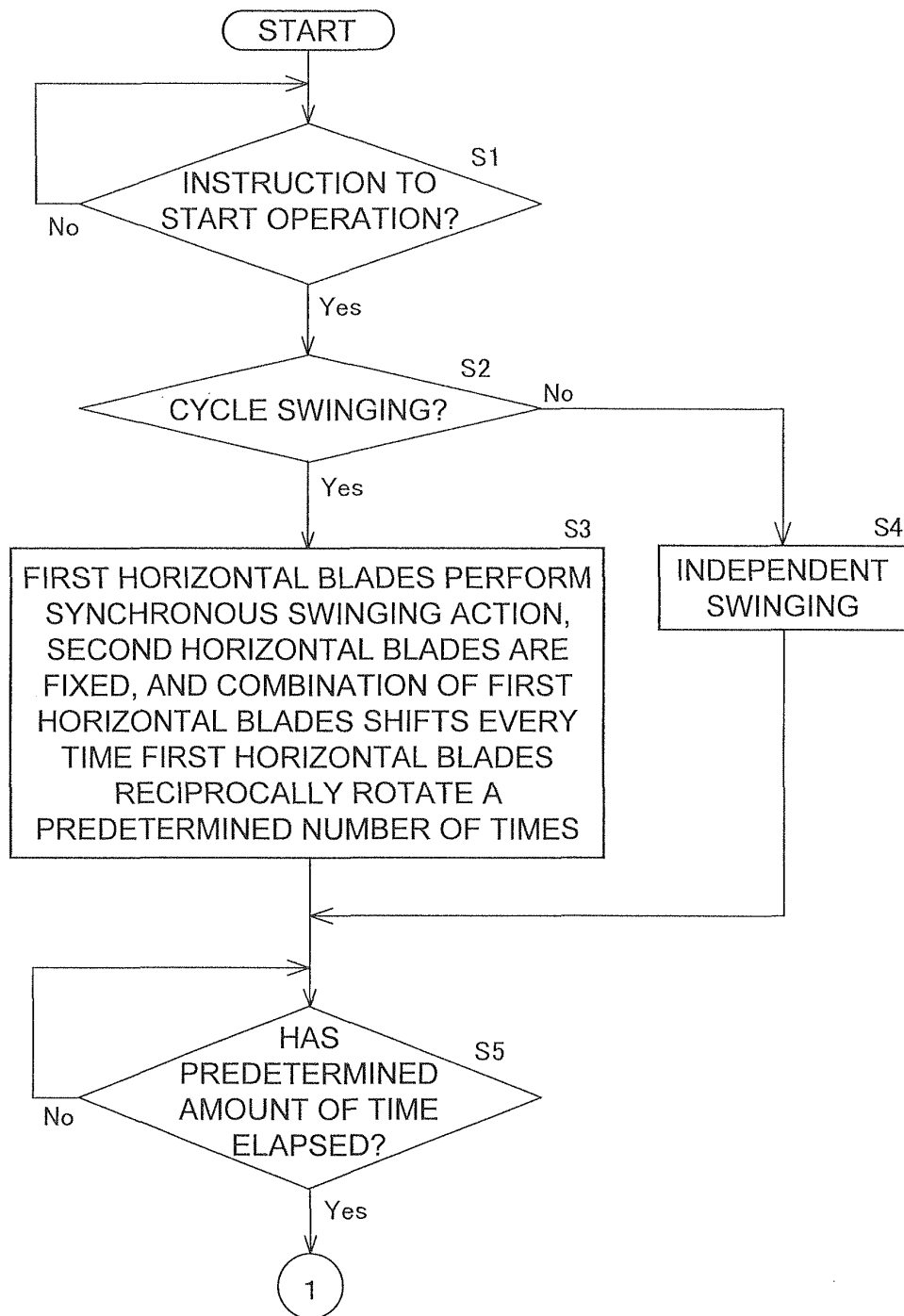


FIG. 14

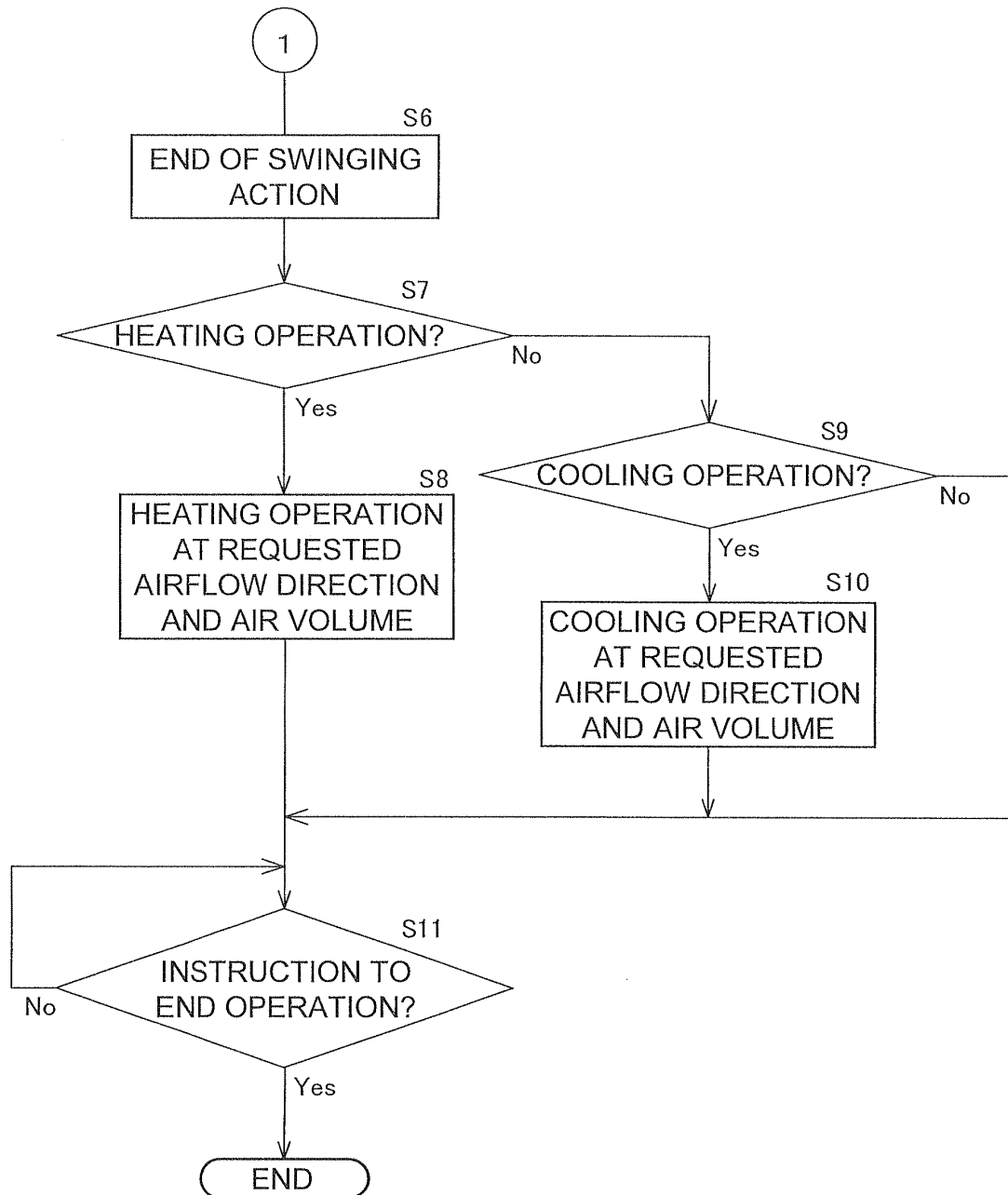


FIG. 15

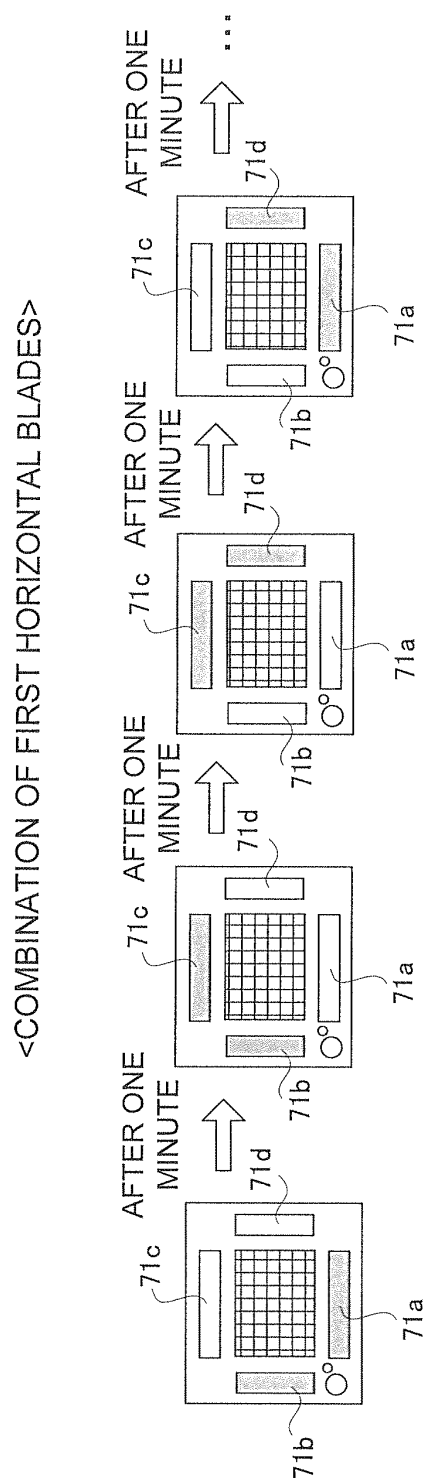


FIG. 16

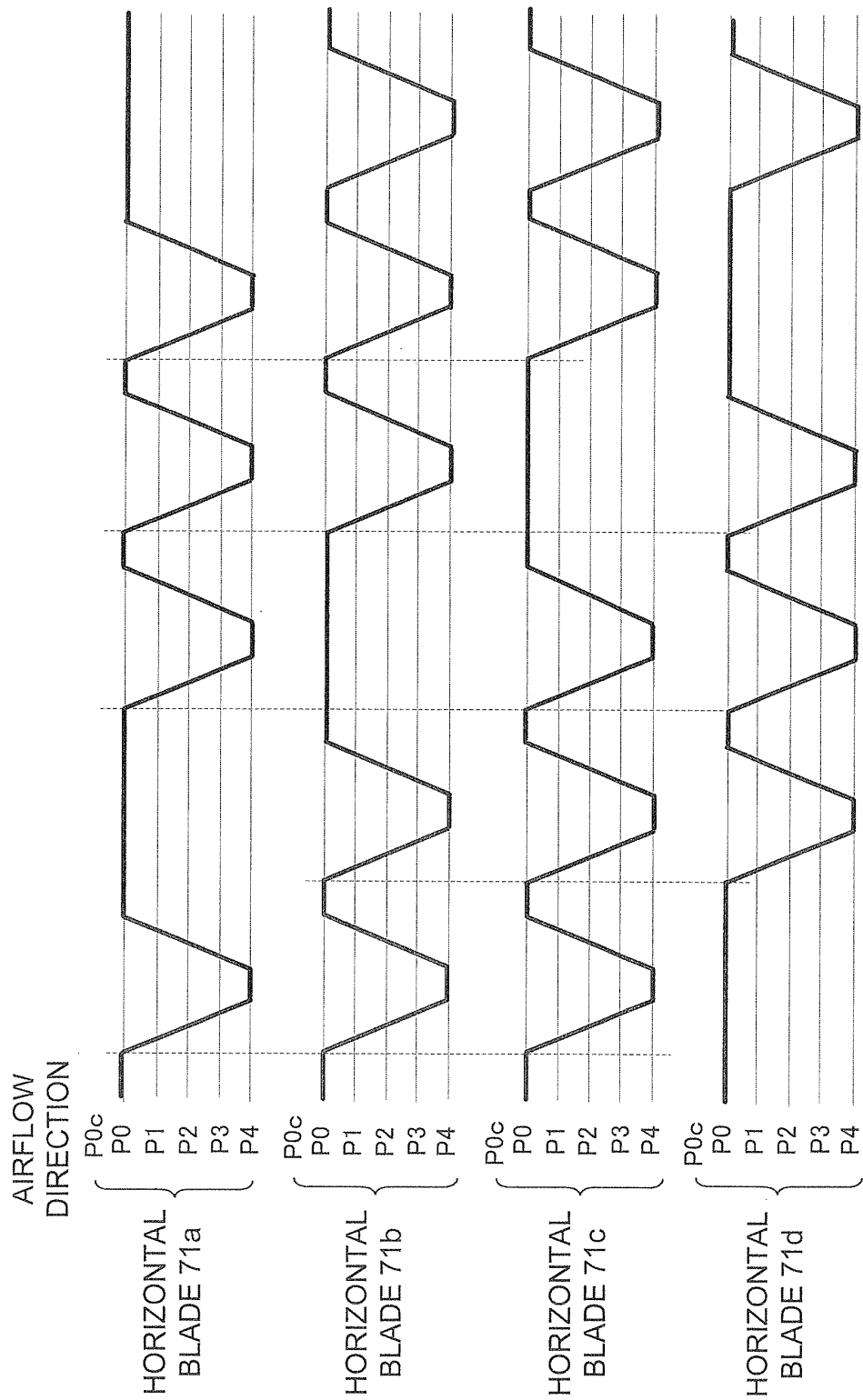


FIG. 17

<COMBINATION OF FIRST HORIZONTAL BLADES>

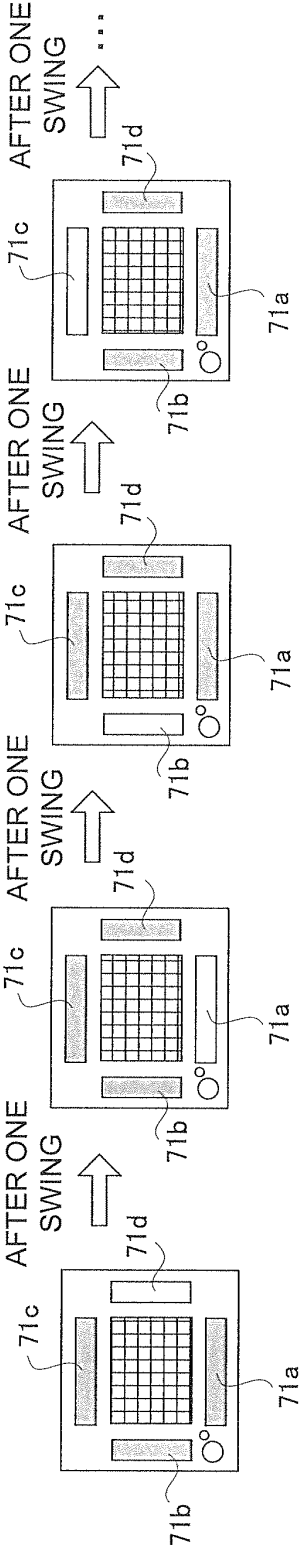


FIG. 18

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/051505

## A. CLASSIFICATION OF SUBJECT MATTER

F24F11/02 (2006.01) i, F24F13/20 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24F11/02, F24F13/20

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

|                           |           |                            |           |
|---------------------------|-----------|----------------------------|-----------|
| Jitsuyo Shinan Koho       | 1922-1996 | Jitsuyo Shinan Toroku Koho | 1996-2011 |
| Kokai Jitsuyo Shinan Koho | 1971-2011 | Toroku Jitsuyo Shinan Koho | 1994-2011 |

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category*   | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                 | Relevant to claim No.     |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| X<br>Y<br>A | JP 2007-24453 A (Mitsubishi Electric Corp.),<br>01 February 2007 (01.02.2007),<br>paragraphs [0007] to [0018]; fig. 1, 3, 7 to 9<br>(Family: none)                                 | 1-3, 5<br>4, 6-8, 10<br>9 |
| Y<br>A      | JP 6-193940 A (Toshiba Corp.),<br>15 July 1994 (15.07.1994),<br>paragraphs [0022] to [0024], [0036], [0037];<br>fig. 3<br>(Family: none)                                           | 4<br>5-10                 |
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☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                                                                                                                                      |                       |
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| Category*                                             | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                   | Relevant to claim No. |
| Y<br>A                                                | Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 54093/1988 (Laid-open No. 158040/1989) (Daikin Industries, Ltd.), 31 October 1989 (31.10.1989), page 1, line 5 to page 2, line 8; fig. 5 (Family: none) | 6<br>7-10             |
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**REFERENCES CITED IN THE DESCRIPTION**

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